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ICMST 2018

INDONESIA NAVAL TECHNOLOGY COLLEGE

INTERNATIONAL CONFERENCE ON MARITIME SCIENCE AND TECHNOLOGY

"DEFENSE SCIENCE AND TECHNOLOGY"

FIELD :

1. Operation Research.
2. Logistics Management.
3. Policy and Strategy.

SURABAYA JULY 26th , 2018

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POSTGRADUATE INTERNATIONAL CONFERENCE

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Postgraduate International Conference

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PREFACE

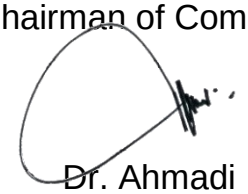
On behalf of the Organising Committee, it is my pleasure to welcome you to the Postgraduate International Conference on Operation Research. It is hosted by Indonesia Naval Technology College (STTAL) and is being supported by Indonesia Navy.

The main theme of International Conference include Operation Reserach, Logistics Management, Policy and Strategy, Naval Technology. The goal of the conference is to provide a platform to academics, scholars, researchers and practitioners to present and disseminate the latest innovative ideas, research results, and findings on various aspects of Maritime Science.

On behalf of the organising committee, I wish to thank all authors for their papers and contributions to this conference. I would like to thank the keynote speakers for sharing their wealth of experiences and knowledge in Maritime Science.

Finally I would like to thank all speakers, participants and attendees. I look forward to days of stimulating presentations, debates, friendly interactions and thoughtful discussions that will forward Maritime Science.

Surabaya July 26th, 2018
Chairman of Commite,



Dr. Ahmadi
Captain Navy

INTERNATIONAL CONFERENCE
STTAL POSTGRADUATE

Defense Science & Technology

SPEAKERS :

1. **LTC CASON GREEN** - *(US ARMY)*
2. **MAJOR MICHAEL COERPER** - *(US ARMY- CALIFORNIA STATE UNIVERSITY)*
3. **MR. KUTJIMA THOMAI** - *(US ARMY CADETS COMMAND)*

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On the Fields of :

1. **Operation Research**
2. **Logistics Management**
3. **Policy and Strategy**

The Paper should be submitted before : July 15, 2018
Email : pascasarjana_sttal@sttal.ac.id
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Time And Place :
Thursday, July 26th, 2018
STTAL Postgraduate Building
Morokrembangan Surabaya Indonesia

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INTERNATIONAL CONFERENCE
ON MARITIME SCIENCE
AND TECHNOLOGY – ICMST
STTAL - 2018

SCEDHULE

International Conference on Maritime Science and Technology
ICMST 2018

Held in STTAL Surabaya, Bumimoro-Morokrembangan, : On Thursday, July 26th , 2018

WEBSITE : http://www.seminarpasca-sttal.ac.id/

08.30 - 09.00 Registration

09.00 - 09.05 Opening & National Anthem : Indonesia Raya

09.05 - 09.10 Wellcome Speech by STTAL Commander

09.10 - 09.30 Keynote Speaker : ROTC Team

09.30 - 09.45 Coffee Break

09.45 - 12.00 **International Conference** :

Moderator Capt. Navy Dr. Ahmadi

***Speaker I : LTC Cason Green (US Army),**

Topic : Defense And Cyber Attack

***Speaker II : Major Michael Coerper (Assistant Professor of Military Science California State University)**

Topic : Defense and Leaderships Character

***Speaker III : Mr. Kujtima Thomai (US Army Cadets Command)**

Topic : Nations Culture

12.00 - 13.00 Break

13.00 - 16.00 **Comission Conference** :

Room 1. Operation Research

Room 2. Logistic Management

Room 3. Policy And Strategy

16.00 – 16.15 Coffee Break & Closing

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FIELD I

OPERATION RESEARCH

THE COUNTRY DEFENSE POLICY IN EACH VILLAGES THROUGH THE FUND'S FISCAL DECENTRALIZATION

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ABSTRACT

The purpose of the writing of this article is to give an idea of strategic and defence policy through decentralization funds given to each village. As we know that at this time every village to obtain what is known as the village fund. Through the Fund expexted the village could manage progress village in Fund expected the village could manage progress village through infrastructure development as well as the establishment of Village-owned enterprises. Namau leader areas have never thought of that not only people's welfare can be created through the production but can also be created through security, safe from terrorist threat from within the country. Through the village Fund could do, socialization desimunation about a threat to State security.

KEYWORDS : Integrasion, marketing, Funds, decentralilalizations

1. INTRODUCTION

Organizing the defense of the country intended to keep and protect the country's sovereignty, territorial integrity and the safety of our whole nation. Defense the State of the Indonesia organized into a system of Defense universe, not aggressive and not expansionary in order to protect national interests. The resolution of problems related to the defense of the country and influenced, performed with emphasis on diplomacy which is reinforced by modern military force

Addressing any dynamics, Indonesia is actively encouraging global partnerships, promote the spirit of togetherness, and realize the dynamic balance that is the condition characterized by the absence of the power of the dominant countries in a region. It is done on the basis of beliefs as opportunities for increased cooperation and partnership in building defense force for the progress of a country. Indonesia upholding non active politics by holding on to the principle of peace-loving but rather the love of freedom, as well as neighboring countries holds that was a companion who shared a commitment to maintain the stability of the security in area. Build in common view is indispensable in order to minimize the problems encountered in international relations, either bilateral or multilateral

Browse through a conflict that exists in the State could arise from abroad or within the country, the threat from abroad is easier because the coming conflict stems from a probe into the State and the country, the real fact secaara aka easier known and easy to be realized.

The emergence of the concepts of modern country through cooperation through various activities and education causes conflicts arising from outside its occurrence indicators will be easily known, but not so with covert conflict in these countries. Indonesia which consists of various islands that are scattered in different areas will be very difficult to keep konfili that exist in each region. Besides that coupled with the least amount of security apparatus in the country.

Browse an existing conflict in international relations is a very long review with an infinite limit. After the birth of the modern concept of the nation-State, the cause of conflicts began to change previously dominated by religious differences. The nation-State in the world began to change the direction of the trend to determine the nature of his own people as a nation.

Then timbulah the new interests of nation States such as the interests of a political, ideological, social and cultural security defense. Construction of the defense of the country held by

keeping the Defense-oriented alignment of the country namely Indonesia actively encourage global partnerships, promote the spirit of togetherness, and realize the dynamic balance

In the terms of realizing the country's defense policy, Governments need to build up a defense force, military defense and defense nonmiliter in order to face the threats, military threats, either nonmiliter, or hybrid. The country's defense in the face of military threat, putting Indonesia national armed forces (TNI) as the main component (Komput) reinforced by a reserve Component (Komcad) and Supporting Components (Komduk). In the face of threats nonmiliter, placing the Ministry/Agency (K/L) on the outside of the field of Defense as the main elements of the Other elements of the nation's Power-assisted. In the face of the threat of hybrids, Indonesia applies the pattern of military defense, backed with the power of the nirmiliter defense diformasikan into Supporting Components according the nature of and the escalation that has occurred

To do the Defense States require no small funds, along this delivered some prosen comparison with the budget of GDP in some countries as follows :

TABLE 1 The percentage allocation of funds defense against GDP

Year	Indonesia	Malaysia	Thailand	Brunei	filipina	India
1997	1,3	2,5	2,1	7,3	1,2	2,2
1998	1,1	1,6	2,1	9,4	1,2	2.2
1999	0,9	2,1	1,8	7,3	1,1	2,3
2000	1,1	1,7	1,5	6,5	1,1	2.3
2001	1,1	2,2	1,4	7,6	1	2,3
2002	1,2	2,4	1.4	7	1	2,3

Stockholm International Peace Research Institute (SIPRI)

When noted on Table 1, then it appears that the percentage of funds used for the defence of the still relatively small when compared with other countries. It showed.

TABLE 2 Comparison of the amount of a percentage of the community who work in the institutions of Defense

Strengthen	Indonesia	Thailand	Malaysia	Singapura	australia	filipina
Total Personel						
Army	230,000	190,000	80,000	50,000	25,150	66,000
Navy	28,000	5,000	12,000	4,500	12,570	16,500
Air Force	27,000	48,000	8,000	6,000	13,200	16,000
Marine Forces	12,000	18,000	-	-	-	7500
Airplane	90	230	95	126	156	50
Helicopter	17	11	6	28	41	67
Warship	158	168	165	71	62	105
Heavy Tank	-	283	-	90	71	-
Light Tank	1,197	1,728	1,236	2,014	546	604

(Cordesman, 2003)

Since January 1, 2001 Indonesia implements the autonomous region from the side of the authorities and decentralized fiscal finances, with this system then expected the village could do the construction of respective regions by using the village Fund and develops local potential that exists in each region respectively. The policy is based on the Act Number 32 year 2004 revised into law No. 23

of 2014 on local governance as well as Act Number 33 year 2004 of Financial Equalization and regional Centre.

Regional autonomy law number 32 of 2004 concerning regional governments article 1 verse 12 mentions the village is the unity of Community law which has territorial boundaries are authorized to arrange and take care of the interests of the local community which is recognized and respected in the system of the Government of Republic Indonesia, this means the construction of the village have been regulated in this law

As it known in national budget funds transferred to the area include funding Equalization and special autonomy and funding adjustments. Equalization Fund consists of funds for the results of the funds division (DBH), General Allocation funds (DAU), and special allocation Fund (DAK). Funds for General allocation of Funds and Results of the fund division in the form of a block grant, with no rules of its use. While specific rules are NOT firmly in the utilization, while DAU and DAK as a tool of equity between regions. While DBH to equalization and the area has been conducted in the era of the new order as a correction over the exploitation of the natural resources (SDA) which was done by the Center of Government.

However, the utilization of these funds still unclear allocation, miskipun there is already legislation which already exists but is still going against the interests of Fund usage terbut. For that it would be nice if those funds are not just for the sake of people's empowerment, infrastructure for the enhancement of the economic family is small but also used a pencegahaan against the dangers people's security stability ganguan originating from within the country for example against the threat of radical groups, the ganguan the teoraris.

2. MATERIALS AND METHODOLOGY

2.1. Material.

The House of realist looking at politics as a struggle to gain power (camp of power) (R. Soeprapto, 1997). View of realism based on the assumption that the State is the most important and main actors in international relations. This is because the country has sovereignty and the power to determine policy on political, economic, and diplomatic relations with other countries. Realism recognizes actors other than the State, such as IGO, NGO, multinational corporations, and terrorist groups, but with the level of interest that's not too dominating.

Lovell argues that there are several factors that can explain the foreign policy strategy for a country that comprises sejmah other variables in analyzing foreign policy, i.e. (lovell. 1970):

(1) The environment (environment), (2) Situations (situation), (3) Capability (capability), (4)Personality (personality), (5) Organization (organization) Lovell also argued that the foreign policy strategy was applied by a country is closely related to two variables, namely the estimated decision makers over the strategy of implementation by other countries and estimates their top capabilities. Initially the use of the terminology of the draft strategy with regard to the operation of a war, but this time it has been used in wider aspect. For example in the fields of politics and economics.

J.e. Nolan defined the cooperative security as a concept is formed to the situation after the cold war, where traditional security strategy based on deterrence and military confrontation is no longer relevant. Cooperative security is carried out with the objective of preventing the occurrence of wars. This concept replaces the preparatory action to counter the threat with precautions against such a threat. This concept emphasizes on the military aspect of cooperative security especially the prevention of conflicts and the supervision of weaponry. (Nolan, 1994).

2.2. The Development Of The Strategic Environment

The Asia-Pacific region is a strategic area, both in the aspect of economic, political, or military. In this region there are countries with a population of over one billion (India and China), the modern military-tech, human resources great military, an influential against global economics and politics. In the perspective of traditional security, the Asia-Pacific region have the opportunity and the challenge which is very complex, as well as risk factors that can cause conflict between countries. The dispute in the South China Sea, the East China Sea, Korea Peninsula, and tension in some areas of the border between Nations is addressed need to wisely. While in the perspective of non-traditional security, the area has a long history of smuggling narcotics, smuggling of human beings, smuggling of weapons, piracy at sea, the theft of natural resources, as well as separatism. In addition, in the last three decades the issue of terrorism is increasingly strengthened,

caused by various factors, among others, economic problems and radical leftism. The development of the Asia-Pacific.

2.3. The development of science and technology

The progress of science and technology affect the shape and pattern of the war in the future. Although the patterns and forms of asymmetric war still going on in some areas, but a conventional war weapons technology is still growing rapidly. The war in the future are increasingly considering the reduction of the impact damage and casualties among civilians, by applying the technology of high accuracy weapons and the application of the technology of robots on a variety of weapons systems in order to reduce the use of and the deployment of personnel or equipment.

The development of information and communication technologies also create network-based warfare that relies on information superiority, as well as being able to implement digital or diranah war room of siber. The impact can make the security situation of the world, including the alarming crime siber which knew no bounds, including the utilization of biotechnology, genetic engineering and nano-technology which is difficult to detect. (Alisjahbana, 2014),

Besides engineering technology is also developing in the world of aviation, the manufacture of nuclear weapons or spacecraft rocket launchers, missile or spacecraft to fly without a crew and satellite technology are also utilized for the interests of the defense of the country. From the aspect of Defense, space siber has become the fifth domain that can serve as a battlefield of the war, in addition to the battlefield by land, sea, air and space. The use of the systems, devices, and internet-based platforms tend to be increasingly pervasive potentially be insecurity.

2.4. The Development Environment.

a. **Ideology**

Pancasila State ideology as the basis and it is fundamental in the life of nation and State order. As the Foundation of the country, Pancasila is the source of all the sources of applicable law in the State Union of Republic of Indonesia. As the State ideology of Pancasila is a philosophical view of life and the nation of Indonesia which consists of moral values, ethics and lofty ideals and goals will be achieved a nation of Indonesia. Implementing Pancasila in the life of nation and State in the form of values of harmony, balance and harmony, unity and oneness, family and togetherness, that always being philosophical foundation for citizens in thinking, behave and act in the framework of the Organization of the defense of the country. Development of Variety values and values of justice contained in the Pancasila was intended to prevent the emergence of other regional ego and reinforce nationalism. The application of the values of Pancasila will dampen the onset of radical peace activities in community environment (Genewati , 2002)

b. **Politics**

National political conditions are experiencing setup significantly on infrastructure aspects of politics, the political superstructure, and political culture. Issues related to political commitment should be exercised proportionately on all aspects of the temporary Government is constantly working to build political communications democratically appropriate mechanisms working relationship.

The next political dynamics that developed at this time continue to undergo improvements towards a democratic order, so the national political system can run well. Democratic system which is expected to run well, still need counting results related improvements in the general election, political will, communication with the Central Government are not optimal, the head the more interests area than national interests, blossoming and territorial border disputes, which will potentially cause a conflict.

c. **Economy**

The trend of global economic uncertainty characterized the policy requires a fast, precise and measurable in order to respond to the opportunities and challenges including the establishment of the ASEAN Economic Community (MEA). Indonesia's readiness in the face of five field includes free flow of goods, services, capital, skilled, and investment is anticipated. The Government has been adjusting its target economic growth in order to improve the performance of Indonesia's economy. These conditions will affect the business climate especially in the

sector of small and Medium Businesses (SMEs) which absorbs labor.

d. **Socio-Cultural**

Globalization is laden with the spirit of the changes impact to change values that affect your mindset, attitude and pattern patterns follow the next generation the nation and nationality issues that significantly affect order of the culture of the nation. The development of science and technology bring certain values that are directly or indirectly affecting socio-cultural values of the nation which already exists.

Understanding the nation's next generation of related values that are contained in the Pancasila, the 1945 constitution of the NRI, SO sesanti, and Bhinneka Tunggal Ika, increasingly eroded by new new values that are not in accordance with the nation's identity. Degradation of sublime values nation Indonesia have influenced the decline of the attitude of nationalism, patriotism and love of homeland for citizens in affirming the unity and the unity of the nation.

e. **Homeland Security**

Separatism is still a security issue that threatens the country's sovereignty, territorial integrity and safety, SO the whole nation. Separatism is done through a political movement and armed with exploiting the weakness of the Organization of the functions of Government. The handling of security in the country as a result of horizontal conflicts triggered by the cultural diversity of the community, ethnic group, religion, ethnicity, and class, as well as social conditions still coloring conflicts that occur in certain areas.(Arismunandar, 2000)

2.5. The Functions Of The Defense Of The Country

The defense of the country serve to embody and defend the entire region as a single entity defense SO capable of protecting State sovereignty, territorial integrity, as well as the safety of all Nations from every threat, whether that comes from outside as well as those arising in the country. The effort of realizing and maintaining the entire region as a single entity defense SO held in the function penangkalan, penindakan, and recovery.

The function penangkalan is the embodiment of the country's defence effort of the whole national strength which has a psychological effect to prevent and nullify any threat, whether from outside or incurred within the country. Penangkalan implemented physical and nonphysical, with make the effort of building and fostering the ability of integrated functions of State defence accord. (Stephen , 1985)

The function the action in the face of the military threat is implemented by exerting the power of the military in accordance with the defense mechanisms of the host defense system. In the face of military threats from outside, the Organization of the penindakan functions adapted to the form of the threat to determine the type of action taken as well as the country's defense force is used. Military threat in the form of aggression faced by the war, and for Indonesia's holding of the war carried out in total in the form of war universe.

The function of action the face of threats nonmiliter, implemented by exerting the power of the defence nirmiliter in accordance with the mechanism of the defense system of the universe. The Action against the threat of nonmiliter is done with a functional approach by family outside of the field of defense based on the type and nature of the threat. The function penindakan is manifested in the form of rescue measures by exerting all its resources and national infrastructure..

The function of action the face of the threat of military force, putting hybrid and integrated nirmiliter according the nature of the threats faced by observing the ability of professionally and proportionally. The restore function is a State Defense business alignment is carried out by integrated defense force military and nirmiliter to restore the condition of the country's security has been compromised due to the war, insurgency or attack the separatist conflict, vertical or horizontal conflicts, riots, terrorist attack, natural disaster or due to the threat of other nonmiliter (Midhio,(2016).

2.6. The Purpose Of Village Development

Program development activities, both physical development as well as a non physical is for the welfare of the whole community. The nature of the need is very basic, until other needs later on can be perceived by the public at large. For that harmony and alignment in the carrying out of development should be realized since the beginning by all parties. The preparation of the development plan is primarily a result of planning from the bottom up and from top

to bottom through the stages of drafting across levels of Government, ranging from village, Sub district, Regency/Municipality, province, regional until national and vice versa (Prabawa, 2015

2.7. Village Development Funds

According to the book the execution on Instruction of Village Development Fund (1986:4) in development funds, explain that the village is some money/funding provided by the Government to the villages directly, in order to carry out or the development process in the village to make it in the form of physical projects that benefit the public welfare improvement in the environment of the village and village, on the state budget burden in order to equitable the development and outcomes.

2.8. The use and supervision of village development funds

Village development funds given by Governments and third parties that should be used to build projects in need by the community of the village which is reflected in each program section Village Representative Institutions (BPD) and other activities that support the growth and improvement of people's income and activities fostering the welfare of society.

In order to support the successful implementation of the management of the village development funds formed a Team Builder as well as supervision and control on many levels of Government with the duties and responsibilities of each. At the level of the village village chief as implementing activities responsible for the successful implementation of village development funds. While the guidance and oversight of the operations funded by the village representative body (BPD) (Prabawa, 2015).

2.9. The Village Fund Allocation

The village fund allocation or abbreviated with ADD are the funds allocated by the County Government for the village were sourced from the part of the Fund's financial center and regional equalization received by District, according to Halim (2004), the key features of good financial management, namely:

a. Simple

A simple system that is more easily understood and studied by those in charge of running it, and the more likely it is followed without wrong, can deliver results more quickly, and easily inspected from inside and from outside. Practical purposes to be achieved in drawing up a financial management one is creating simple procedures in line with the objectives or results achieved.

b. Complete

Financial management should be used to achieve all the goals, and should include any financial activity in terms of area, so activities should uphold the validity of budget compiling receipts and expenses. Keep the area can always pay off their financial obligations, running the oversight from within, trying to achieve results and effectiveness in activities and extended to keep there receipts and expenditure that does not enter the plans or not included in the budget.

c. Useful

In this case, the power to have two facets:

1) Power to attached to financial management concerned should be raised, which means that high result set must be achieved at a cost of low , from a number of staff and funds are needed or results achieved should be the maximum.
2) financial management concerned should be designed in such a way so as to enlarge the power to become a tool that local governments to run activities it and not slow him down.

d. Easily adjustable

Financial management never made so stiff so it is difficult to apply it or adjust at different circumstance

2.10. Financial Reporting

The financial report is a structured report regarding the financial position and the transactions carried out by an entity reporting. Government accounting standards (SAP) via PP. No. 24 in 2005, which is the first SAP owned by the Government of Indonesia. The Position Of Government Accounting Standards (SAP). The reporting entity is the Government unit that consists of one or more units of Government that are a mandatory statutory provisions deliver accountability in the form of

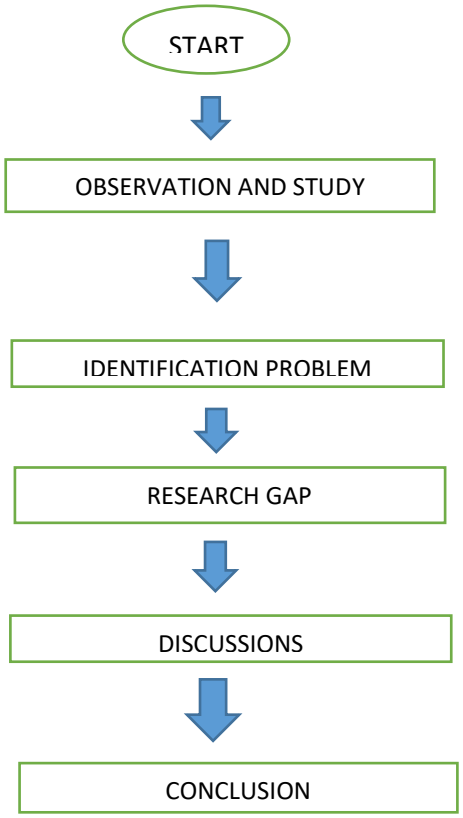
financial statements, with regard to the reporting entity consist of:

a. Central Government

b. local governance

c. The units of Central Government environmental organization/region or any other organization, if the Organization's units according to the legislation in question is obligated to present the financial report

2.11. Methodology



3. RESULT AND DISCUSSION

Results and Discussion in this study the author uses realist paradigm that makes the State as the primary actor in international relations that is rational, monolith, and take into account the cost and benefit of each of its actions. Level and the unit of analysis used in this study is the nation-State (the nation-state done by the State and how the State decided to take policies based on national interests (national interest). The level of analysis is more focused on what is

Theories relevant to the discussion of the problems in this research is the theory of theory of security strategies. The design strategy is not based on moral considerations, beliefs or things emotionally, but based on rationality decision makers (Rizal,2003) Based on the strategy policy makers trying to achieve the national interests and prevent barriers over the interests of security is understood as the ability to defend yourself (survival) in real threat (existential threat). (Mochtar,1989)

For the State and the continuity of his life regarding the issue of how projecting sovereignty and how to develop and maintain their identity. Required policy alignment between all the instruments of power nasional to secure national interests. In the context of dispute facing the South China Sea, instrument and instrument of defence diplomacy Indonesia must traverse a theoretically integrated one step. The existence of the defence instruments among which is to support diplomacy, including if it deems diplomacy failed. Indonesia's efforts in the field of diplomacy between focuses on handling the issue of the South China Sea dispute in a frame

The construction of the country's defence posture is directed to improve the defense of the country. Potential threats facing Indonesia are increasingly complex and diverse, so it requires a strong State defense capability. The country's defence posture is constantly adapted and directed in order to answer the various possibilities of challenge, as well as a real threat and not real. The construction of the State's defense held for realize a military defense and defense nirmiliter towards a regional maritime power respected in the Asia Pacific region with active defensive principle in order to ensure national interests. The country's defence effort organized through the development of the country's defence posture on an ongoing basis to realize the power, the ability and the title.

Construction of posture military defense is directed at fulfilling the Principal Strength Minimum (Minimum Essential Force/MEF) major components and setting up other defense components, which prioritized the development of the maritime defense force by leveraging technology satellite systems and drones. While the construction of the defensive posture nirmiliter prioritized on: Increasing the role of family corresponding tasks and their respective functions in the face of the threat of non military; Resource management capabilities and national infrastructure; as well as in the construction of the ability of the defence nirmiliter in support of the

interests of the defense of the countryn (*Muladi, 2003)*

In anticipation of the development of the security situation of the maritime region of Indonesia at this time, particularly in the area of Natuna Islands and territories of Merauke, the increase in the country's defense force development in the two areas are part of the the construction of the country's defense posture overall policy Plan National long-term development (Akmal & Pazli, 2016)

The construction of the national character as part of a mental revolution, organized through the construction of the country's defense capability and awareness for all citizens of Indonesia to prepare human resources for the defence of the country, as well as the strengthening of identity nation based on personality and cultural based on Pancasila and UUD 1945 NRI. National character development done on integrated in all family, local government, and the nation's other components. Coaching programs Awareness Bela Negara (PKBN) realized to form cadres bela negara which has awareness and ability based on the values of bela negara

Empowerment of State Defense geared to maintaining and developing the whole country's defense power and potential in an integrated and targeted by involving the entire citizens, and make use of the whole

4. CONCLUSION

Based on the discussion that is the strategy and defense policy not only performed at the central level but also can be done at the local level. The emergence of the law regarding the village Fund is an opportunity as well as a great opportunity to involve pertahanlkan at village level, especially with the existence of a village Fund then at least the village could do the socialization and anticipation about the existence of the threat terrorists from within the country. Through the village Fund at least the village could make budget on defense through the use of the village Fund.

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APPLYING INTERPRETIVE STRUCTURAL MODELING FOR DESIGN OF MITIGATION MODEL BASED ON WORK ACCIDENT RISK

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ABSTRACT

Work accidents that happens in construction industry is more often comparing to others industries, it is 32%. So that construction work has risk of accident because its area is outdoor. The causes of accident comes from the worker or manpower itself. Based on this, it is important to mitigate the risk that can cause the accident. The method used in this research is Interpretive Structural Modeling (ISM). Risk mitigation that has high driver power is applying the standard of OSH for the High Rise Building worker, learning MSDS (Material Safety Data Sheet). Workers must have SKT ((Technical Skills Certificate) or TSC (Technical Skill Certificate), Upgrading OSH Management. While mitigation of giving space in setting and removing the scaffolding. All the setting of scaffolding must be checked by the certificated officer. Working method must be suited with the condition of worker and the socialization of the dangerous of spilled paint, create and obey the lifting plan, isolate the cable connection based on the PUIL 2000. Those who are in quadrant II has low level of Driver Power so that these variables have no power to influence other variables in the system. It is hoped that work accident can be decreased and it can minimize the risk (zero accident) for the construction workers.

KEYWORDS : Mitigation, Risk, Work Accident.

1. INTRODUCTION

Construction industry has significant different characteristic comparing with other industries. This difference is in the condition and work system, in construction project almost all of jobs done by manpower with many specializations that create different problems in each work (Andi, et.al 2005). Besides, this kind of work has a high risk of work accident (Handayani, 2017).

According to Sepang (2013), construction work is such a complexity that involved construction materials, construction equipment, construction method, construction cost, and manpower that may cause accidents. In line with Mohamed (2002), he states that construction industry is well known as the industry that has a low level of work safety comparing with other industries. It is same with what has been written in Kompas (2016) that the work accident which happens in construction industry is more often than other industries; it is 32%, manufacture industry 31,6%, transportation industry 9,2%, forestry industry 3,8%, mining industry 2,6%, and other industries 20,7%. It can be concluded that construction work has a high risk in work accident because this kind of working located in outdoor area (Maryani, 2012)

The risk of work accident in construction work comes from its manpower itself (Handayani, 2017) and (Andi et.al, 2015), it is different with Reason

(19995) in Andi et.,al (2015) states that work accident is the result of organization and management, while Sutarto (2008) states there are 3 factors that influence the work safety in construction site, they are management, workplace condition, and the workers' awareness. The mitigation of work accident can prevent the accident so that there is a correlation between the mitigation to overcome the risk. In order to resolve the risk in work accident, it needs to understand the correlation between one mitigation of risk and others. So that in modeling the correlation between mitigation model of work accident using interpretive structural modeling (ISM), because this method is widely used in modeling the problem of systems (Sianipar, 2012). The objective of this research is modeling the mitigation plan of work accident in order to reduce accident in construction project.

2. METHODOLOGY

This research applies *Interpretive Structural Modeling* (ISM) in overcoming OSH risk that happens in construction project, and the steps are:

2.1. The Identification of Risk Mitigation.

Before identifying risk mitigation, for the first we should understand the potential risk that should be resolved. The potential risk based on the result of research from Handayani (2017). The identification of risk mitigation done by discussing with the expert toward FGD (Focus Group Discussion). Besides, identification is also done by the study of literature based on HIRARDC. This identification is aimed to understand the appropriate of mitigation in handling the risk by considering its trigger.

2.2. Deciding the type of each mitigation contextually.

Comparison is used in deciding the type of relation, it compares risk mitigation by using contextual relation, which most of it are; the influence, the cause and verbs which deals with risk mitigation (Kanungo and Jain; 2009)

2.3. Creating Structural Self-Interaction Matrix (SSIM) by using pairwise.

In analyzing the relation between elements, contextual relation with what kind of type the relation is, which one element triggers other elements, it stated in this third phase. The relation between 2 sub element (i and j) and the direction of those elements are questioned (Thakar dkk., 2007). There are four symbols in stating the relation:

V = for relation of mitigation risk i to risk j, one way, the existence of mitigation
i triggered mitigation j

A = for mitigation j to i, one way. Mitigation j exist if only mitigation i is done

X = it is for mitigation I to mitigation j and from j to i, two ways, those two
mitigations are triggered each other

O = if the relation among mitigation seems not valid (not connected)

2.4. Creating Reachability Matrix (RM) and checking the transitivity.

In this phase, it is focused on the making of Reachability, and this is a binary matrix

- If relation (i, j) noted as V so input (i, j) in RM become 1 and (j, i) become 0
- If relation (i, j) noted as A so input (i, j) in RM become 0 and (j, i) become 1
- If relation (i, j) noted as X so input (i, j) in RM become 1 and (j, i) become 1
- If relation (i, j) noted as O so input (i, j) in RM become 0 and (j, i) become 0

2.5. Matrix Test with Transitivity.

Transitivity is the basic assumption to ISM which is used to achieve Final Reachability Matrix (FRM). Transitivity states that if element A has relation with element B and element B has relation with element C. if the element of risk mitigation (i and

j) from RM is zero (0), so there are no direct or indirect correlation from mitigation i to j. RM actually has no this character because there is only indirect relation from element i to j, input (i and j) and also zero (0). The direct relation can be shown up by changing FRM to successive power till there is no input, this condition is finished if it reaches $M^{n-1} < M^n = M^{n+1}$. The application of the Transitivity is done by checking cells in reachability matrix with value 0, whether it is fulfill the regulation of transitivity or not.

2.6. Deciding partitionary level from reachability matrix.

It includes the extraction from hierarchical ordering from RM by partitioning in this phase. The objective of this phase is to become the first input for the creating of digraph from RM. The level partition uses elements in sj and si. Reachability set R(si) consist of some its elements and other unsure that can be reached by si. There are also some elements that reach si that act as the antecedent A(si). Next, the interaction from some reachability and antecedent ($R(s_i) \cap A(s_i)$). The element $R(s_i) = (R(s_i) \cap A(s_i)$ is the top element from ISM hierarchy. The top element has no relation to the other element above its hierarchy. If the top element was identified so they will be separated from other elements. The same process continuous to all elements. This identification level is helpful in creating digraph and the last model of ISM.

2.7. Creating digraph with eliminated transitivity connection.

The first digraph included transitivity relation comes from the conical shape from RM. The conical matrix gained from the RM partition with the arranging of element based on its level, which mean all elements with the same level are collected, element that has most zero (0) in half of diagonal and the element that has most 1 in the below of it. To make the digraph simple, it is erased to get the last one. If there is a relation between risk i and j, it shown by the arrow which headed from i to j.

2.8. Converting graph to ISM and checking the inconsistency conceptually.

The result of digraph from this phase is converted to ISM by eliminating the information from the element point. Finally the ISM model is checked for its compatibility.

3. RESULT AND DISCUSSION

Potential risk and its causes that should be done based on the research of Handayani (2017). The plan of risk mitigation that has been identified by the experts and the literature HIRARDC shows as below in Table 1.

Table 1. Potential Risk and Mitigation Risk

No	Risk	Causes	Mitigation
1	Confined	Limited workplace	Give space when setting and removing the scaffolding
2	Fall	Scaffolding was broken	Each of the setting scaffolding must be checked by the certificated Scaffolder
3	Inhaling the chemical substance	Workers do not aware of OSH	The work method is suited with the condition of the job, and give the socialization of the dangerous of the spilled paint

No	Risk	Causes	Mitigation
			Studying MSDS (material safety data sheet
4	The material substance hit the skin	Workers do not wear the proper suit.	The working method should follow SNI (Indonesian National Standard)
			OSH Management Improvement
5	Electrocution	Shorted	Isolate the cable connection based on the PUIL 2000
6	Electrocution	Get a shock from electricity	Isolate the cable connection based on the PUIL 2000
7	Fall	The construction method is not standard	Follow the standard of OSH for working in high place
8	Scratched	The worker is unskillful	The worker must have SKT (Technical Skill Certificate)
9	Slipped and fall	There is no handle	Provide railing and board for footing
10	Confined	Mistake in manual handle	Creating and obeying the lifting plan
11	Dropped of material	In a rush	Applying OSH in High Rise Building
12	Hand cramps	Get less rest	Create the SOP
13	Fall	Working while joking	Each of the setting scaffolding must be checked by the certificated Scaffolder
14	Eyes got material, hand scratched, finger cute, get the coating liquid	Careless	Create the SOP of cutting equipment
15	Inhale the chemical substance, fall in hole, excavatgor hit, hand scratched	Less of OSH commitment	Sign located and workplace safety
			Do *Safety Morning* and *Safety Induction*

The risk mitigation that has been identified by OSH experts in Table 1 and the next is comparing risk mitigation in matrix relation by using contextual or correlation of each risk mitigation. The next step in building the hierarchy model of ISM. The relation between risks, for instance, for cell (i_1,j_{15}) it says got score 4, which means it has no relation, in cell (i_1,j_4) it says got 1, which means i_1 can trigger risk for j_4. While in (i_1,j_9) it says got 2 which means risk mitigation i_1 fulfilled if only risk mitigation j_9 Is done.

Table 2. Risk Mitigation

No	Mitigation
1	Give space when setting and removing the scaffolding
2	Each of the setting scaffolding must be checked by the certificated Scaffolder
3	The work method is suited with the condition of the job, and give the socialization of the dangerous of the spilled paint
4	Studying MSDS (material safety data sheet
5	The working method should follow SNI (Indonesian National Standard)
6	OSH Management Improvement
7	Isolate the the cable connection based on the PUIL 2000
8	Follow the standard of OSH for working in high place
9	The worker must have SKT (Technical Skill Certificate)
10	Provide railing and board for footing
11	Creating and obeying the lifting plan
12	Applying OSH in High Rise Building
13	Create the SOP
14	Create the SOP of cutting equipment
15	Sign located and workplace safety
16	Do *Safety Morning* and *Safety Induction*

3.1. Structural Self-interaction Matrix (SSIM)

The data of the relation among risk mitigation in SSIM by converting number into the letter which says relation category (AVXO). The next is creating reachability matrix (RM), it is by changing SSIM into binary matrix. It is replaces symbol V, A, X, and O with 0 and 1. The result can be seen in Table 3.

Table 3. Reachability Matrix

Variabel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Driver Power
1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	4
2	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	4
3	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	4
4	0	0	0	1	1	1	0	1	1	0	1	0	1	1	0	0	8
5	1	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	9
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
7	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2
8	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	7
9	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	13
10	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	4

11	0	0	0	0	0	1	0	0	1	0	1	1	1	1	0	0	6
12	1	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	10
13	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	3
14	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	3
15	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	5
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Dependence	8	7	4	6	7	11	5	9	9	5	9	9	9	9	6	2	

The next is creating Conical Matrix (Lower Triangular Format) by arranging variable based on the level in Reachability Matrix Final. This Canonical Matrix will be helpful in making the Digraph Structural Model. Canonical Matrix that has been arranged can be seen on Table 4.

Table 4. Canonical Matrix

Variabel	**7**	**9**	**6**	**13**	**14**	**11**	**12**	**1**	**1**	**4**	**16**	**5**	**8**	**3**	**15**	**10**	**DP**	**Level**
7	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	2	**I**
9	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	0	13	**I**
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	**I**
13	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	3	**II**
14	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	3	**III**
11	0	0	0	0	0	1	0	0	1	0	1	1	1	1	0	0	6	**IV**
12	1	1	0	0	0	1	0	1	0	1	1	1	1	1	1	0	10	**IV**
1	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	4	**IV**
2	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	4	**V**
4	0	0	0	1	1	1	0	1	1	0	1	0	1	1	0	0	8	**V**
16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16	**V**
5	1	0	0	0	1	0	1	1	1	0	1	1	1	1	0	0	9	**V**
8	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	7	**VI**
3	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	4	**VI**
15	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	5	**VI**
10	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	4	**VI**
Dependence	8	7	4	6	6	11	5	9	9	5	9	9	9	9	6			

The score of Driver Power gained from the sum of scores in column horizontal j, while Dependence Power gained from the sum of scores in vertical i.

3.2. Driver Power Dependence Matrix

The next step is classifying the key variable which is important to develop the program. Those variables are divided into 4 parts, those are; driver, linkage, autonomous, and dependent (Pfohl, 2011). Dependence from those variables is in the Figure 1

.

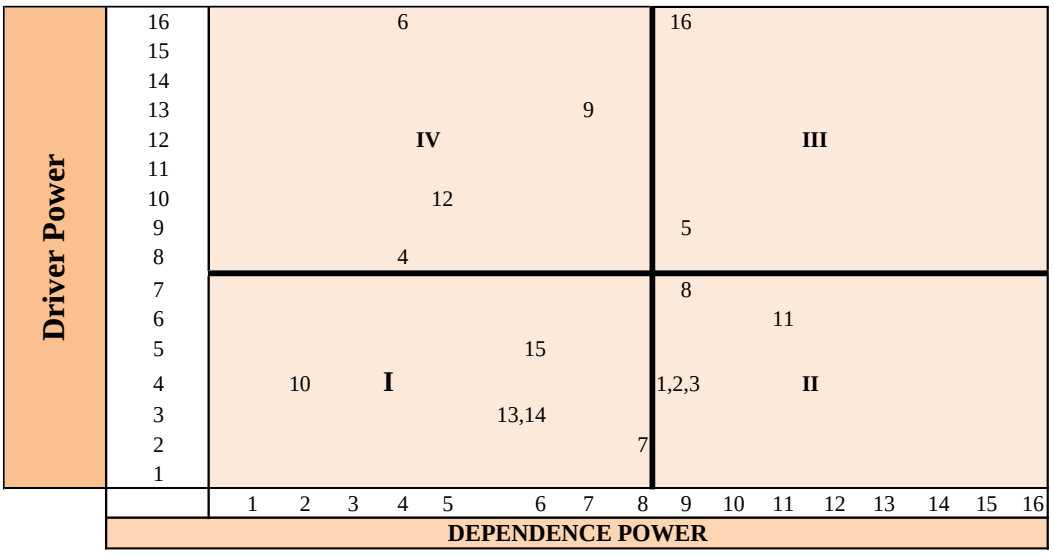

Fig. 1 Driver Dependent Matrix

Risk mitigation in 12, 4, 9, and 6 which is located in quadrant IV have a high driver power, so that this variable has power to influence other variables in the system (Retno, 2013) and these risk mitigation as a key factor in managing risk events. These mitigations are: Applying standard of OSH in High rise Building, Learning MSDS (Material Safety Data Sheet), workers must have the certificate SKT (Technical Skills Certificate) or TSC (Technical Skill Certificate), Upgrading OSH Management. While mitigation of giving space in setting and removing the scaffolding. All the setting of scaffolding must be checked by the certificated officer. Working method must be suited with the condition of worker and the socialization of the dangerous of spilled paint, create and obey the lifting plan, isolate the cable connection based on the PUIL 2000. Those who are in quadrant II has low level of Driver Power so that these variables have no power to influence other variables in the system (Laili, 2014)

Quadrant I. Weak Driver-Weak Dependent Variable (Autonomus), risk mitigation in this quadrant has a relatively small or unrelated influence (Mirah, 2014). Risk mitigation in quadrant I that are: Create the SOP, Create the SOP of cutting equipment, Sign located and workplace safety, Provide railing and board for footing, Isolate the cable connection based on the PUIL 2000

Quadrant III: Strong driver-strongly dependent variable (linkage). Risk mitigation in this position will support the success in addressing the causes of OSH risk that may lead to risk events. Where as if action is not taken from this risk mitigation then the risk incident cannot overcome. Risk mitigation in quadrant III that is work method must follow SNI (Indonesian national standard), Conduct Safety Morning And Safety Induction.

3.3. Structured Hierarchy of OSH Risk Mitigation

Preparation of hierarchical structure model based on Driver Power and level. (Pfohl 2010), The results of the study put the overall mitigation in 6 levels as shown in Figure 2. The hierarchy level determination indicates the dependence between mitigation at the lower level.

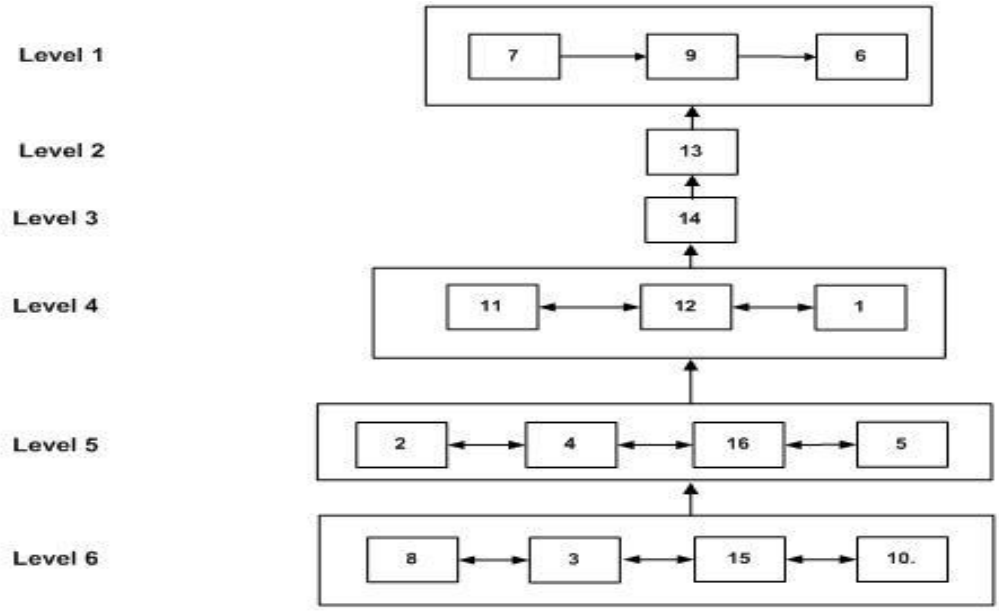

Fig. 2 Structured Hierarchy Model of OSH Risk Mitigation

4. CONCLUSION

The ISM technique produces a structural model of risk mitigation and a DP-D matrix to interact the hierarchy and linkages between each risk mitigation. The risk mitigation that should be done in overcoming the work accident is by applying the standard of OSH in the work of High rise Building. Learning MSDS (Material Safety Data Sheet), workers must have SKT (Technical Skill Certificate), Upgrading OSH Management. By having this risk mitigation, it is hoped that work accident can be decreased and it can minimize the risk (zero accident) for the construction workers.

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THE BORDA METHOD AND ANALITIC HIERARCY PROCESS FOR DETERMINATION OF LANDING BEACH LOCATION AMPHIBIOUS OPERATIONS - THE WEST PAPUA SEA WATER

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ABSTRACT
Determination of landing beach is the most important ability of Indonesian Marines Troop as an element of the Landing Forces in order to carry out a special amphibious operation task to determine the ideal landing beach location for the successful execution of the task. Requirements on the determination of ideal landing beaches should be in accordance with predetermined parameters and serve as an important component in determining the weighting value of landing beach selection criteria. This study aims to determine the location of landing beaches by using Borda method combined into Analytic Hierarcy Process (AHP). The research stages started from the determination of the value of the weight of the selection criteria and the value of the alternative weight of the landing beach result of the analysis with Borda method then processed again in the framework of AHP method arranged in the hierarchy model by performing pairwise comparison analysis to obtain the result of landing beach selection which is logical and has an objective value in accordance with accurate data and is very helpful for decision makers to solve multi-criteria problems. The result of the analysis with Borda method is known that the physical properties of Hydro-Oceanography become the first sequence with the value of weight of 0.207 followed by the criterion of reference point with the weight value of 0.193 in the second sequence and the type of beach criterion with the weight of 0.171 on the third sequence. From the results of analysis with AHP method can be seen that Beach 2 with a value of weight of 0.639 was chosen to be the most appropriate beach location for amphibious landing operations. While for the second order is Beach 1 with a weight value of 0.259 and the third is Beach 3 with a weight of 0.101.

KEYWORDS : Amphibious Operations, Landing beach, Borda method, AHP method.

1. INTRODUCTION.

As an archipelagic country, especially in the eastern part of Indonesia with its abundant natural resources, it has not been optimally utilized so that it is very vulnerable to illegal activities, such as illegal fishing, illegal mining, illegal logging and other illegal activities (Headquarter, 2017). World Maritime Axis Policy issued by the President of the Republic of Indonesia demands that Indonesia should anticipate able to maintain security stability in the jurisdiction of NKRI. For that reason it is necessary a thought that can answer the problems faced by Indonesia in the eastern part of Indonesia (Headquarter, 2017).

The expansion process in the Papua region contributes well to establish Third of The Sea Area Command and Marine Force in Sorong West Papua due to infrastructure development(Headquarter, 2017), facilities and infrastructure of the local area is

getting better. In order to carry out the function of empowering the marine defense area requires the ability of sea defense and also the ability to maintain all the natural resources potential (Brink, 2000).

Understanding about the coastal characteristics of Sorong especially related to determination of landing beach is a should be for landing troop element in order to carry out the task of amphibious operation especially to determine the ideal landing beach location (Headquarter, 2013)(Brink, 2000). Requirements to determinate the ideal landing beach should be in accordance with predetermined parameters (Brink, 2000) and serves as an important component in determining weight value of landing beach selection criteria (Koc & Burhan, 2015).

By using Borda method which is combined into AHP method, the research stage starts from determination of the criteria weight value and the alternative weight value (Velazques & Hestler, 2013) (Koc & Burhan, 2015). Analysis results with the Borda method is then reprocessed in the AHP framework which arranged in the hierarchical model by performing pairwise comparison analysis, it is processed in the form of a complete matrix with consistency analysis (Koc & Burhan, 2015). So it is expected to get the result of alternative landing beach are logic and objective value in accordance with accurate data and is very helpful for decision makers to solve multi-criteria problems(Velasquez & Hester, 2013).

The systematic study of this research is as follows: Chapter 2 contains a literature review on the definition of Amphibious Operations, landing beach and basic theories which used for the Borda and AHP methods. In chapter 3 the results and discussion are presented and the last is chapter 4 conclusions.

2. LITERATURE REVIEW.

2.1. Amphibious Operations.

The amphibious operation is an attack carried out from the sea by a naval unit and a landing troop of the Indonesian Navy loaded in ships and amphibious landing means and landed on the beach or coastal potential of the enemy (Headquarter, 2013).

2.2. Landing Beach.

The landing beach is part of the coastline required for landing one Battalion of Landing Team or equivalent unit (Staff, 2014). Beach landing can also be part of a coastline that has tactical values, such as a bay beach that can be used to land a smaller entity than the Battalion of the Landing Team (Headquarter, 2013). In landing beach selection, some types of oceanographic data (Brink, 2000) should be given enough consideration so that the Marines can safely carry out their landings (Staff, 2014)(Brink, 2000). These types of data include the concept of landing troop operations, coastal capacity to maneuver amphibious landing troops, coastal approaches, natural obstacles, coastal backdrop traits, communications infrastructure including railroads and weather and other hydro-oceanographic data (Collins, 1998).

2.3. Borda Method.

Borda's method proposed by its founder Jean Charles de Borda in the 18th century is one of the methods used to determine the best alternative of selected alternatives (Costa, 2017). Each alternative decision-maker choice will be judged by its weight based on its ranking. The greatest weight is the best alternative for decision makers (Mohajan, 2012) (Costa, 2017). The privilege of this method can overcome the difficulties of other methods where people or things that are not in the first rank will be automatically eliminated (Ishida, 2017). The basic idea in Borda Method is by assigning weight to each of the first rank, second rank, and so on (Ishida, 2017).

2.4. AHP Method.

AHP method is a method of decision-making analysis that applies pairwise comparison theory to decision variables that become the main criteria of decision as a derived element of the predetermined objectives(Saaty, 2012) where the determination of the priority scale of these criteria depends on the assessment of experts in order to determine the alternative choice of solutions (Saaty, 2008).

3. RESEARCH METHODOLOGY.

3.1. Flowchart of Research.

In this study is divided into four stages of research activities are arranged sequentially starting from the stage of identification, data collection phase, analysis and data processing and conclusions. Its can be seen as Figure 1. as follows (Saaty, 1990) :

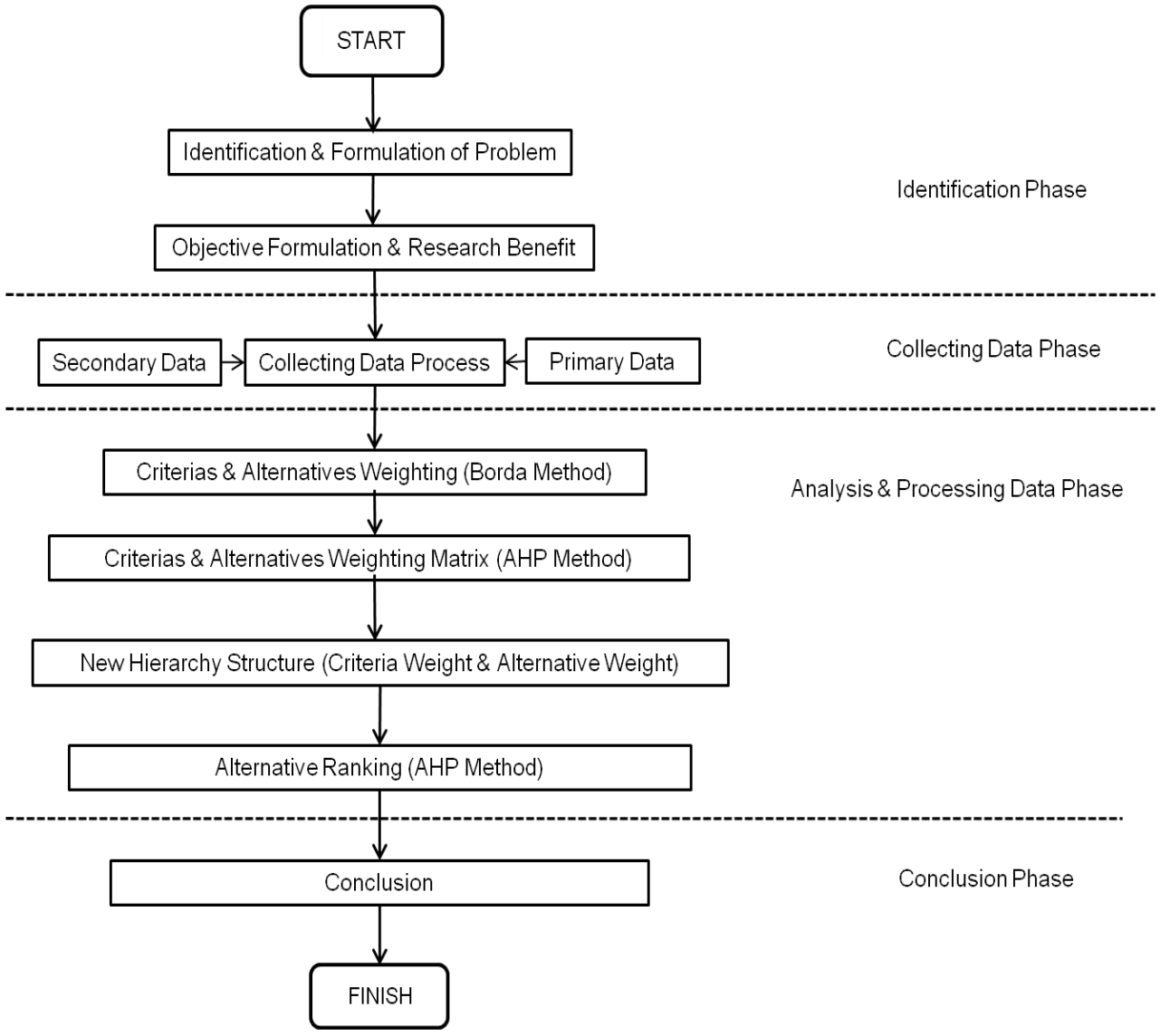

Fig. 1. Flow Chart of Research.

3.2. Research Object.

This research focuses on the process of choosing the ideal landing beach location analysis so that the variables that become the main criterion in landing beach location should be analyzed according to the prepared method. The location of the research was conducted at TPI Jetty of Sap Papua West Papua (Figure 2) located at 01 ° 07 '34.71 "S - 131 ° 13' 29.98" E (Headquarter, 2012).

Sorong district of West Papua has an area of 13,603.46 km² which consists of land area of 845,71 km² and an area of ocean 514.65 km² (Headquarter, 2012). .

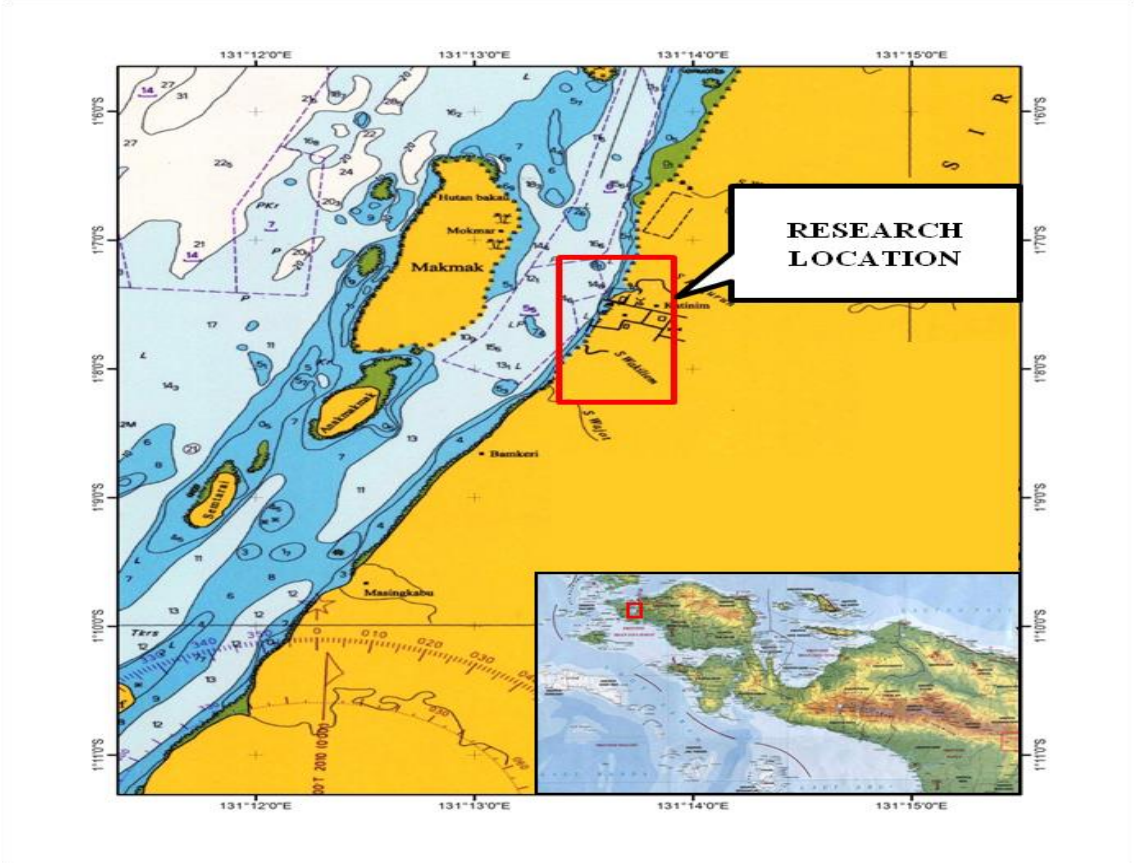

Fig.2. Research Location Map.

3.3. Research Stages.

In this research, there are several stages of data processing analysis using a combination of two different methods where Borda method as the initial determination of the criteria weighting value and the alternative of landing beach selection followed then next stage is the analysis of AHP method which is used as the main framework of decision maker system builder as well as determining the value of alternative weighted value through the process of pairwise comparison analysis up to the final stages of the research (Michela, 2015).

3.3.1. Determination of landing beach criteria weight value.

The criteria of landing beach selection in this research can be seen in table 1 as follows (Collins, 1998):

Table 1. Criteria for selection of landing beach (Collins, 1998).

NO	CRITERIA	INFLUENCE IN AMPHIBIOUS OPERATIONS	IDEAL PARAMETER
1	**2**	**3**	**4**
1	**Type of Shorelines.** a. Straight shoreline. b.Convex shoreline. c.Concave shoreline.	a. Influence on currents and waves. b. Effect on the direction of the shot the opposing coastal defense.	Straight shoreline
2	**Composition of the seafloor.** a. Sand. b. Sand pabbles. c. Muddy sand. d. Rocky gravel.	Influence on surface manuver	Sand.
3	**Coastal gradient.** a. Steep (gradient 1:15) b.Moderate (1:15 >gradient≥ 1:30) c.Gentle (1:30 > gradient≥ 1:60) d.Mild (1:60>gradient≥1:120) e. Flat (gradient > 1:120)	a. Influence on determination of ship type & landing lifeboat. b. Influence on type of break wave in shallow water area	a. Moderate gradient. 1:15 > gradient ≥ 1:30 b. Gentle gradient 1:30 > gradient ≥ 1:60
4	**Physical hydro-oceanography** a. Wave b. Tidal c. Current	a. Effect on landing lifeboat and amphibious vehicle. b.To determinate type of lifeboat & amphibious vehicle to be used.	a. spilling wave type. b.Semidiurnal and Mixed Semidiurnal tidal type c. Current parallel shoreline velocity < 1 knots.
5	**Back area of beach**	a. Influence on manuver of troops & amphibious vehicles. b. Defence area for protection after landing.	a. Flat with an elevated beach backdrop. b. There is a ramp to the rear of the beach.
6	**Point of reference for landing beach.**	a. To help identification process about landing beach. b. As a navigation mark when on sea surface.	Can be a known terrain sign for its position
7	**Coastal obstacles.** a. Natural obstacles	a. Influence in motion power of combat materials and troops	Selected beaches which minimum natural obstacle.
1	**2**	**3**	**4**
	b. Artificial obstacles	b. Can make amphibious vehicle and lifeboat become broken.	
8	**Beach access**	Make easy to manuver for troops & vehicle on landing beach.	Selected beach which have enough total access.

.

Determination of the criteria weighting value was analyzed by using Borda method after obtaining the table of values of criteria ranking value from expert choice as in table 2. below

Table 2. Obtaining the rating criteria (Costa, 2017).

NO	CRITERIA	RANK		
		1	2	3
1	CRITERIA 1			
2	CRITERIA 2			
3	CRITERIA 3			

The determination of the ratio value for all rankings is weighted across all criteria (R_1) (Ishida, 2017):

$$R_1 = \sum_{j=1}^{n} R_{ij} \qquad (1)$$

Determination of the weight value of each criteria (W_1) (Ishida, 2017):

$$W_1 = \frac{R_1}{\sum_{i=1}^{m} R_1} \qquad (2)$$

Where:

R_1: The sum of all rankings is weighted for all criteria 1.

R_{ij}: The rankings are evaluated by *j* for the criteria 1.

W_1: Weight criteria 1 for the evaluator *n*.

The steps for calculation with Borda method are as follows (Mohajan, 2012):

a. Each decision maker assigns n-1 to first choice criteria or alternative, n-2 for second choice, n-3 for third option and so on up to 0 for last choice criteria or alternative (Ishida, 2017).
b. The optional alternative with the highest amount is the winner (Ishida, 2017).

3.3.2. Determination of alternative weighted value of landing beach option.

Determination of the weight value of landing beach alternative is also analyzed by Borda method as in table 3 as follows (Ishida, 2017) :

Table 3. Obtaining the rating criteria (Mohajan, 2012).

NO	CRITERIA	RANK		
		1	2	3
1	ALTERNATIVE 1			
2	ALTERNATIVE 2			
3	ALTERNATIVE 3			

As for the determination of the weight value of each alternative in the same process as the formula (1) and (2).

3.3.3. Weighting matrix of criteria with AHP Method.

In order to make a decision in the AHP method it is necessary to process the problem with the following stages (Saad, et al., 2016):

a. Create a hierarchy structure.

The multicriteria problem in AHP is arranged in the form of hierarchy consisting of three main components namely the main objectives, assessment criteria and alternative choice (Koc & Burhan, 2015). The structure of the hierarchy can be illustrated as shown in Figure 3 following (Taha, 2007) :

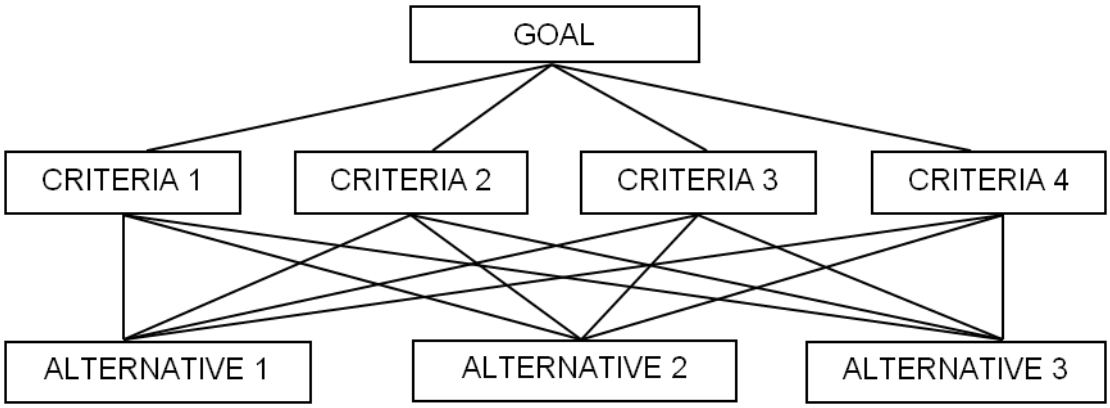

Fig. 3. Hierarchy structure (Taha, 2007).

b. Create a pairwise comparison matrix.

1) Pairwise comparison based on Saaty Scale.

At this stage begin pairwise comparison in order to determine the weighting value of assessment criteria based on the Saaty Scale as in table 4 below (Saaty, 2008) :

Table 4. Assessment of criteria weighting based on Saaty scale (Koc & Burhan, 2015).

Value	Definition	Explanation
1	The same important	
3	Slightly more important	
5	More important	
7	Very important	
9	Absolute is very important	
2,4,6,8	Average	When in doubt between two adjacent values
1/3,1/5,1/7,1/9	The opposite of the value 1,3,5,7,9 (Reciprocal)	If the value of A to B is 4 then the value of B to A is 1/4

2) Calculates the criteria weight (priority vector).

Calculation of the value of criteria weight by normalizing the matrix value of pairwise comparison by dividing all matrix values by the sum of each matrix column(Triantaphyllou & Mann, 1995). After that is done the calculation of the average value of the sum in each line matrix according to the following formula (Saaty, 2008) (Triantaphyllou & Mann, 1995):

$$A = (a_{ij}) = \begin{bmatrix} 1 & W_1/W_2 & \cdots & W_1/W_n \\ W_2/W_1 & 1 & \cdots & W_2/W_n \\ \vdots & \vdots & \cdots & \vdots \\ W_n/W_1 & W_n/W_2 & \cdots & 1 \end{bmatrix} \quad (3)$$

The matrix value generated from the process is the value of the priority vector (Triantaphyllou & Mann, 1995).

3) Testing Consistency Ratio (CR).

At this stage tested the level of consistency ratio of matrix comparison in

pairs of criteria assessment that has been determined the value of weight criteria (priority vector) (Triantaphyllou & Mann, 1995). If *CR*>0,1 then the pairwise comparison process should be repeated again until it gets results *CR*≤0,1. CR value is derived from the division between Consistency Index (*CI*) with Index Ratio (*IR*) with the following calculation phases (Koc & Burhan, 2015):

a. Determine λ_{maks} by formula (Saaty, 2008):

$$[Ax = \lambda_{maks}x] \quad (4)$$

Where *x* is *eigen vector* value obtained from the calculation *priority vector.* After process (4) has obtained λ_{maks} matrix and than determine average value of λ_{maks}.

b. Determine Consistency Index (CI) by formula (Saaty, 2008):

$$CI = \frac{(\lambda_{maks} - n)}{(n-1)} \quad (5)$$

Where:

CI : Consistency Index.

λ_{maks} : Average value $\frac{Ax}{x}$.

n :Total weight.

c. Determine CR value by formula (Saaty, 2008):

$$CR = \frac{CI}{IR} \quad (6)$$

Where Index Ratio value determined in accordance with Table 5 as follows:

Table 5. *Index Ratio (IR)* (Saaty, 2008).

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IR	0,00	0,00	0,58	0,90	1,12	1,2	1,3	1,4	1,5	1,49	1,51	1,48	1,56	1,57	1,59

At this stage it should be ensured that CR values must be consistent (*CR*≤0,1) (Triantaphyllou & Mann, 1995).

4) Develop a new hierarchy complete with criteria weight.

The preparation of a new hierarchy is needed to reinforce the key assessment criteria that will be used in the next weighting process ie the choice of alternative weighting against each assessment criterion(Gorener, et al., 2012). The preparation of the new hierarchy can be seen as shown in Figure 4 following (Triantaphyllou & Mann, 1995) :

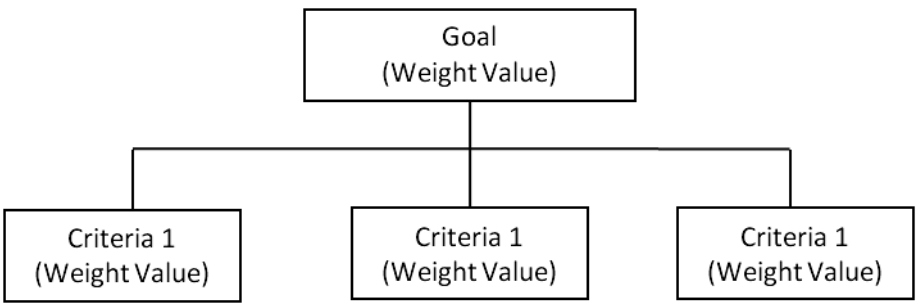

Fig. 4. Hierarchy structure with weight value (Triantaphyllou & Mann, 1995).

5) Calculation of the value of alternative weight for each criteria.

The calculation of the value of alternative weight for each criterion is needed in order to construct a pairwise comparison matrix between the alternative elements of choice in the operation of the assessment criteria matrix(Yogi, et al., 2017). This process carried out a number of assessment criteria such as table 6 as follows (Saaty, 2012) :

Table 6. Matrix Table of Assessment Criteria (Saaty, 2012).

Criteria	Alternative 1	Alternative 2	Alternative 3	...	Alternative n
Alternative 1	1	...	...	...	...
Alternative 2	...	1	...	...	...
Alternative 3	...	...	1	...	...
...	...	...	...	1	...
Alternative n	...	...	...	...	1

6) Develop a new hierarchy complete with the value of the weighting criteria and the value of alternative weight.

The preparation of a new hierarchy structure with the value of the criteria weight and the value of alternative weight is required in order to display the weight values of the matched comparison matrix results of all alternative alternatives in each assessment criterion that will produce alternative weighting for each criteria (priority vector). The preparation of the new hierarchy can be seen in Figure 5 as follows (Saaty, 2012) :

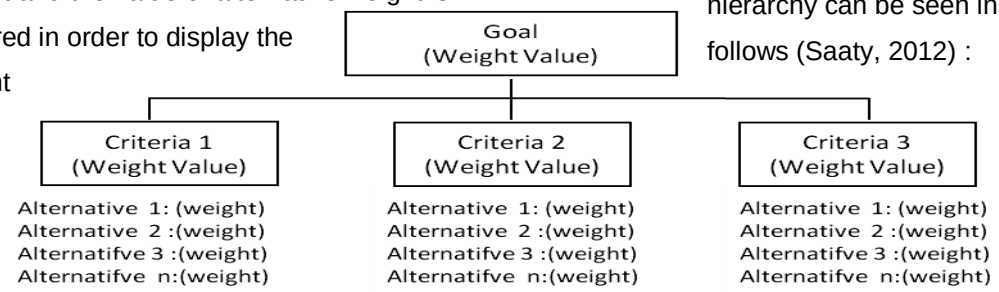

Fig. 5. Structure hierarchy with weight value (Saaty, 2012).

a. Determine the preferred alternative ranking.

The determination of the optional alternative rank corresponds to the following matrix calculations (Saaty, 2012) (Triantaphyllou & Mann, 1995):

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} k \\ l \\ m \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix} \quad (7)$$

In determining the rankings in the alternative option is done multiplication process between matrix of alternative weight value (Triantaphyllou & Mann, 1995) as the priority matrix element with the matrix of the corresponding criteria weighting value as the criteria weights element so that the final priority value of the alternative matrix is ready to be sorted according to the rank (Koc & Burhan, 2015).

4. RESULT AND DISCUSS

4.1. Determination of the weight value of landing beach criteria.

From the results of data collection filling questionnaire of choice of experts filled by 10 experts

according to their respective fields and obtained data table 7 as follows :

Table 7. The result of filling the questionnaire of coastal criteria criterion

NO	CRITERIA	RANK							
		I	II	III	IV	V	VI	VII	VIII
1	TYPE OF SHORELINE	1	3	1	4		1		
2	HYDRO-OCEANOGRAPHY	3	3	3	1				
3	COASTAL GRADIENT			1	3	3		1	2
4	COMPOSITION OF SEAFLOOR	1	1	2	1	4	1		
5	POINT OF REFERENCE	4	2	2		1		1	
6	BACK AREA OF BEACH	1	1			1	4		3
7	COASTAL OBSTACLES			1	1		3	4	1
8	BEACH ACCESS					1	1	4	4

a. Determination ratio value for all of ranking in all criteria (R_1):

$$R_1 = \sum_{j=1}^{n} R_{ij}$$

R_1=$[(1x7) + (3x6) + (1x5) + (4x4) + 0 + (1x2) + 0 + 0]$+ $[(3x7) + (3x6) + (3x5) + (1x4) + 0 + 0 + 0 + 0]$+$[0 + 0 + (1x5) + (3x4) + (3x3) + 0 + (1x1) + 0]$+$[(1x7) + (1x6) + (2x5) + (1x4) + (4x3) + (1x2) + 0 + 0]$+$[(4x7) + (2x6) + (2x5) + 0 + (1x3) + 0 + (1x1) + 0]$+$[(1x7) + (1x6) + 0 + 0 + (1x3) + (4x2) + 0 + 0]$+$[(0 + 0 + (1x5) + (1x4) + 0 + (3x2) + (4x1) + 0]$+$[(0 + 0 + 0 + 0 + (1x3) + (1x2) + (4x1) + 0]$

R_1= 48+58+27+41+54+24+19+9

R_1= 280

b. Determination criteria weight value (W_1):

$$W_1 = \frac{R_1}{\sum_{i=1}^{m} R_1}$$

W_1=$[(1x7) + (3x6) + (1x5) + (4x4) + 0 + (1x2) + 0 + 0]$/280

W_1= 48/280 = 0,171

W_2= $[(3x7) + (3x6) + (3x5) + (1x4) + 0 + 0 + 0 + 0]$/280

W_2= 58/280 = 0,207

W_3=$[0 + 0 + (1x5) + (3x4) + (3x3) + 0 + (1x1) + 0]$/280

W_3= 27/280 = 0,096

W_4=$[(1x7) + (1x6) + (2x5) + (1x4) + (4x3) + (1x2) + 0 + 0]$/280

W_4= 41/280 = 0,146

W_5=$[(4x7) + (2x6) + (2x5) + 0 + (1x3) + 0 + (1x1) + 0]$/280

W_5=54/280 = 0,193

W_6=$[(1x7) + (1x6) + 0 + 0 + (1x3) + (4x2) + 0 + 0]$/280

W_6=24/280 = 0,086

W_7=$[(0 + 0 + (1x5) + (1x4) + 0 + (3x2) + (4x1) + 0]$/280

W_7=19/280 = 0,068

W_8=[(0 + 0 + 0 + 0 + (1x3) + (1x2) + (4x1) + 0]/280

W_8=9/280 = 0,032

d.

c. The ranking sequence of landing beach selection criteria in Table 8 below:

Table 8. The sequence of landing beach selection criteria

NO	CRITERIA	RANK								WEIGHT VALUE	LEVEL
		I	II	III	IV	V	VI	VII	VIII		
1	TYPE OF SHORELINE	1	3	1	4		1			0,171	**3**
2	HYDRO-OCEANOGRAPHY	3	3	3	1					0,207	**1**
3	COASTAL GRADIENT			1	3	3		1	2	0,096	**5**
4	COMPOSITION OF SEAFLOOR	1	1	2	1	4	1			0,146	**4**
5	POINT OF REFERENCE	4	2	2		1		1		0,193	**2**
6	BACK AREA OF BEACH	1	1			1	4		3	0,086	**6**
7	COASTAL OBSTACLES			1	1		3	4	1	0,068	**7**
8	BEACH ACCESS					1	1	4	4	0,032	**8**

4.2. Determination of alternative weighted value of landing beach option.

The data was filled by 10 experts who filled in the alternative questionnaire table landing beach selection and obtained the results as in table 9 as follows :

Table 9. Results of filling questionnaires for alternative beaches

NO	CRITERIA	RANK		
		I	II	III
1	BEACH 1	4	3	3
2	BEACH 2	3	6	1
3	BEACH 3	3	1	6

a. Determination of the ratio value for all weighted rankings (R_1):

$$R_1 = \sum_{j=1}^{n} R_{ij}$$

R_1=[(4x2) + (3x1) + 0]+[(3x2) + (6x1) + 0]+[(3x2) + (1x1) + 0]

R_1= 11+12+7

R_1= 30

b. Determination of the weight value from each criterion (W_1):

$$W_1 = \frac{R_1}{\sum_{i=1}^{m} R_1}$$

W_1=[(4x2) + (3x1) + 0]/30

W_1= 11/30 = 0,367

W_2= [(3x2) + (6x1) + 0]/30

W_2= 12/30 = 0,4

W_3= [(3x2) + (1x1) + 0]/30

W_3= 7/30 = 0,233

c. The ranking sequence of landing beaches alternative in Table 10. follows:

Table 10. Alternative ranking sequence of landing beach selection

NO	CRITERIA	RANK			WEIGHT VALUE	LEVEL
		I	II	III		
1	BEACH 1	4	3	3	0,367	**2**
2	BEACH 2	3	6	1	0,4	**1**
3	BEACH 3	3	1	6	0,233	**3**

4.3. Matrix weighting criteria with AHP Method.

a. Create a hierarchy structure.

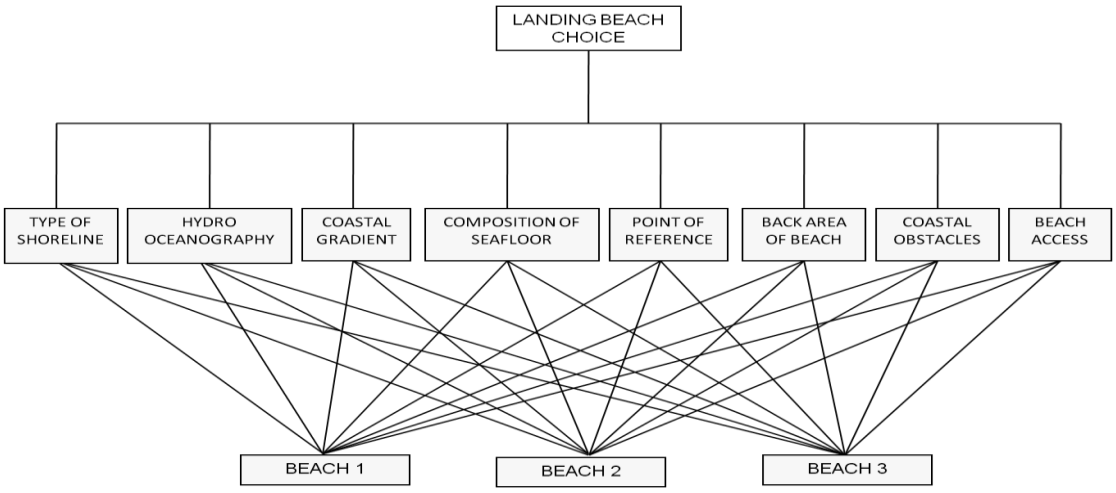

Fig. 6. Hierarcy structure

b. Determine pairwise comparison matrix.

The ranking sequence of weighted criteria by Borda method in the previous stage makes the basis of determining preference at this stage so it is helpful decision maker to determine the numbers in pairwise comparison matrix with Saaty scale like table 11. below :

Table 11. Criteria pairwise comparison matrix

NO	CRITERIA	TYPE OF SHORELINE	HYDRO-OCEANOGRAPHY	COASTAL GRADIENT	COMP. SEAFLOOR	POINT REFERENCE	BACK AREA OF BEACH	COASTAL OBSTACLES	BEACH ACCESS
1	TYPE OF SHORELINE	1	0,333333	2	0,5	0,333333	3	4	5
2	HYDRO-OCEANOGRAPHY	3	1	4	3	2	5	7	9
3	COASTAL GRADIENT	0,5	0,25	1	0,5	0,333333	2	3	5
4	COMPOSITION OF SEAFLOOR	2	0,333333	2	1	0,333333	3	4	5
5	POINT OF REFERENCE	3	0,5	3	3	1	4	5	7
6	BACK AREA OF BEACH	0,3333333	0,2	0,5	0,333333	0,25	1	2	3
7	COASTAL OBSTACLES	0,25	0,142857	0,3333333	0,25	0,2	0,5	1	2
8	BEACH ACCESS	0,2	0,111111	0,2	0,2	0,142857	0,333333	0,5	1
JUMLAH		10,283333	2,870634921	13,033333	8,783333	4,5928571	18,83333333	26,5	37

a. Determine priority vector.

Priority vector is generated from 2 stages of calculation, the first step is to normalize the value of each pairwise comparison matrix column and then the second stage is to calculate the average of the sum of each matrix row. The normalization result matrix and priority vector can be seen in table 12:

Tabel 12. Priority vector

MATRIX A								**X**	**AX**	**λmax (AX/X)**
1	0,333	2	0,5	0,333	3	4	5	0,1177	0,972	8,254
3	1	4	3	2	5	7	9	0,3121	2,631	8,430
0,5	0,25	1	0,5	0,333	2	3	5	0,0871	0,708	8,129
2	0,333	2	1	0,333	3	4	5	0,1370	1,158	8,451
3	0,5	3	3	1	4	5	7	0,2307	1,982	8,590
0,333	0,2	0,5	0,333	0,25	1	2	3	0,0553	0,448	8,100
0,25	0,143	0,333	0,25	0,2	0,5	1	2	0,0362	0,295	8,151
0,2	0,111	0,2	0,2	0,143	0,333	0,5	1	0,0239	0,196	8,219
									TOTAL =	66,325
									AVERAGE =	**8,291**

b. Test Consistency Ratio (CR).

If $CR > 0{,}1$ then the pairwise comparison process should be repeated again until it is obtained $CR \leq 0{,}1$. Determine λ_{maks} by formula: $[Ax = \lambda_{maks}x]$,where *x* is the eigenvector.

Table 13. Table of λ_{maks} matrix

NO	CRITERIA	TYPE OF SHORELINE	HYDRO-OCEANOGRAPHY	COASTAL GRADIENT	COMP. SEAFLOOR	POINT REFERENCE	BACK AREA OF BEACH	COASTAL OBSTACLES	BEACH ACCESS	PRIORITY VECTOR
1	TYPE OF SHORELINE	0,0972447	0,11611833	0,1534527	0,056926	0,0725765	0,159292035	0,1509434	0,135135	0,1177
2	HYDRO-OCEANOGRAPHY	0,2917342	0,34835499	0,3069054	0,341556	0,4354588	0,265486726	0,26415094	0,243243	0,3121
3	COASTAL GRADIENT	0,0486224	0,087088748	0,0767263	0,056926	0,0725765	0,10619469	0,11320755	0,135135	0,0871
4	COMPOSITION OF SEAFLOOR	0,1944895	0,11611833	0,1534527	0,113852	0,0725765	0,159292035	0,1509434	0,135135	0,1370
5	POINT OF REFERENCE	0,2917342	0,174177495	0,230179	0,341556	0,2177294	0,212389381	0,18867925	0,189189	0,2307
6	BACK AREA OF BEACH	0,0324149	0,069670998	0,0383632	0,037951	0,0544323	0,053097345	0,0754717	0,081081	0,0553
7	COASTAL OBSTACLES	0,0243112	0,049764999	0,0255754	0,028463	0,0435459	0,026548673	0,03773585	0,054054	0,0362
8	BEACH ACCESS	0,0194489	0,03870611	0,0153453	0,02277	0,0311042	0,017699115	0,01886792	0,027027	0,0239
TOTAL		1	1	1	1	1	1	1	1	

Consistency Index (CI) obtained by formula:

$CI = (\lambda_{maks} - n)/(n-1)$

CI = (8,291-1)/(8-1) = 0,291/7 = 0,0416.

Consistency Ratio (CR) testing:

Table 14. Table of *Index Ratio (IR)*

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
IR	0,00	0,00	0,58	0,90	1,12	1,2	1,3	1,4	1,5	1,49	1,51	1,48	1,56	1,57	1,59

$CR = CI/IR$ (n=8)

CR = 0,0416/1,41 = 0,0295 ($CR \leq 0{,}1$ so consistent).

c. Develop a new hierarchy structure based on the criteria weighting value.

Tabel 15. Criteria weight matrix

NO	CRITERIA	WEIGHT
1	TYPE OF SHORELINE	0,1177
2	HYDRO-OCEANOGRAPHY	0,3121
3	COASTAL GRADIENT	0,0871
4	COMPOSITION OF SEAFLOOR	0,1370
5	POINT OF REFERENCE	0,2307
6	BACK AREA OF BEACH	0,0553
7	COASTAL OBSTACLES	0,0362
8	BEACH ACCESS	0,0239

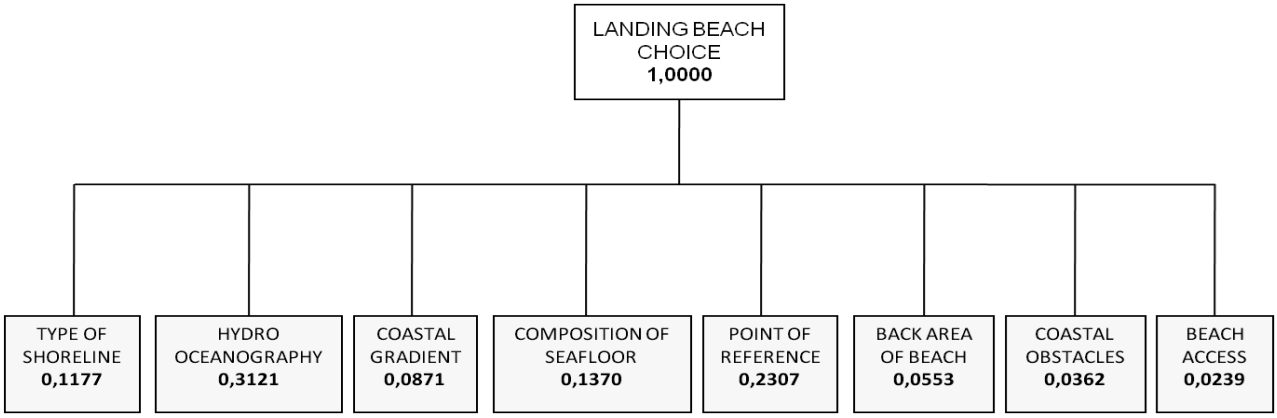

Fig. 7. New Hierarcy structure with criteria weight

d. The result of calculating alternative weight values for each criteria.

1. TYPE OF SHORELINE

TYPE OF SHORELINE	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,25	4	0,190	0,167	0,444	0,267
BEACH 2	4	1	4	0,762	0,667	0,444	0,624
BEACH 3	0,25	0,25	1	0,048	0,167	0,111	0,108
TOTAL	5,25	1,5	9	1	1	1	

2. HYDRO-OCEANOGRAPHY

HYDRO-OCEANO	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,2	5	0,161	0,149	0,385	0,232
BEACH 2	5	1	7	0,806	0,745	0,538	0,697
BEACH 3	0,2	0,142857	1	0,032	0,106	0,077	0,072
TOTAL	6,2	1,342857	13	1	1	1	

3. COASTAL GRADIENT

COASTAL GRADIENT	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,33333	3	0,231	0,200	0,429	0,286
BEACH 2	3	1	3	0,692	0,600	0,429	0,574
BEACH 3	0,3333	0,33333	1	0,077	0,200	0,143	0,140
TOTAL	4,3333	1,66667	7	1	1	1	

4. COMPOSITION OF SEAFLOOR

COMP. OF SEAFLOOR	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,333333	3	0,231	0,211	0,375	0,198
BEACH 2	3	1	4	0,692	0,632	0,500	0,608
BEACH 3	0,333333	0,25	1	0,077	0,158	0,125	0,120
TOTAL	4,333333	1,583333	8	1	1	1	

5. POINT OF REFERENCE

POINT OF REFERENCE	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,25	5	0,192	0,179	0,385	0,252
BEACH 2	4	1	7	0,769	0,718	0,538	0,675
BEACH 3	0,2	0,14286	1	0,038	0,103	0,077	0,073
TOTAL	5,2	1,39286	13	1	1	1	

6.BACK AREA OF BEACH

BACK AREA OF BEACH	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,5	2	0,286	0,273	0,333	0,297
BEACH 2	2	1	3	0,571	0,545	0,500	0,539
BEACH 3	0,5	0,333333	1	0,143	0,182	0,167	0,164
TOTAL	3,5	1,833333	6	1	1	1	

7. COASTAL OBSTACLES

COASTAL OBSTACLE	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,5	3	0,300	0,250	0,500	0,350
BEACH 2	2	1	2	0,600	0,500	0,333	0,478
BEACH 3	0,3333	0,5	1	0,100	0,250	0,167	0,172
TOTAL	3,3333	2	6	1	1	1	

8. BEACH ACCESS

BEACH ACCESS	BEACH 1	BEACH 2	BEACH 3	NORMALIZIED MATRIX			PRIORITY VECTOR
BEACH 1	1	0,5	2	0,286	0,250	0,400	0,312
BEACH 2	2	1	2	0,571	0,500	0,400	0,490
BEACH 3	0,5	0,5	1	0,143	0,250	0,200	0,198
TOTAL	3,5	2	5	1	1	1	

The new hierarchy arrangement is complemented by the criteria and alternative weights.

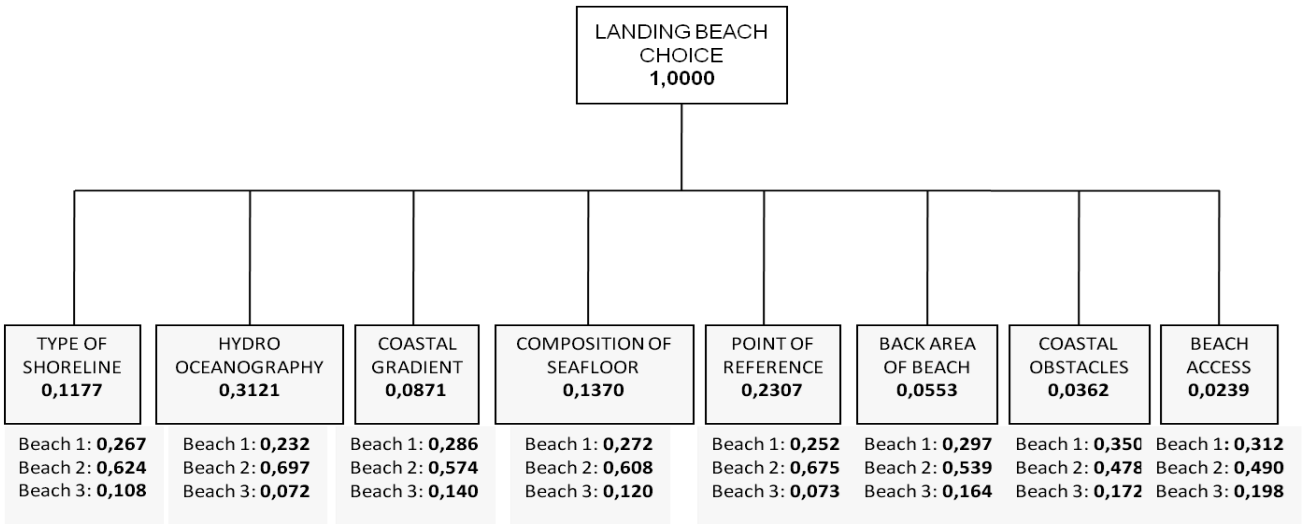

Fig. 8. New hierarcy structure with criteria and alternative weights.

e. Determine the preferred alternative ranking (Final Priority).

The calculation of priority matrix with the criteria weight can be seen in the following matrix multiplication:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} k \\ l \\ m \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$

$$\begin{bmatrix} 0{,}267 & 0{,}232 & 0{,}286 & 0{,}272 & 0{,}252 & 0{,}297 & 0{,}350 & 0{,}312 \\ 0{,}624 & 0{,}697 & 0{,}574 & 0{,}608 & 0{,}675 & 0{,}539 & 0{,}478 & 0{,}490 \\ 0{,}108 & 0{,}072 & 0{,}140 & 0{,}120 & 0{,}073 & 0{,}164 & 0{,}172 & 0{,}198 \end{bmatrix}$$

$$\begin{bmatrix} 0{,}1177 \\ 0{,}3121 \\ 0{,}0871 \\ 0{,}1370 \\ 0{,}2307 \\ 0{,}0553 \\ 0{,}0362 \\ 0{,}0239 \end{bmatrix} \qquad \begin{bmatrix} 0{,}259 \end{bmatrix}$$

Priority Matrix

Then we get the result of alternative choice of landing beach based on the value of weight on matrix final priority:

Tabel 16. Final result from rank of beach

PRIORITY MATRIX	FINAL PRIORITY	RANGKING
BEACH 1	0,259	**2**
BEACH 2	0,639	**1**
BEACH 3	0,101	**3**

The ranking results show that Beach 2 is the first rank, Beach 1 is the second rank and the last is Beach 3.

4. CONCLUSION

Based on the results of research conducted through data analysis conducted obtained the following results:

a. The result of the analysis with Borda method on the determination of the criteria rank and the landing beach alternative choice is known that the physical properties of Hydro-Oceanography become the first sequence with the value of weight of 0.207 followed by the criterion of reference point with the weight value of 0.193 in the second sequence and the type of beach criterion with the weight of 0.171 on the third sequence. As for the other criteria in order of rank that has been presented complete with the value of each weight. The results of this analysis can be used as a basis of preference for the decision maker in determining the preference of the next stage.

b. From the results of analysis with AHP method Final Priority each 2 with a value of weight of 0.639 was chosen to be the most appropriate beach location for amphibious landing operations. While for the Criteria Weight Beach 1 with a weight value of 0.259 and the third is Beach 3 with a weight of 0.101.

c. The integration between the Borda and AHP methods is well worth using in solving the landing beach location problem in amphibious operations where in the early stages of processing and data analysis the Borda method is able to provide preference support for decision makers to analyze data at a later stage (AHP) according to the stage of the process so that the results of the resulting alternative rankings are logical and objective.

d. In determining ideal landing beaches to carry out amphibian operations, there is a need for an analysis of the components to be used as the main criterion for selecting and alternating landing beach options that are multi-criteria.

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APPLICATION OF MULTI ATRIBUT DECISION MAKING ANP MODEL FOR SELECTION OF SUBMARINES COMPATIBLE BATTERIES

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Abstract

The Navy as a defense and security force has its combat equipment and its supporting facilities projected within the Integrated Fleet Weapon System (SSAT) with several components consists of KRI, marines, aircraft and bases. One of the KRI's strengths is the submarine where the current condition is over 30 years old resulting in the decrease of combat and cruising power. In order to improve the capabilities of submarine warfare, the Navy has made new procurement and extension of submarine life, the constraint in extending its life span is the discharged battery life of the submarine. This paper described the selection of submarine batteries in the extended life of the ship by using the Analytic Network Process method to determine the value of the priority weight of the alternative management system attributes based on the criteria. The results of the research was alternative submarine batteries. The chosen one was KSB SEBANG made in Korea with a priority weighting value of 0.474. Priority types of battery were Durability with weight of 0.201, 0.143 as operational weight, 0.129 as maintenance weight, 0.122 of spare part convenience weight, 0.115 as complexity weight, 0.110 as power weight, 0.076 as power weight, 0.071 as reliability weight and 0.033 as dimension weight.

Keywords: Battery, Submarine, Analytic Network Process.

1. INTRODUCTION.

The Navy as a defense and security force has its own combat tools and supporting facilities in the Integrated Fleet Weapon System (SSAT) consists of KRI, marines, aircraft and bases. The arrangement of the Navy's combat strength is aimed at achieving a minimum essential force (MEF), which means a capability designed force to face threats in order to guard and protect the sovereignty of the state, the Republic of Indonesia Unity and the safety of the entire nation with the assumption that possible risks is greater than the designed capabilities.

One of the KRI's strengths is the submarine. The current condition of the submarine is over 30 years old. So, the combat and cruising power is decreased. In order to improve the capabilities of submarine warfare, the Navy has made new procurement and extension of submarine life. The constraint in the extended life span is the submarine battery itself, where current batteries are depleted and outdated in the latest technology, reducing the submarine's movement.

A more compatible battery replacement was required to be able to perform the technological functions of submarine batteries that have been depleted. This paper aimed to provide an explanation of the submarine batteries selection as a new replacement in the ship using Analytic Network Process method to determine the value of the priority weight of alternative management system attributes based on the criteria prepared.

An ANP method is a mathematical theory that allows a decision maker to deal with dependent factors and systematic feedback. ANP is the latest method of multi-criteria decision making that is able to explain systematic interaction especially problems in supply chain strategy. ANP was developed to overcome the weaknesses of AHP that allows modeling problems in the form of Network. ANP is a method of solving an unstructured problem and the dependence of relationships between elements, permitting the interaction and feedback of elements in the cluster (inner dependence) and between clusters (outer dependence).

In decision-making, the ANP method has several advantages including its ability to assist decision makers in measuring and synthesizing a number of factors in the hierarchy or network, making it more general and more applicable to various qualitative studies (Nguyen et al 2014) .

Some of international journal were used in this study. The title of article journals used were described as follow, The Theoritical Structure of Fuzzy Analytic Network Process (FANP) with Interval Type-2 Fuzzy Sets (Senturk, et al., 2016). Designing a Decision Support System to Evaluate and Select Supplier Using Fuzzy Analytic Network Process (Razmi, et al., 2009). An Analytic network Process Model for Financial-Crisis Forecasting (Niemiraa & Saaty, 2004). A Hybrid Approach for Fuzzy Multi-Attribute Decision Making in Machine Tool Selection with Consideration of The Interaction of Attributes (Nguyen, et al., 2014). Analytic Network Process (ANP) Approach for Product Mix Planning in Railway Industry (Toroudia, et al., 2016). Applying Fuzzy Analytic network Process in quality Function Deployment Model (Afsharkazemi, et al., 2012). An analytic network process-based approach for location problems:the case of a new waste incinerator plant in the Province of Torino (Italy) (Bottero & Ferretti, 2011). Location selection for the construction of a casino in the greater London region (Ishizaka, et al., 2013). An ANP based TOPSIS approach for Taiwanese service apartment location selection (Chang, et al., 2015). Selection of non-traditional machining processes using analytic network process (Das & Chakraborty, 2011). Fundamentals of the analytic network process (Saaty, 1996). A fuzzy ANP approach to shipyard location selection (Guneri, et al., 2009). Fuzzy group decision-making for facility location selection (Kahraman, et al., 2003). Selection of the optimal tourism site using the ANP and fuzzy TOPSIS in the framework of Integrated Coastal Zone Management: A case of Qeshm Island (Morteza, et al., 2016). Supplier Selection: A Fuzzy-ANP Approach (Dargi, et al., 2014). Cutting tool material selection using grey complex proportional assessment method (Maity, et al., 2012). An integrated fuzzy synthetic evaluation approach for supplier selection based on analytic network process (Pang & Bai, 2013). Application of fuzzy analytic network process for supplier selection in a manufacturing organisation (Vinodh, et al., 2011).

Benefits of performing this studies was to provide a basic alternative decision-making to stakeholders in the selection of submarine batteries in the extended life of use.

This paper presented systematics flow as follows, part 1 was Introduction, part 2 was the material and methodology used, part 3 was results and discussion, section 4 was the conclusion.

2. METHODOLOGY

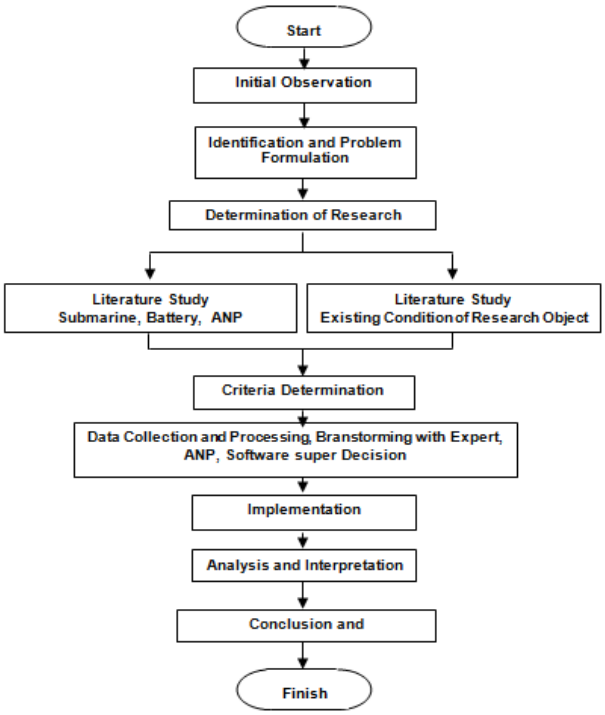


Fig. 1 Research Flow Chart

2.1. Initial Observation.

Initial observation was a preliminary activity of the research implementation to find ideas of research held by researchers, because of that the results of this research can be implemented and useful in solving problems faced by the students.

2.2. Identification and Problem Formulation.

After the preliminary observation, problem identification was subsequently performed. It would be used as research material in this study which was the selection of compatible Submarine batteries to support the essential tasks as Striking Forces Submarine in Navy Fleet.

2.3. Objective of The Study.

The next stage was to determine the purpose of this research which was to get a model to select the submarine batteries.

2.4. Literature Study.

In solving the problems, this study used of decision making theory basis using ANP (Analytic Network Process) to analyze the qualitative and quantitative criteria. Meanwhile, the supporting reference was a strategic policy of the Navy that had relevance about the election of compatible Submarine batteries.

2.5. Field Study.

Literature studies were performed to study the various theories that support the research. Some sources of literature study were reference books, Scientific Journals and similar research that discusses the concept of Multi Criteria Decision Making MCDM and Analytic Network Process (ANP). Field study conducted at KRI Nanggala 402 Submarine Command Unit Head of Eastern Fleet Command, PT. PAL Surabaya, School Submarine at Kobangdikal and STTAL. The objective was to find out the current state of the submarine battery and the conditions of alternative batteries that would serve as a substitute for references and Brainstroming with the experts.

2.6. Criteria Determination for Selecting Submarine Batteries.

Determination of criteria in the selection of available and compatible submarine batteries obtained by brainstorming with battery energy experts from PT. PAL Surabaya, and expert/user such as Commander and Head of Machine Department in KRI Cakra 401, Commander and Head of Machine Department in KRI Nanggala 402, Commander of Koarmatim Submarine Unit, Submarine School Commandant and STTAL Officer with submarine as their research concentration.

The minimal initial criteria that were compatible for the selection of submarine batteries were mentioned as follows:

a. Weight, or the weight of submarine battery.
b. Dimension, or the size of submarine battery.
c. Reliability of submarine battery.
d. Power resulted from submarine battery.
e. Spare Part Convenience.

f. Maintenancebility, or the convenience in maintaining Submarine battery

g. Operational of submarine battery.

h. Durability of the submarines.

i. Complexity against all vessel propulsion system.

Those criteria were initial criteria that would be developed after brainstorming with experts was performed.

2.7. Data Collection and Processing.

The next step was data collection and processing. The data were collected from the documents and interviews with Experts as mentioned above. These data include data on the influence factors of battery type and battery characteristics selection. The collection of data based on the collecting way were called primary data and secondary data. Primary data obtained from the data collection through filling questionnaires and interviews with correspondents who were decision makers and experts about Submarine. Secondary data was obtained from the results of the study or reference book related to criteria and alternatives.

Data processing data were performed by calculating relationship extent of a criterion using ANP Method. The results would be recorded in the program model, then will be processed using the software Superdecision.

2.8. Implementation.

Weighting results from each criterion were obtained from the data processing. It will be implemented to the real condition of submarine battery selection.

2.9. Interpretation and Analysis.

The analysis of data obtained from data processing was performed. This analysis was focused on the results of the weighting and ranking obtained in data processing.

2.10. Conclusion and Recommendation

In this final section, a thorough conclusion was drawn based on the results obtained to solve the problems that had been formulated upfront. The recommendation was an input to the Leader in the form of a suitable alternative and compatible battery for submarines to replace old batteries that had been expired.

3. RESULT AND DISCUSSION.

Steps of data collection needed in this research would be explained at this stage. The data collection was determination of submarine batteries criteria and modeling of network ANP along with analysis and discussion.

3.1. Criteria and Alternatives Determination.

Alternatives and Criteria used for submarines battery collection was obtained from brainstorming. Based on the results of interviews and brainstorming with experts and literature studies that had been implemented, the criteria had been arranged and described in Table 1 along with the alternatives that would be presented in Table 2.

Table. 1 Criteria Used

No.	Raised Criteria	Definition/Assessment Parameter
1	Operational Requirements (Opsreq)	Requirements related to usage operational of submarines battery
2	Technical Requirements (Techreq)	Technical Requirements related to design and specification of submarines battery

Table. 2 Alternatives Used

No.	Requirements	VARTA BZM (Jerman)	HAGEN (Jerman)	KSB SEBANG (Korea)
I	**Operational Requirements (Opsreq)**			
1	Operational	√	√	√
2	Complexity	√	√	√
3	Maintanancebility	√	√	√
4	Spare Part Convenience	√	√	√
II	**Technical Requirements (Techreq)**			
1	Weight	480 cell x59 kg √	480cell x 61kg √	480cell x55kg √
2	Dimension 1 cell	133x29x45 cm√	145x30x45 cm√	130x25x45 cm√
3	Power	1,5-2,7V,200 A√	1,5-2,5V,200 A√	1,5-3V,220 A √
4	Reliability	√	√	√
5	Durability	10-12 th√	9-11 th√	10-15 th√

Notes: √ Met the requirements for submarines.

The alternatives shown in Table 2 were the results of Brainstroming about Battery Submarines that had met all operational and technical requirements. The criteria mentioned in Table 3.1 was subcriteria that had been reviewed by experts in which the Operational Requirements (Opsreq) criteria had 4 (four) subcriteria while for Technical Requirements (Techreq) criteria had 5 (five) subcriteria. In Table 3 and Table 4 was a brief description of each subcriteria of the two criteria.

Table. 3 Sub-criteria on Operational Requirements (Opsreq) Criteria.

No.	Subcriteria Raised	Definition/Assessment Parameter
1	Operational	Operational convenience of how to use the battery from start until finish.
2	Complexity	The complexity condition of the battery system that was capable of working with other systems in the submarine includes trouble shooting convenience.
3	Maintanance	Convenience of care and maintenance period.
4	Spare part convenience	Convenience to obtain component/spare part for repairing and maintenance.

Table. 4 Sub-criteria on Technical Requirements (Techreq) Criteria

No.	Subcriteria Raised	Definition/Assessment Parameter
1	Weight	Battery weight that affects overall stability and speed of submarine
2	Dimension	Dimension/battery size that affects overall stability and speed of submarine.
3	Power	The system and the amount of power that can be generated and integrated with populsion and electrical system of submarine.
4	Reliability	Battery reliability at critical times required including reliability of supporting components.
5	Durability	Durability and battery life in normal maintenance condition.

The description was summarized in Table 5 below:

Table. 5 Criteria dan Sub-criteria Selection Submarine.

No.	Sub-criteria	Criteria
1	Operational	Operational Requirements (Opsreq)
2	Complexity	
3	Maintanance	
4	Spare part convenience	
5	Weight	Technical Requirements (Techreq)
6	Dimension	
7	Power	
8	Reliability	
9	Durability	

3.1.2. The Making of ANP Model Network. After determining the assessment criteria, then the ANP hierarchy model as shown in Figure 2 was arranged.

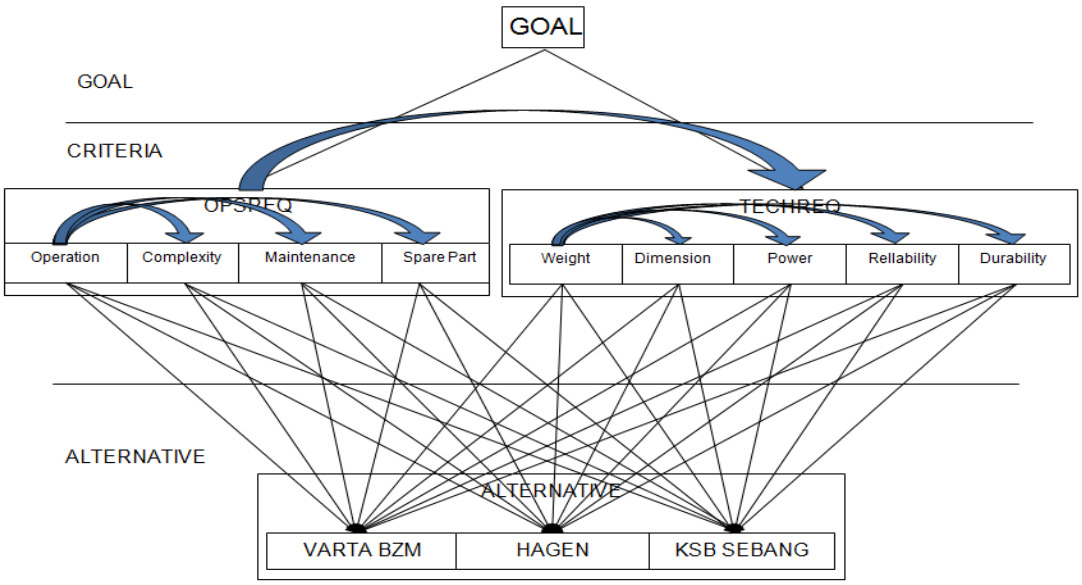


Fig. 2 ANP Hierarchy Model.

Based on the concept of existing models, a model using Super Decisions software was created to identify the existence of relationships that affect logically. There were 9 (nine) sub-criteria that were grouped into 2 cluster criteria: Operational Requirements (Opsreq) and Technical Requirements (Techreq) which had 5 (five) sub-criteria plus 1 (one) Goal. In Figure 3, a Network ANP model using Super Decisions software would be described.

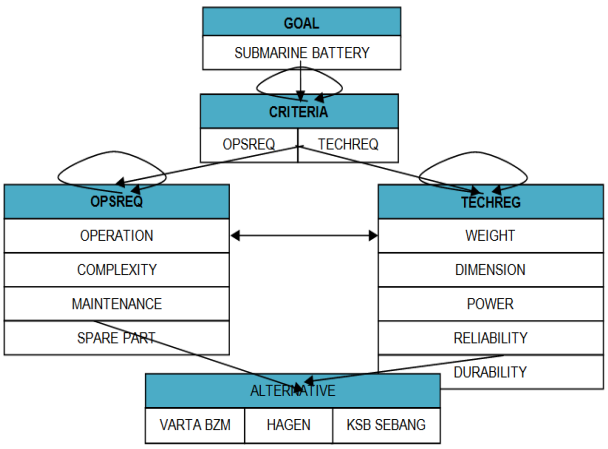


Fig. 3 ANP Model Network using Super Decisions.

The arrows in Figure 3 showed that there was effect. The base of the arrow means that the cluster had effect, while the arrow direction means the cluster that was affected. For example, the elements in Opsreq affected the Alternatives cluster in Figure 3. While the two-way arrow showed the relationship of mutual influence between two clusters or the intended element (feedback). In Figure 3, the two-way arrows on the Opsreq and Techreq clusters indicated that the Opsreq cluster affected the Techreq cluster and vice versa, the Techreq cluster affect Opsreq cluster.

3.1.3. Innerdependence and Outerdependence Relationship

In the ANP network model there were a whole of innerdependence and outerdependence of the clusters and elements in it. The arrows in the picture were the influence, the base of the arrow means the element of the affected criterion, while the incoming arrow means that the element of the criterion that influences. Relationships that occur in determining the relationship innerdependence and

outerdependence was the result of brainstorming according to the experience of experts as experienced officials.

a. **Innerdependence Relationship in Each Cluster.**

The following is an explanation of the relationship of each cluster's Innerdependence criterion:

1) Innerdependence relationship in Opsreq. Cluster

Table. 6 Innerdependence relationship in Opsreg Cluster

No.	Innerdependence	Definition/Assessment Parameter
1	Operation with Complexity	How to operate submarine battery from start until finish, affecting on condition of electrical power complexity system and submarine propulsion.
2	Operation with Maintenance	How to operate submarine battery from start until finishing, affecting on the battery maintanance type of submarines.
3	Complexity with Maintenance	Complexity of Battery System affecting on the battery maintanance type of submarines.
4	Complexity with Spare Part Convenience	Condition The complexity of the battery system requires the existence of an easy and good spare part procurement system.
5	Maintenance with Spare Part Convenience	battery maintanance type of submarines. requires the existence of an easy and good spare part procurement system.

In Table 6 innerdependence relationship between the criterion elements present in one Opsreq cluster.

2) Innerdependence relationship in Techreq Cluster.

Table. 7 Innerdependence Relationship in Techreq Cluster

No.	Innerdependence	Definition/Assessment Parameter
1	Weight with Dimension	The weight condition of the submarine's batteries is influenced by the size / dimensions of the Battery.
2	Weight with Power	Condition The battery's weight on the submarine requires enough power to drive the submarine.
3	Dimension with Power	The weight condition of the submarine's batteries requires enough power to drive the submarine.
4	Power with Reliability	Power / daya baterei mempengaruhi kehandalan atau reliability dari baterei Kapal selam.
5	Power with Durability	Power / battery power affects the reliability of the Battery armored submarine.
6	Reliability with Durability	The reliability of submarine batteries is strongly influenced by the durability of submarine batteries.

In Table 7, innerdependence relationship between the criterion elements present in one Techreq cluster was described.

b. **Outerdependence Relationship among Clusters.**

In addition to the relationship of Innerdependence that occurs within each cluster, there is also an Outerdependence relationship between the clusters in the network, which are described as follows:

Table. 8 Outerdependence Relationship among clusters.

No.	Outerdependence	Definition/Assessment Parameter
1	Opsreq -- Techreq	The subcriteria present on **(Opsreq)** affects the technical specifications of submarine batteries purchased later on, so as to support the entire mission. Similarly, it is vice versa with the more complete and fulfillment of Sub technical criteria **(Techreq)** that exists, then the tactical and operational values obtained will be better and higher.

In Table 8, the outerdependence relationship between the Opsreq cluster and the Techreq cluster was explained.

3.1.4. Questionnaire Data Collection.

Preparation of questionnaires were done using reference network model that had been formed. The questionnaire was based on the relationship between the criterion elements of innerdependence and outerdependence and the preference relationship between the criteria along with the goals by pairwise comparison between the cluster or the cluster elements.

This questionnaire aimed to find out about how big the relationship was, based on the assessment of the respondents. The respondents were the experts, who were directly related of the submarine such as Navy officers / direct users

Reasons for selecting different respondents to fill out this questionnaire was because the stakeholder representation was expected to give different point of view so the result would be close to the actual conditions.

This questionnaire led to 2 (two) assessment objectives that were determining the submarine's alternative priorities and determining the criteria for ultimate/critical selection of submarines.

In answering the questions in this questionnaire, respondents did not need to do discrete weighting by numbers but only intuitively through linguistic variables. The linguistic variable was a variable whose value was words or sentences. Here, we would use a statement to compare two criteria with five basic linguistics that were equally important, slightly more important, more important, very important and most important. The composition of the questionnaire that had been made can be seen in Appendix I of this Final Project.

3.2. Data Processing.

The next stage after obtained data, was the activity of data processing. The method used in this study was ANP method and the data processing was performed through Super Decisions software. The questionnaire data which was filled with respondent perception about submarine selection was the data that being processed.

To facilitate the data processing, a new notation on alternatives criteria and sub-criteria was created The notation list was presented in Table 9.

Table. 9 List of Notation

No.	Name	Code
1	Submarine Battery Selection	G
2	Operational Requirements	O
3	Technical Requirements	T
4	Operational	O1
5	Complexity	O2
6	Maintenance/	O3
7	Spare Part Convenience	O4
8	Weight	T1
9	Dimension	T2
10	Power	T3
11	Reliability	T4
12	Durability	T5
13	VARTA BZM	A1
14	HAGEN	A2
15	KSB SEBANG	A3
16	Respondent 1 / PT. PAL	R1
17	Respondent 2 / Dan KRI 401	R2
18	Respondent 3 / Kadepsin 401	R3
19	Respondent 4 / Dan KRI 402	R4

No.	Name	Code
20	Respondent 5 / Kadepsin 402	R5
21	Respondent 6 / Dan Satsel	R6
22	Respondent 7 / Dan Sekasel	R7
23	Responde8 8 / Pwa STTAL	R8

3.2.1 Matched Comparison Matrices.

Once the network model was created, the value pairwise comparison between criteria and alternatives for each subcriteria could be determined. The pairwise comparison value was obtained by using questionnaire. The priority weight value for each category obtained based on pairwise comparison value would be compared to get the final priority weight value.

The data obtained from the questionnaire distribution were pairwise comparison values between criteria and inter-alternatives for each subcriteria. Assessment of respondents wouldl be incorporated by using the geometric mean as follows:

$$\sqrt[n]{\prod_{i=1}^{n} X_i} \qquad (1)$$

X_i = Decision on comparison of the first criterion

The calculation of the average geometric of pairwise comparison value from the questionnaire results could be seen in Appendix III. Geometric mean recap of pairwise comparisons between criteria and sub-criteria was presented in Table 10

Table. 10 Geometrical Average Record Value Pairwise Comparison.

Matched Comparison	Geomean
For G	
O vs T	1,00
For O	
O1 vs O2	3,00
O1 vs O3	3,54
O1 vs O4	1,17
O2 vs O3	3,91
O2 vs O4	1,03
O3 vs O4	0,28
For T	
T1 vs T2	0,98
T1 vs T3	0,98
T1 vs T4	1,17
T1 vs T5	0,29
T2 vs T3	0,94
T2 vs T4	0,78
T2 vs T5	0,31
T3 vs T4	3,17
T3 vs T5	0,31
T4 vs T5	0,29
For O2	
O1 vs O3	4,31
O1 vs O4	2,47
O3 vs O4	0,31
For O2	
T1 vs T2	2,77
T1 vs T3	1,12
T1 vs T4	3,00
T1 vs T5	0,90
T2 vs T3	0,32
T2 vs T4	1,12
T2 vs T5	0,31
T3 vs T4	3,04
T3 vs T5	0,86
T4 vs T5	0,34
For O3	
T3 vs T5	1,06
For O4	
T2 vs T4	1,00
T2 vs T5	0,36
T4 vs T5	0,27
For T3	
O1 vs O2	3,72
O1 vs O3	3,77
O2 vs O3	3,03
For T3	
T1 vs T4	1,10
T1 vs T5	0,29
T4 vs T5	0,33
For T4	
O2 vs O4	0,96
For T4	
T1 vs T2	0,28
T1 vs T3	0,29
T1 vs T5	0,99
T2 vs T3	0,45
T2 vs T5	0,30
T3 vs T5	0,93
For T5	
O2 vs O4	0,28
For T5	
T1 vs T3	1,05
T1 vs T4	2,04
T3 vs T4	2,74

The calculated geometric mean was subsequently inserted into pairwise comparison matrices. For example, Table 11 showed a pairwise comparison matrix between subcriteria on Opsreq criteria. Other pairwise comparison matrices could be seen in Appendix III.

Table. 11 Match Comparison Matrices Opsreq criteria

O	O1	O2	O3	O4
O1	1,00	3,00	3,54	1,17
O2	0,33	1,00	3,91	1,03
O3	1,00	0,26	1,00	0,28
O4	3,91	1,00	3,54	1,00

After obtaining one pairwise comparison value for each relationship, the calculation of local priority weighting was subsequently performed. This calculation aimed to determine the weight of each interconnected element. Each time the weighting of local priorities was performed, the value of consistency was needed to be considered. The value of inconsistency should not exceed 0.1. For example, it could be seen in Table 8. which showed the inconsistency value of pairwise comparisons between subcriteria on Opsreq criteria.

Apparently, Table 12 showed that the Inconsistency Index was obtained at 0.057779. The value was still below 10% or 0.1 which means that the answers given by the respondents in this questionnaire had been consistent.

Table. 12 Inconsistency Index on Matching Comparison between Sub-criteria on Opsreq Criteria.

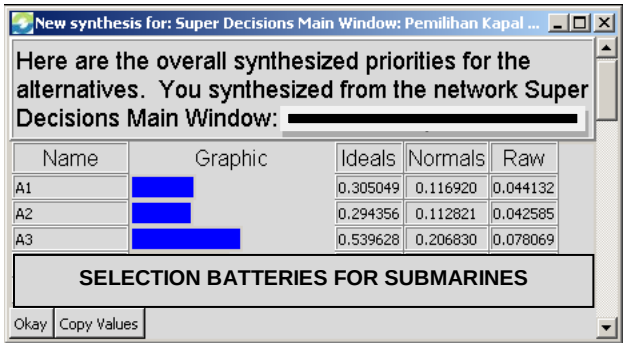
Inconsistency Report

Rank	Row	Col	Current Val	Best Val	Old Inconsist.	New Inconsist.	% Improvement
1. Tom	01	02	3.000000	1.775379	0.057779	0.016134	72.08 %
1. Exp. Choice	01	02	3.000000	1.012598	0.057779	0.001316	97.72 %
1. Bill	01	02	3.000000	1.012598	0.057779	0.001316	97.72 %
2. Tom	01	03	3.540000	5.149719	0.057779	0.039687	31.31 %
2. Exp. Choice	01	03	3.540000	7.395784	0.057779	0.035308	38.89 %
2. Bill	01	03	3.540000	7.395784	0.057779	0.035308	38.89 %
3. Tom	02	03	3.910000	2.900631	0.057779	0.043709	24.35 %
3. Exp. Choice	02	03	3.910000	2.195911	0.057779	0.038541	33.30 %
3. Bill	02	03	3.910000	2.195911	0.057779	0.038541	33.30 %
4. Tom	01	04	1.170000	1.505585	0.057779	0.050997	11.74 %
4. Exp. Choice	01	04	1.170000	1.900808	0.057779	0.050267	13.00 %
4. Bill	02	04	1.030000	1.408070	0.057779	0.048143	16.68 %
5. Tom	02	04	1.030000	1.179195	0.057779	0.051045	11.65 %
5. Exp. Choice	02	04	1.030000	1.408070	0.057779	0.048143	16.68 %
5. Bill	01	04	1.170000	1.900808	0.057779	0.050267	13.00 %
6. Tom	03	04	3.571400	3.420411	0.057779	0.057654	0.22 %
6. Exp. Choice	03	04	3.571400	3.285665	0.057779	0.057729	0.09 %
6. Bill	03	04	3.571400	3.285665	0.057779	0.057729	0.09 %

3.2.2 Data Processing with Super Decisions Software.

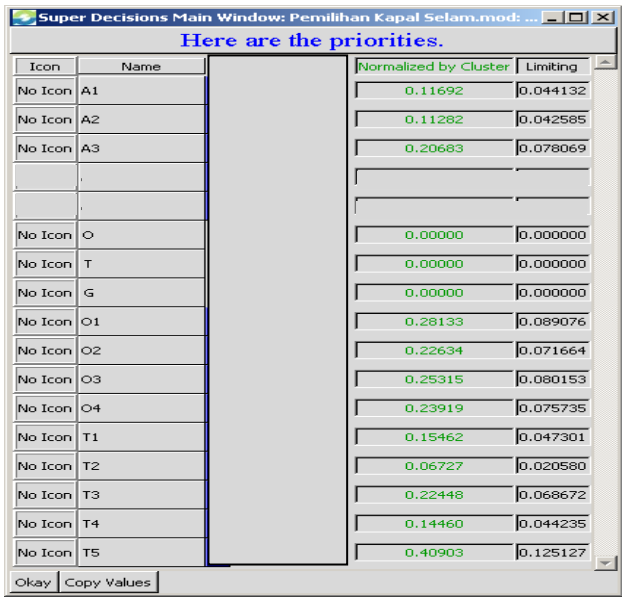
After inserting all geometric mean into the questionnaire format in the Super Decisions software, the software did all the ANP method steps by running Synthesize, which contained alternate weight values as seen in the red circled value in Table13.

Table 13 Alternatif Weight Value.



As for knowing the overall alternative and criteria, Priorities menu on Super Decisions can be used to obtain the weight value of alternatives and criteria as seen in Table 14.

Table 14 Alternatives and Criteria Weight Value.



3.2.3. Analysis and Results of Processing Data Analysis.

At this stage results from data processing in the previous sub-chapter would be analyzed and interpreted.

3.2.4. Consistency Ratio Analysis

Based the results of data processing in the form of questionnaires, Consistency Ratio (consistency ratio) could be obtained, where all the value of consistency ratio was below 10% (0.1). So, according to the fact that stated by (Saaty, 1996), the assessment system had been called consistent.

3.2.5. Alternative Priority Analysis.

In the data processing by using Super Decisions software, priority alternatives could be known by looking at the weight value of each alternative. From Table 13, we could get an alternative priority sequence based on the weight value of each alternative as follows:

a. First Priority was alternative 3 (A3) with a weight value of 0.20683.

b. Second Priority was alternative 1 (A1) with weight value 0.11692.

c. Third Priority was alternative 2 (A2) with weight value 0,11282.

So, if the normalization of weight values was performed, then the Priority Order of Nanggala Class Selected Submarine Batteries could be labeled as follows:

Table 15 Final Weighting of Battery Type Selected

Priority	Kode	Jenis Baterei	Nilai Bobot	Normalisasi Nilai Bobot Akhir
1	A3	KSB SEBANG	0,20683	0,474
2	A1	VARTA BZM	0,11692	0,268
3	A2	HAGEN	0,11282	0,258
Jumlah			0,43657	1,000

3.2.6. Criteria Process Analysis

In addition to alternative priorities, the results of data processing using Super Decisions software also included priority criteria for submarine batteries. The priority sequences of Battery Criteria were based on the weight value of each alternative as follows:

a. First Priority was Criteria T5 with the weight of 0,125127.

b. Second Priority was Criteria O1 with the weight of 0,089076.

c. Third Priority was Criteria O3 with the weight of 0,080153.

d. Forth Priority was Criteria O4 with the weight of 0,075735.

e. Fifth Priority was Criteria O2 with the weight of 0,071664.

f. Sixth Priority was Criteria T3 with the weight of 0,068672.

g. Seventh Priority was Criteria T1 with the weight of 0,047301.

h. Eight Priority was Criteria T4 with the weight of 0,044235.

i. Ninth Priority was Criteria T2 with the weight of 0,020580.

So if the normalization of weighted values was performed, then the Priority Order of Battery Criteria Submarine could be labeled as follows:

Table 16. Final Weighting of Submarine Battery Criteria.

Priority	Kode	Kriteria	Nilai Bobot	Normalisasi Nilai Bobot Akhir
1	T5	Durability	0,125127	0,201
2	O1	Operasional/Cara Pemakaian	0,089076	0,143
3	O3	Maintenance/Perawatan	0,080153	0,129
4	O4	Kemudahan Spare Part	0,075735	0,122
5	O2	Complexity/Kompleksitas	0,071664	0,115
6	T3	Power/Daya	0,068672	0,110
7	T1	Weight/berat	0,047301	0,076
8	T4	Reliability/Kehandalan	0,044235	0,071
9	T2	Dimension/Dimensi	0,020580	0,033
Jumlah			**0,622543**	**1,000**

4. CONCLUSION.

Selection of Submarine batteries could be solved by Analytical Network Process (ANP) method, which was a selection method with many criteria of MCDM (multi criteria decision making) that was structured, systematic and had the ability to accommodate interconnectedness between criteria or alternatives. Based on the results of brainstorming with the experts, the criteria obtained were: Operational Requirements (Opsreq) with 4 (four) sub-criteria include operational, complexity, maintenance, ease of spare parts. Meanwhile, Technical Requirements (Techreq) criteria had 5 (five) sub-criteria such as weight, dimension, power, reliability, durability.

Result of the research was alternative of submarine battery chosen. The chosen one was KSB type made in Korea with priority weight value 0,474. In sequence, the next alternative priority was Varta BZM batteries made in Germany with a priority weight of 0.268 and the next was Hagen German-made batteries with a priority weight of 0.258

In addition to the priority of alternative types of batteries, this research had also resulted in the priority of battery criteria. The priority sequence of Battery Criteria was as follows: Durability with weight of 0.201, operational with weight of 0.143, maintenance with weight of 0.129, spare part convenience with weight of 0.122, complexity with weight of 0.115, power with weight of 0.110, weight of 0.076, reliability with weight of 0.071, and dimension with weight of 0.033.

Based on the above research, the priority weight of each battery was not much different so it only needs a suitable price for the purchase of these batteries.

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THE PROMETHEE ANALYSIS TO DETERMINE OPTIMUM AMPHIBIOUS RAID TARGET IN AMPHIBIOUS OPERATION

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ABSTRACT

Indonesia as one of world archipelagic country has larger water area than its land area. It has unrestricted sea access to the main shoreline and generated threat to Indonesian territorial sovereignty. An amphibious operation is a sea to land war operation and it most suitable for Indonesian geographic. Amphibious raid can be combined with amphibious assault in Amphibious operation. The aim of the paper is determining the optimum amphibious raid target that gives best impact and effectivity. Promethee analysis approach compares alternatives target based on 6 criteria. Criteria used for determining landing point are the value of the target, time to reach the target area, obstacle of the lane, a risk of detected, vehicles availability and withdrawal support. From 3 alternatives given by data simulation, the best alternative has 3 benefits from given 6 criteria.

KEYWORDS : Amphibious operation, Amphibious raid, Promethee.

1. INTRODUCTION

Indonesia that located in south-east Asia has coverage of area approximately 7,9 million square kilometers, is one of world archipelagic country (Persoon & Weerd, 2006). It has 13.466 named islands stretched in equatorial, which 5 main islands are Sumatra, Java, Borneo, Celebes and Papua (Tumonggor & et. al., 2013). It gets to benefit from the geographical position as central to cross line Asia and Australia Continent and Indian and Pacific Ocean (Manurung, 2016). The changed of goods delivery method from land transportation route (silk road) to ocean shipping transportation made Indonesia become connector of Eurasian Blue Belt that gives them great strategical value (Habova, 2015).

Indonesian people blessed with larger water coverage compared to their land area, approximately 63% (Hutomo & Moosa, 2005). Plenty of natural resources especially mining resources and the fishing product must be managed well to increase people prosperity (Subekti, 2013). Indonesia has lots of volcanoes from Aceh in the north of Sumatra stretched until Moluccas (Rinard Hinga, 2015). High rainfall rate and soil fertility as the effect of volcanoes eruption create large of rainforest area in Indonesia. The most important of all, Indonesia has 3 world shipping line: ALKI 1, ALKI 2 and ALKI 3 (Vantier, et al., 2005).

In another hand, this geographical benefit gives weaknesses in the transportation sector. They found difficulties for their transportation as land transport vehicles cannot reach all the landscape (Ralahatu & Jinca, 2013). This situation creates centralized of developing in Java Island. Indonesia needs good water transportation facilities to support the movement of humans, goods, and technology to the rest of the country (Georgescu, 2014). The structure of Indonesian islands composition and unrestricted access from the sea in lots of shorelines increase maritime vulnerability (Bakir, 2007). The government needs to assure national security and

unity of Indonesian territory. Defense Ministry gets this role, and it executes by Indonesian Armed Force (TNI) (Indonesia, 2004).

Indonesia embraces active defensive defense principal (Indonesia, 2015). It's mean that Indonesia will avoid expansion to another nation, but will be ready to eliminate every threat from outside. This principal need responsive defense system. It affected in last 10 years defense posture development be the main priority of Defense Ministry that booked in Indonesian Minimum Essential Force (MEF) (Piesse, 2015). This military policy made an extension of the dynamic changes of military power in South East Asia and Pacific region (Shekhar, 2013).

Java Island as the center of Indonesian government and economics activities in Indonesia. This circumstance followed by military power concentrated in Java. Defense elements composition in islands other than Java are adequate, create susceptible areas especially in nation borders (Guild & Carrera, 2013). This situation can increase eagerness of invasion to Indonesia territory.

An amphibious operation is war operation that most suited for enemy's beach area assault. The amphibious operation generally described as troops attack movement from sea to beach foundation area using amphibious vehicles. Amphibious operation initially with battleship maneuver in the sea to deploy amphibious vehicles. Amphibious operation arranged by a good collaboration of communication and water movement between the battleship and amphibious landing unit. The accuracy of deciding beach foundation area that giving advantageous needed to ensure amphibious operation well executed (Navy, 2014).

Amphibious Surveillance Unit is an elite troop of Indonesian Marine Corps. It has best known in special military operation. Speed, secret and deadly ability are the main characteristic of this unit. All that descriptions make Amphibious Surveillance Unit especially used as a beach spies mission and amphibious raid (TNI AL, 2003).

One of the main war principal said that war must be finished in the shortest period (Tzu & Hou, 2003). This principle requires strategy developing from usual strategies. Shock factor in a battle can decide the result of war (Clausewitz & Gatzke, 1942). Technology and knowledge development make basic and plot strategies can learn handily. It became a vulnerable side to anticipate and exploited by enemies. Amphibious raid implementation concept planned an attack from the unpredicted side can boost chaos effect for enemies.

The aim of this paper is giving optimum amphibious raid target as an early part of amphibious operation using Promethee. Promethee used for determining best amphibious raid target option from available given alternatives.

Promethee developed by French professor Jean-Pierre Brans, is an abbreviation of Preference Ranking Organization Method for Enrichment of Evaluations (Figueira, et al., 2005). It calculates suitable alternatives for purpose and integrated problem understanding. Promethee determines decision problem rational and comprehensive, grouped action, identify and quantified conflict and synergy, and giving alternatives for a structured reason (Behzadian, et al., 2010).

The inscriptive benefit from this paper in giving academic contribution in amphibious operation which referenced to improving Indonesian national defense.

2. MATERIALS/METHODOLOGY

2.1. Promethee

Multi-criteria analysis help managers and leaders in the decision making of decision alternatives compared with some criteria (Department for Communities and Local

Government, 2009). One of multi-criteria analysis methods popularly use is Promethee. Promethee generally used in one by one comparison based on criteria. This approach mostly applied to environmental management, business management, logistics and distribution, and factory production and assembly.

Promethee used to give a solution in:

a. Alternative decision-making
b. Priority decision making
c. Resources allocation
d. Ranking
e. Conflict resolution

Promethee process consists of:

a. Threshold value calculation
b. Preference degree value calculation
c. Preference index value calculation
d. Preference direction calculation

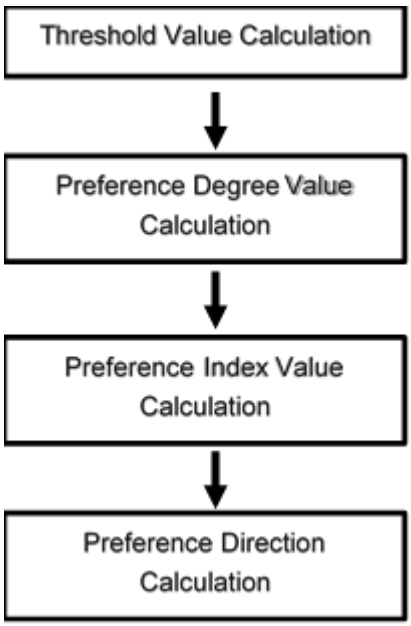

Fig. 1 Flowchart

Preference Value

Calculate preference value between alternatives using preference function

$$H(d) = \begin{cases} 0 & d \leq 0 \\ 1 & d > 0 \end{cases} \quad \text{.....(1)}$$

H(d) = criteria margin function

d = margin of first criteria and second criteria

Preference Index

Preference index is intensity of decision maker preference that stating first alternative is better than second alternative. Its considered simultaneously from all of criteria.

$$\varphi(a,b) = \sum_{i=1}^{n} \pi_i P_i(a,b) : \forall a,b \in A \quad \text{.....(2)}$$

$\varphi(a,b) = 1$; strong preference a than b

$\varphi(a,b) = 0$; weak preference a than b

Leaving flow

Leaving flow is node lead away from a point, for example point a.

$$\emptyset^{+}(a,x) = \frac{1}{n-1} \sum_{X \in A} \varphi(a,x) \quad \text{.....(3)}$$

$\varphi(a,x)$ =alternative preference of a better than x

n = total value

Entering flow

Entering flow is node inside to a point, for example point a.

$$\emptyset^{-}(a,x) = \frac{1}{n-1} \sum_{X \in A} \varphi(a,x) \quad \text{.....(4)}$$

$\varphi(a,x)$ = alternative preference of a better than x

n = total value

Net flow

Net flow is margin between leaving flow and entering flow

$$\emptyset = \emptyset^{+}(a) - \emptyset^{-}(a) \quad \text{.....(5)}$$

2.2. Amphibious Operation

First amphibious operation performed by Continental Navy and Continental Marines in 1776 for Nassau War (Nassau Assault) in the Bahamas. The objectives of this attack are to capture Britain gunpowder storage, arms, and munitions. It engages 210 marines and 50 sailors utilize ships (Anderson, 1962). Based on usage, amphibious operation classified in 5 types (Navy, 2014):

a. Amphibious Raid
b. Amphibious Demonstration

c. Amphibious Assault

d. Amphibious withdrawal

e. Other Operations such as conflict prevention and disaster mitigation.

5 important phases of amphibious operation:

a. Planning; using backward planning start from landing vehicles maneuver.

b. Embarkation; prepare every material used to perform an amphibious operation.

c. Rehearsal; make sure every unit mastering their assignment.

d. Moving; consist of sea maneuver and preparation to debark amphibious vehicles into several phases.

e. Action; is projection amphibious operation to the land.

Amphibious operation planning conducted based on land movement to avoid miscommunication and allow good coordination when personal carrier vehicles reach beach foundation area.

2.3. Amphibious Raid

Amphibious raid is quick executed amphibious assault with a planned withdrawal. There are 3 main aspects of Amphibious Raid:

a. Speed

b. Stealthiness

c. Support

Speed is related to time needed to reach target area and obstacles in the lane. Stealthiness mean a risk of being detected by enemies from every movement we made. Support is a combination of landing vehicles availability and withdrawal plan support. Amphibious raid main task is to create destruction, secure the information, divide enemy's concentration and search and rescue personnel/material duty. Amphibious raid involves small unit and operated before or simultaneous with an amphibious assault.

Amphibious raid landing location criteria need to consider 3 main aspects above. Each criterion will be assessed using rating 1-5 depend on an advantage of each criterion refer to operation achievement :

a. 1 is a high disadvantage

b. 2 is a low disadvantage

c. 3 is neutral

d. 4 is a low benefit

e. 5 is a high benefit

Amphibious raid landing location criteria in this analysis determined as:

a. Value of target

b. Time to reach target area

c. The obstacle in the lane

d. Risk of detected

e. Landing Vehicles availability

f. Withdrawal support

Table 1. Criteria

Code	Criteria
C1	Value of target
C2	Time to reach target area
C3	Obstacle of the lane
C4	Risk of detected
C5	Landing vehicles availability
C6	Withdrawal support

Measurement score of every criterion are:

a. Value of target measured by the importance of each target for enemy side.

b. Time to reach target area measured by the time needed to reach each target.

c. Obstacle of the lane measured by difficulties on approach road to each target.

d. Risk of detected measured by enemy detection possibilities caused by raid amphibious movement.

e. Landing vehicles availability measured vehicles action complexity to approach each target.

f. Withdrawal support measured by difficulty for withdrawal movement.

2.4. Target

The target of analysis in this paper is giving an optimal target for amphibious raid based on criteria decided.

3. RESULT AND DISCUSSION

Given 3 alternative targets based on intelligent data simulation. Promethee analysis given by:

Table 2. Alternative targets

Target	A	B	C
C1	Communication center	Gunnery	Port
C2	80 minutes	60 minutes	40 minutes
C3	Hillside	Plain surface	Beach area
C4	Minimal risk	Considerable risk	Medium risk
C5	Difficult access	Accessible	Accessible
C6	Open withdrawal spot	Close withdrawal spot	Open withdrawal spot

Table 3. Scoring Table

	A	B	C
C1	5	4	3
C2	3	3	5
C3	2	4	3
C4	5	4	2
C5	1	4	4
C6	5	2	4

Table 4. Preference value

Criteria	(A,B)		(A,C)		(B,A)		(B,C)		(C,A)		(C,B)	
	d	H(d)	d	H(d)	d	H(d)	d	H(d)	d	H(d)	d	H(d)
C1	1	1	2	1	-1	0	1	1	-2	0	-1	0
C2	0	0	-2	0	0	0	-2	0	2	1	2	1
C3	-1	0	-1	0	2	1	1	1	1	1	-1	0
C4	1	1	3	1	-1	0	2	1	-3	0	-2	0
C5	-3	0	-3	0	3	1	0	0	3	1	0	0
C6	3	1	1	1	-3	0	-2	0	-1	0	2	1

Preference index Multi criteria preference index result

(A,B) = $^1/_6$ (1+0+0+1+0+1) = 0.50

(A,C) = $^1/_6$ (1+0+0+1+0+1) = 0.50

(B,A) = $^1/_6$ (0+0+1+0+1+0) = 0.33

(B,C) = $^1/_6$ (1+0+1+1+0+0) = 0.50

(C,A) = $^1/_6$ (0+1+1+0+1+0) = 0.50

(C,B) = $^1/_6$ (0+1+0+0+0+1) = 0.33

Table 5. Preference index

	A	B	C
A	-	0.50	0.50
B	0.33	-	0.50
C	0.50	0.33	-

Leaving flow result for each alternative

A = 1/(3-1) (0.50+0.50) = 0.50

B = 1/(3-1) (0.33+0.50) = 0.417

C = 1/(3-1) (0.50+0.50) = 0.417

Entering flow result for each alternative

A = 1/(3-1) (0.50+0.50) = 0.417

B = 1/(3-1) (0.50+0.50) = 0.417

C = 1/(3-1) (0.50+0.25) = 0.50

Net flow as result of Promethee analysis

A = 0.50 – 0.417 = 0.083

B = 0.417 – 0.417 = 0

C = 0.417 – 0.50 = - 0.083

Promethee analysis for amphibious raid target selection based on criteria determined are:

Table 6. Overview result of Promethee

Alternative	Leaving flow	Entering flow	Net flow	Ranking
A	0.50	0.417	0.083	1
B	0.417	0.417	0	2
C	0.417	0.50	-0.083	3

4. CONCLUSION

From this paper analysis provide result:

a. Amphibious raid target selection evaluated with 6 criteria; Value of target, Time to reach target area, Obstacle of the lane, Risk of detected, Landing vehicles availability, and Withdrawal support.

b. Each alternative target based on intelligent data simulation has specific situation and analyzed using Promethee method.

c. Alternative A gives 3 benefits and 2 disadvantages. Alternative B gives 4 benefits and 1 disadvantages. Alternative C gives 3 benefits and 1 disadvantage.

d. Alternative A receives highest Net Flow score; 0,083 compared to 0 for alternative B and -0.083 for alternative C.

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FIELD II

LOGISTICS MANAGEMENT

AUTONOMOUS UNDERWATER VEHICLE SYSTEM ANALYSIS ON STABILITY OF 2-DOF MOTION CONTROL SYSTEM

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ABSTRACT

This paper analyzes the motion control system stability using Sliding Mode Control (SMC) method with 2-DOF motion equation on Autonomous Underwater Vehicle (AUV). The 2-DOF motion equation consists of surge and roll motions in the form of nonlinear motion equations. The stability analysis was applied to AUV system using Lyapunov method. The simulation results of the SMC control system with the 2-DOF motion equation on the AUV system showed that the system was stable at the determined set-point value with an error of ≤1% and locally, asymptotically stable.

KEYWORDS : AUV, motion control, stability analysis, Lyapunov

1. INTRODUCTION.

The geographical territory of Indonesia covers islands and waters. About one third of Indonesia territory is land area, while the rest, the two-thirds, is water. Indonesia's strategic region with its tropical climate provides a lot of potential and natural wealth contained in it (Oktafianto,2015). An area of approximately 70% of ocean needs special attention to be paid to the natural resources contained therein.Underwater technology is required to explore and safeguard the natural resources of Indonesian state, that is, underwater vehicle (Herlambang et al,2014).

Underwater vehicles that are commonly developed by many countries today are unmanned water robots or unmanned submarines. Such a robot is widely known as Autonomous Underwater Vehicle (AUV) which is one of the unmanned vehicles or the unmanned vehicle that works automatically without any direct control by humans (Herlambang,2017). The benefits of AUV are that it can be utilized not only for marine resources exploration, but also underwater mapping and underwater defense system equipment (Herlambang, 2015).

This study began by making up the model of motion equation with 2-DOF, that is, surge motion and roll motion. Surge and roll motions are translation and rotation motions on the x-axis. Then motion control system design for forward movement was developed by using Sliding Mode Control (SMC). The next step was to find stability analiysis with Lyapunov Function, and we get system is locally asymptotically stable .

2. AUTONOMOUS UNDERWATER VEHICLE (AUV) MODEL

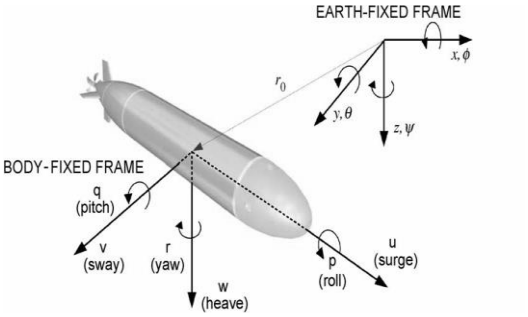

Fig. 1. Six degree of freedom of AUV motion (Yang, 2007)

To analyze the AUV system there are two important things to note, namely the axis system consisting of Earth Fixed Frame (EFF) and Body Fixed Frame (BFF) which have been represented in Figure 1 (Yang, 2007). EFF is used to explain the position and orientation of AUV, where the x-axis position leads northward, the y-axis to the east and the z-axis toward the center of the earth. While the BFF defines the positive x-axis as desired direction of the vehicle, the positive y-axis was direction to the right side of the vehicle, and the positive z-axis as direction to downward (Fosen,2005). The BFF system is used to explain the speed and acceleration of the AUV with the starting point at the center of gravity (Herlambang,2017). This study used motion equations with 2-DOF i.e. surge and roll, ignoring sway motion, heave, pitch and yaw. Below are the motion equations in 2-DOF:

$$\dot{u} = \frac{X_{res}+X_{|u|u}u|u|+X_{prop}}{m-X_{\dot{u}}} \quad (1)$$

$$\dot{p} = \frac{K_{res}+K_{p|p|}p|p|+K_{prop}}{I_x-K_{\dot{p}}} \quad (2)$$

Where X_{res} dan K_{res} are hydrostastic forces and moments in the x-axis direction, X_{prop} dan K_{prop} as force and moment of thrust.AUV specifications are listed in Table 1.

Table 1.Specification of AUV

Weight	18 Kg
Length	1600 mm
Diameter	200 mm
Controller	Ardupilot Mega 2.0
Communication	Wireless Xbee 2.4 GHz
Camera	TTL Camera
Battery	Li-Pro 11,8 V
Propulsion	12V motor DC
Propeller	3 Blades OD : 50 mm
Speed	3.1 knots (1.5m/s)
Maximum Depth	8 m

3. SLIDING MODE CONTROL (SMC)

The design of the SMC controller can be described as follows (Herlambang et al,2017):

a. Determine the function of Switching *S(x,t)*as in the equation $S(x,t) = \dot{e} + \lambda e = 0$ of tracking error of dynamic system.

b. Determine the Sliding surface, ie *S(x,t)=0*of the Switching function obtained.
c. Determine the estimated value of the controller $\hat{u}$. Dynamics under sliding condition can be written as: $\dot{S} = 0$

by completing the switching function, expression for the estimated value of the controller was obtained as equivalent control. When using dynamic SMC at the moment S=0, $\hat{u}$ was obtained.

d. Define the rules of SMC, that is, using control law,

$$u = \hat{u} - K\,\mathrm{sgn}(S)$$

where the signum function, sgn is defined as:

$$\mathrm{sgn}(x)\begin{cases} -1 & , x < 1 \\ 1 & , x \geq 1 \end{cases}$$

e. Substitute the value of $\hat{u}$ in*control law* so as to obtain new*control input* as subtitute of previous *control input*.
f. Determine the value of *K* in conformance to the *sliding* condition in equation of stage 4.

Then work on designing the SMC control system in the motion equation of non-linear model with 2-DOF.

4. Designing SMC Control System of 2-DOF non-linear Model

In this part the SMC control system was designed to obtain control input for surge and roll motions.

4.1. Surge Control System

To find control of surge, the tracking error of the surge was determined first as follows

$\tilde{u} = u - u_d$ u_d=constant

Since the system is of order 1, *switching* function was formulated as follows :

$S(u,t) = \left(\frac{d}{dt}\right)^{n-1} \tilde{u}$ with n=1

$S(u,t) = \left(\frac{d}{dt}\right)^{1-1} \tilde{u}$

$S(u,t) = \tilde{u} = u - u_d$

Whereas the derivative of S is as follows :

$$\dot{S}(u,t) = \dot{u} - \dot{u}_d \quad (3)$$

Sinceu_d=constantm then$\dot{u}_d = 0$

By subtituting equation (1) to equation (3), it becameas follows:

$$\dot{S}(u,t) = \frac{X_{res} + X_{|u|u} u|u| + X_{prop}}{m - X_{\dot{u}}} \quad (4)$$

Then the value of$\hat{X}_{prop}$in equation (4) where $\dot{S} = 0$ was determined as follows.

$$\frac{X_{res} + X_{|u|u} u|u| + X_{prop}}{m - X_{\dot{u}}} = 0 \quad (5)$$

So$\hat{X}_{prop}$ obtained was

$$\hat{X}_{prop} = -\left(X_{res} + X_{|u|u} u|u|\right) \quad (6)$$

Based on*control law* meeting*sliding*condition was :

$$X_{prop} = \hat{X}_{prop} - K_1\, sgn\,(S) \quad (7)$$

Then from equation (6) and (7) the following was obtained

$$X_{prop} = -\left(X_{res} + X_{|u|u} u|u|\right) - K_1\, sgn\,(S) \quad (8)$$

By subtituting equation (8) to (5), the following equation was obtained :

$$\dot{S}(u,t) = \frac{X_{res} + X_{|u|u} u|u| + \left(-\left(X_{res} + X_{|u|u} u|u|\right) - K_1\, sgn\,(S)\right)}{m - X_{\dot{u}}}$$

$$\dot{S}(u,t) = -\frac{K_1\, sgn\,(S)}{m - X_{\dot{u}}} \quad (9)$$

Then the K value was designed by substituting equation (9) into equation (10) in order to meet the sliding conditions:

$S\dot{S} \leq -\eta|S|$ (10)

$$-S\frac{K_1\, sgn\,(S)}{m - X_{\dot{u}}} \leq -\eta|S|$$

$$-AA_1K_1\ sgn\ (S) \leq -\frac{\eta|S|}{S}$$

$$K_1 \geq \frac{(m-X_{\dot{u}})\eta}{sgn\ (S)} \quad (11)$$

From equation (11) the value of K was obtained:

$$K_1 = |\max(m - X_{\dot{u}})\eta| \quad (12)$$

Then a boundary layer was used to minimize chattering by changing the signum function (sgn) into saturation function (sat) as follows:

$$X_{prop} = \hat{X}_{prop} - K\ sat\ \left(\frac{S}{\phi}\right) \quad (13)$$

Thus the control system design obtained by substituting equations (6) and (12) into equation (13) is as follows:

$$X_{prop} = -\left(X_{res} + X_{|u|u}u|u|\right) - |\max(m - X_{\dot{u}})\eta|\ sat\ \left(\frac{S}{\phi}\right) \quad (14)$$

4.2. Roll Control System

To find control of the roll,the tracking error of the roll was determined first as follows.

$\tilde{p} = p - p_d$ p_d=constant

Since the system was of order 1, the the switching function was formulated as follows:

$S(p,t) = \left(\frac{d}{dt}\right)^{n-1}\tilde{p}$ with n=1

$$S(p,t) = \left(\frac{d}{dt}\right)^{1-1}\tilde{p}$$

$$S(p,t) = \tilde{p} = p - p_d$$

Whereas the derivative of S is as follows :

$$\dot{S}(p,t) = \dot{p} - \dot{p}_d \quad (15)$$

Sincep_d=constant, then$\dot{p}_d = 0$

By subtituting equation (2) into (15), then it became :

$$\dot{S}(p,t) = \frac{K_{res}+K_{p|p|}p|p|+K_{prop}}{I_x-K_{\dot{p}}} \quad (16)$$

Next the value of$\hat{K}_{prop}$in equation (16) with the value of $\dot{S} = 0$ was determined as follows.

$$\frac{K_{res}+K_{p|p|}p|p|+K_{prop}}{I_x-K_{\dot{p}}} = 0 \quad (17)$$

So$\hat{K}_{prop}$ obtained is

$$\hat{K}_{prop} = -\left(K_{res} + K_{p|p|}p|p|\right) \quad (18)$$

Based on*control law* meeting the*sliding* condition is :

$$K_{prop} = \hat{K}_{prop} - K\ sgn\ (S) \quad (19)$$

So from equation (18) and (19) the following was obtained :

$$K_{prop} = -\left(K_{res} + K_{p|p|}p|p|\right) - K\ sgn\ (S) \quad (20)$$

Dengan mensubstitusikan persamaan (20) ke (16), diperoleh :

$$\dot{S}(p,t) = \frac{K_{res}+K_{p|p|}p|p|+\left(-\left(K_{res}+K_{p|p|}p|p|\right)-K\ sgn\ (S)\right)}{I_x-K_{\dot{p}}}$$

$$\dot{S}(p,t) = -\frac{K\ sgn\ (S)}{I_x-K_{\dot{p}}} \quad (21)$$

Then the value of K was designed by subtituting equation (21) into equation (22) so as to meet *sliding* condition, that is :

$$S\dot{S} \leq -\eta|S| \quad (22)$$

$$-S\frac{K\ sgn\ (S)}{I_x - K_{\dot{p}}} \leq -\eta|S|$$

$$K \geq \frac{(I_x-K_{\dot{p}})\eta}{sgn\ (S)} \quad (23)$$

From equation (23) it was obtained that the K value is :

$$K = \left|\max\left(I_x - K_{\dot{p}}\right)\eta\right| \quad (24)$$

Then a boundary layer was used to minimize chattering by changing the signum function (sgn) into saturation function (sat) as follows:

$$K_{prop} = \hat{K}_{prop} - K\ sat\ \left(\frac{S}{\phi}\right) \quad (25)$$

Thus the control system design obtained by substituting equations (18) and (24) into equation (25) is as follows:

$$K_{prop} = -\left(K_{res} + K_{p|p|}p|p|\right) - \left|\max\left(I_x - K_{\dot{p}}\right)\eta\right|\ sat\ \left(\frac{S}{\phi}\right) \quad (26)$$

5. RESULT OF STABILITY ANALYSIS

The SMC control system design of the nonlinear 2-DOF model was obtained, from AUV 2-DOF motion equations: surge and roll, control law was obtained by using lyapunov function as a candidate is

$$V(u,p) = \frac{1}{2}u^2 + \frac{1}{2}p^2$$

It was shown that function $V(u,p) = \frac{1}{2}u^2 + \frac{1}{2}p^2$ is lyapunov function in conformance to the above definition :

a. Function V is continuous and has partial derivative of S

Function $V(u,p) = \frac{1}{2}u^2 + \frac{1}{2}p^2$ is a quadratic function, it is clear that the quadratic function is continuous in E. Then the partial derivative is also continuous.

b. Take any $T = (u,p) \in \gamma$ with $T \neq T_1$, so $V(T) = \frac{1}{2}u^2 + \frac{1}{2}p^2 > 0$

Take any $T = (u,p) \in \gamma$ with $T \neq T_1$, so $V(T) = \frac{1}{2}0^2 + \frac{1}{2}0^2 = 0$

c. $\dot{V}(u,p) = \frac{\partial V}{\partial u}\dot{u} + \frac{\partial V}{\partial p}\dot{p}$

$\dot{V}(u,p) = u\dot{u} + p\dot{p}$

$$\dot{V}(u,p) = u\left(\frac{X_{res} + X_{|u|u}u|u| + X_{prop}}{m - X_{\dot{u}}}\right) + p\left(\frac{K_{res} + K_{p|p|}p|p| + K_{prop}}{I_x - K_{\dot{p}}}\right)$$

Choose $X_{prop} = -\left(X_{res} + X_{|u|u}u|u|\right) - Ksgn(S)$

Choose $K_{prop} = -\left(K_{res} + K_{p|p|}p|p|\right) - Ksgn(S)$

So the following is obtained

$$\dot{V}(u,p) = u\left(-\frac{K_1 sgn(S)}{m - X_{\dot{u}}}\right) + p\left(-\frac{K_2 sgn(S)}{I_x - K_{\dot{p}}}\right) \leq \left[-\frac{K_1}{m - X_{\dot{u}}}\right][u] + \left[-\frac{K_2}{I_x - K_{\dot{p}}}\right][p]$$

Choose $K_1 = [m - X_{\dot{u}}]\eta$ dan $K_2 = \left[I_x - K_{\dot{p}}\right]\eta$

So the followings were obtained $\dot{V}(u,p) \leq [-\eta]|u| + [-\eta]|p|$

$$\dot{V}(u,p) \leq -\eta[|u| + |p|]$$

Having met those three requirement, function $V(u,p) = \frac{1}{2}u^2 + \frac{1}{2}p^2$ is Lyapunov function and locally, asymptotically stable.

6. CONCLUSION.

Based on the results and discussion it can be concluded that the Sliding Mode Control (SMC) method can be applied as a control system of surge and roll motion with an error of ≤1 and is locally asymptotically stable.

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CONSTRUCTION OF INDONESIAN ADDITIONAL MILITARY LAYER INTEGRATED WATER COLUMN (AML IWC) PROTOTYPE

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ABSTRACT

The NATO has produced what they called Additional Military Layer (AML) which basically Electronic Chart for Military purposes. Based on NATO STANAG 7170, AML is defined as : ''...a unified range of digital geospatial data products designed to satisfy the totality of NATO non navigational maritime defence requirements''.One of AML type is called Integrated Water Column Component 1 (AML IWC Component 1) in which contain water column physical properties of temperature and salinity. The purpose of IWC gridded dataset, is to provide marine climatological data to describe the likely conditions found within the water column. IWC is delivered in the netCDF format. Meanwhile US Navy has also developed the same climatological gridded dataset as AML IWC which they called Generalized Digital Environmental Model (GDEM). Inspired by the existence of AML IWC and GDEM, authors are willing to research the possibility of constructing Indonesian AML IWC Component 1 that cover the sea area of Indonesia. Observation temperature and salinity profiles are downloaded from World Ocean DataBase13 (WOD13). These thousands observation profiles collected for more than 100 years in Indonesian waters and surrounding area then processed with Ocean Data View and Mathlab to make a gridded data set with 1/4° spatial resolution and monthly temporal resolution In only one netCDF format file.

KEYWORD : Indonesian AML IWC, netCDF, salinity, temperature, WOD13.

1. INTRODUCTION

Successful execution of ASW operations (detection, prosecution, localization) depends on four factors i.e. : The ambient acoustic and meteorologic conditions, Own-force asset capabilities, The nature and tactics of the opposition, The strategic and tactical acumen of the ASW commander and his staff. When at sea, the first three factors are the ASWC's states of nature. Keen understanding of the principles of the propagation of sound through the water and the effects of the meteorologic conditions thereon is requisite since underwater sound (sonar) is virtually the only means of detecting submerged submarines (M.G. Alexandridis, 1984).

ASW acoustic predictions are done with the aid of sound velocity profiles from areas of the ocean. ASW sensor selection and tactics are determined by these acoustic predication (B.H. Brunson, 1989). One of the general form of the equation for the speed of sound was developed by Mackenzie who derived the

empiric formula from three variables, they are : temperature, salinity and depth (Mackenzie, 1960).

For years, experts of Defence Maritime Geospatial Infromation has produced varies form of paper military charts. With the move to digital products, NATO has produced AML (Additional Military Layer) to provide maritime geospatial information to the defence user in an efficient and standardised digital format. AML is defined as ‘’...a unified range of digital geospatial data products designed to satisfy the totality of NATO non navigational maritime defence requirements’’ (Captain Jones, 2016). One type of AML that related to water column is Gridded AML products (UKHO, 2008). This type of AML shows the spatial and sometimes temporal variation in an environmental feature (UKHO, 2006). For example, gridded products can represent a large number of CTD observations collected over a long period giving the user information about the temperature and salinity that may be expected at a specific month (Peter C. Chu, 2004). Gridded information may be presented to the user in a variety of ways, including isolines derived from the grid and colour banding. Alternatively the data may be used by a specific system for computational purposes without directly representing the data to the user through a Graphical User Interface (GUI) (Captain Jones, 2016).

The NATO AML Integrated Water Column product specification is further divided into three components, which are water column physical properties, ocean currents and marrine mammals (UKHO, 2006). For this research, authors are willing to produce an AML IWC Component 1 consisting of temperature and salinity monthly variation for Indonesian Sea and surrounding in 1/4° spatial resolution. Raw data of temperature and salinity profiles are downloaded from World Ocean Database 13 (WOD13) which cover all available observations in and arround Indonesian Waters. The observation data collected then filtered and prepared to be used in estimation process of temperature and salinity values at each standar depth and spatial coordinates with a quarter degree interval. The estimation values of temperature and salinity for each month then compiled into an array for further writing become a netCDF file format which is the standard file format for AML IWC (UKHO, 2006). From that standing point, authors propose a hypothese that Indonesian AML IWC netCDF file could be constructed from WOD13 database utilizing some already available function in ODV (Schlitzer, 2013) and netCDF package in mathlab (Mathworks, 2015).

Once the Indonesian AML IWC netCDF file succesfully made, it can be presented to give a better situasional awareness for a Navy ships or operator may extract temperature and salinity data from it for computational purpose such as ray tracing of hull mounted sonar (HMS) or variabel depth sonar(VDS) so the anti submarine ship could predict its HMS shadow zone or its best VDS operational depth to get the optimum coverage. With the availability of AML IWC component 1 netCDF file may prevent the necessity of a anti submarine ships to deploy CTD or XBT to get temperature and salinity data in its operation area (W.J. Teague, 1990).

2. MATERIALS AND METHODOLOGY

2.1. Observation Data

To produce a climatological gridded data set such as AML IWC, we must have an adequate observations that not only has good spatial distribution but also temporally long enough with at least 50 years period time span of observations. For example in the making of first GDEM in 1990, US NAVOCEANO had

been collecting for more than 100 years (W.J. Teague, 1990). And in 2010 GDEM report it was writen that final data set for GDEM4 construction consist of 4,412,454 temperature profiles and 1,969,081 salinity profiles (M. Carnes, 2010). In order to fulfill the pre-requisite of constructing a climatological dataset, authors have selected World Ocean Data Base for the reason that this product of National Oceanographic Data Centre (NODC) Ocean Climate Laboratory (OCL) is claimed as the world's largest collection of freely available oceanographic data that dating back to the late 1700's (NOAA, 2017).

As previously mentioned that temperature and salinity profiles data set used in the calculation of Indonesian IWC Component 1 was downloaded from NODC/Ocean Climate Laboratory/OCL Products/WOD13. From here, authors proceed to WOD data sorted geographically to get the webpage that shows 10 degrees square geographically sorted data set. For Indonesian sea area, authors downloaded ten squares with square number 1009, 1010, 1011, 1012, 1013, 3009, 3010, 3011, 3012 and 3013. Inside the respective square there are some types of data that collected in a .gz compression format with respect to the equipment of data acquisition, they are : OSD, MBT, CTD, XBT, PFL, MRB, DRB, APB, UOR, GLD, SUR (NOAA, 2017).

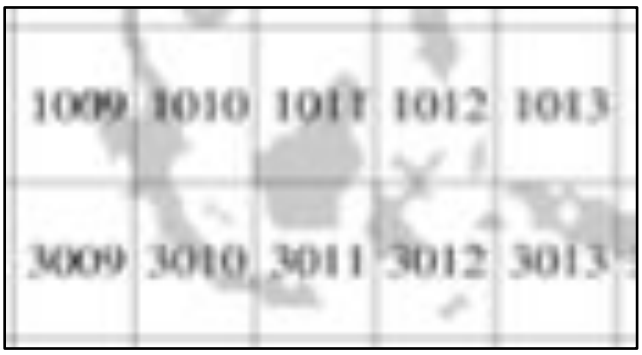

Fig 1. WOD 13 square download (NOAA, 2017)

The downloaded temperature and salinity dataset then imported, readed, extracted or collected into Ocean Data View (ODV) software for further process (Schlitzer, 2013). Based on data import statistic in ODV software, the ten downloaded squares containing 169,959 observation points with the oldest time recorded is 1827 and the newest time recorded is 2017. So this data base has been collected for 190 years. But it was not until 1914 the count of observations is more than 100 observation per year. And starting from 1961 the recorded observation hit more than 1,000 per year. The poin is with such number of observation and such a long periode historical data, the WOD13 is valid to be used in calculation, estimation and construction of Indonesian AML IWC.

2.2. Horizontal Gridding and Estimation

Once the WOD13 data sets are all imported into ODV collection, first thing to do is to prepare the xy coordinate text files. The Indonesian AML IWC is planned to have 1/4° x 1/4° spatial resolution. Meanwhile the area is limited by 90 ºE to 140 ºE and 10 ºS to 10 ºN. Using these data, authors produce a grid file utilizing the grid file generator tool that provided in the ODV software (M.R. Carnes, 2009).

Secondly, authors planned to make The Indonesian AML IWC into 63 standard depth levels. This standard depth level starts from 0 m up to 3000 m. The intervals between depth level are set so the upper layer interval will be shorter than the lower layer interval. For example the interval between 0 m to 10 m depth is set in 2 m between each standar depth, but the interval between 2000 m to 3000 m depth is set in 200 m between each standar depth (M.R. Carnes, 2009).

Before the estimation can be done, authors should add the isosurface variables for temperature and salinity at each standar depth so it can be plotted in surface window as Z values. There will be 126 isosurface variables to be added one by one (Schlitzer, 2013).

In order to be able to use the 2D estimation function in ODV software, the imported data should be gridded in the surface window. But before gridding, authors verify that station selection criteria has been done for the selected month and selected variable in the map window and sample selection criteria has been done for only accepted value data. After both criteria checks have been passed, authors plot the isosurface variable by gridding method. The gridding method used is DIVA gridding. DIVA is a gridding software developed at the University of Liege that offers a number of advantages over the weighted averaging methods built into ODV. DIVA allows analyzing and interpolating data in an optimal way, comparable to optimal interpolation (OI). Unlike OI, DIVA also takes into account coastlines and bathymetry features to structure and subdivide the domain on which estimation is performed. Calculations are performed on a finite element mesh adapted to the specific gridding domains (Schlitzer, 2013) (Troupin, 2012).

With 2D estimation function, for each xy coordinates in the input file, ODV will estimate a Z-value, and will write the estimated values together with the respective xy coordinate to an output file. The output file is written to the same directory as the input file, and the file name is of the form <name>_est.<ext>, where <name>.<ext> is the name of the input file. Each line in the output file contains the X, Y, and Z values of one estimation point. A Z value of -1.e10 indicates that the particular xy coordinate is far from any data point and that no reliable estimation could be performed. Z values at points outside the window domain or in regions exceeding the window's quality limit (white areas in the plot) are set to -1.e10 (Schlitzer, 2013).

2.3. Bathymetri

Bathymetri is also important for construction on netCDF file. As mentioned above that the estimation through 2D estimation with DIVA gridding method takes into account coastlines and bathymetri features to perform estimation. The Indonesian AML IWC bathymetry for estimation process in ODV software is loaded from GEBCO_2014_6X6min_Global (S. Tani, 2017). Meanwhile bathymetry bottom depth at each grid point on the ¼º x ¼º grid was derived by estimation from GEBCO_2014_2D_90.0_-10.0_140.0_10.0.nc file. The bottom depth estimation was done in ODV software, the similar way as temperature and salinity estimation. The bottom depth estimation will be writen into the netCDF file (Schlitzer, 2013) (Mathworks, 2015).

2.4. Constructing one temperature array, one salinty array and one bottom depth array from the estimation txt files

From the estimation process, authors are able to produce 63 txt files for each month and each temperature and salinity variabel and 1 txt file for bottom depth. In order to be able to be writen into a netCDF format file, authors sholud combine the values into 1 array of variabel with pre-defined dimension planned.

For temperature and salinity variables the pre-defined dimension will be 201 x 81 x 63 x 2. The dimension consist of longitude by latitude by depth by

month. While bottom depth variabel will have 201 x 81 dimension consist of longitude by latitude.

2.5. Construction of netCDF file from the 4-dimension and 2-dimension arrays.

NetCDF is a widely used file format in atmospheric and oceanic research – especially for weather and climate model output – which allows storage of different types of array based data, along with a short data description. The NetCDF format (Network Common Data Format, http://www.unidata.ucar. edu/software/netcdf/) has been developed since 1988 by Unidata (a programme sponsored by the United States National Science Foundation) with the main goal of making best use of atmospheric and related data for education and research (R. Rew et al, 1990) (R. Rew et al, 2011).

A NetCDF dataset contains a symbol table for variables containing their name, data type, rank (number of dimensions), dimensions, and starting disk address. Each element is stored at a disk address which is a linear function of the array indices (subscripts) by which it is identified. Hence, these indices need not be stored separately (as in a relational database). This provides a fast and compact storage method (R. Rew et al, 2006). The advantage of the NetCDF library is that there is no need for the user to take care of the physical representation of multidimensional data on the disk.

One particular advantage of NetCDF over some other binary formats, such as the RData format used by R, is the ability to access and modify arbitrary sections of array data. This allows massive datasets to be processed efficiently, even if they are larger than the virtual memory available on a particular system. To reduce disk space requirements, floating-point values are often packed into 8- or 16-bit integers, and the NetCDF-4 (HDF5) format supports transparent compression using the zlib library (Pavel Michna et al., 2013).

For the Indonesian AML IWC experiment, authors used mathlab software to construct the netCDF file. the script is writen by netCDF package library that already available in the mathlab software. Generally the scripting steps is the un-interupted steps from the 4-D arrays and 2-D array construction (Mathworks, 2015).

Shortly, the netCDF file is produced as the following sequences :

- preparing the arrays to be writen which are longitude, latitude, depth, month, temperature, salinity and bottom depth.
- Create the netCDF file.
- Writing the global attributes.
- Define the dimension which are longitude, latitude, depth and month.
- Writing each dimension attributes.
- Define the variables which are longitude, latitude, depth, month, temperature, salinity and bottom depth.
- Writing each variable attributes.
- Writing the array to respective variable.

Result of this process is Indonesian AML IWC in the form of netCDF file.

Standard deviation of estimation values for each 4-dimension coordinate is calculated using mathlab software (M.F. Al-Saleh et al., 2009) (UKHO, 2006). This calculation utilizes the above previously produced netCDF file . The result of this step is two 4-dimension array of temperature standard deviation and salinity standard deviation. After that, those two variables will be writen into netCDF files so the last product will have 5 variables, which are temperature,

salinity, temperture standard deviation, salinity standard deviation and bottom depths.

3. RESULT AND DISCUSSION

3.1. Input File Facts

The Input files facts used for the experiment that has been downloaded from the WOD13 could be extracted from WOD13 meta data which can be analyzed from the statistic function inside the ODV software (Schlitzer, 2013). Below are Input files facts summary table showing general statistic of the input data.

Table. 1 Input File facts summary

1	Format	US NODC Formats/World Ocean Data Base
2	File type	.gz
3	Size	457 MB(compressed)
4	Longitude	90 E to 140 E
5	Latitude	10 S to 10 N
6	Time	28/91827 to 2/4/2017
7	Points observed	169,959
8	Avg. points obs. by month	14,164
9	Points with T var	162,820
10	Points with Sal var	82,892

Table. 2 Input File dataset based on acquisition method

1	OSD	bottle, low res CTD and XCTD, plankton data
2	MBT	MBT, DBT, Micro BT data
3	CTD	high res CTD data
4	XBT	expandable bathytermograph data
5	PFL	profiling float data
6	MRB	moored buoy data
7	DRB	drifting buoy data
8	APB	autonomous pinned bathytermograph data
9	UOR	undulataing oceanographic recorder data
10	GLD	glider data
11	SUR	surface data

3.2. Output File Facts

From this input data, this experiment investigates the possibility of Indonesian AML IWC construction utilizing ODV software and mathlab software. General information of how to construct a climatology of ocean temperature and salinity is described in refrence describing about GDEM, products of US Navy (M.R. Carnes, 2009) (M. Carnes, 2010). These documents is the primary reference used by authors on developing steps of Indonesian AML IWC, while the decision to delivere it in the form of netCDF format file is because of it is the standard of AML IWC which produced and maintained by UKHO (UKHO, 2006).

In the netCDF output files every xyz coordinates must have values. As consequences the values on the lands and at the depth levels less than 3000 m that limited by the bathymetri will be set as -1.e10. The facts summary regarding the output files are as follows.

Table. 3 Output File facts summary

1	File type	.nc (netCDF)
2	Size	62.7 MB(uncompressed) 2 months climatology
3	Longitude	90 E to 140 E
4	Latitude	10 S to 10 N
5	Time	January and February
6	gridded sta 1 month	16,281
7	Visible gridded sta 1 month	13,125
8	gridded sta overland 1 month	3,156
9	key variables	temperature, salinity, temp_sd, sal_sd, bottom depth

This Indonesian AML IWC size is 62.7 MB equivalent with 13,125 profiles x 1 variable x 2 month equal to 26,250 profiles per variable or 105,000 profiles temperature, salinity and each standard deviation. By a simple math the 12 month Indonesian AML IWC could take about 62.7 MB x 6 or equal to 376.2 MB.

Authors also try to export the complete data from Indonesian AML IWC into text file using ODV software. The exported text file is a tab delimited single file with the size of 106 MB about twice bigger the size of netCDF file.

Each gridded station of netCDF file could be exported or extracted to be used for further calculation or modelling. Authors investigates the size of a single gridded station export which consist of station meta data, temperature, salinity and sound speed data and founded that the size of text file approximately 5.05 KB. If we want to export each Indonesian AML IWC gridded station into different text file it will take about 5.05 KB

x 13,125 station or equivalent with 66.3 MB per month or 132.6 MB for 2 month, about twice larger than the size of netCDF file. Not to mention we should handle 13,125 different files only for one month.

While the usual observation data is generally delivered as txt file or excel file. With netCDF format, authors are able to compile thousands of temperature and salinity profiles for Indonesian area in only one single file with less memory storage required. This bring benefit over the storing of every temperature and salinity profiles in different txt or excel files.

3.3. Discussion

Indonesian AML IWC is more regularly spaced compared to original WOD13 observation data which maintain their observation position as reported. Below figures shows the differences between WOD13 and Indonesian AML IWC spatial distribution.

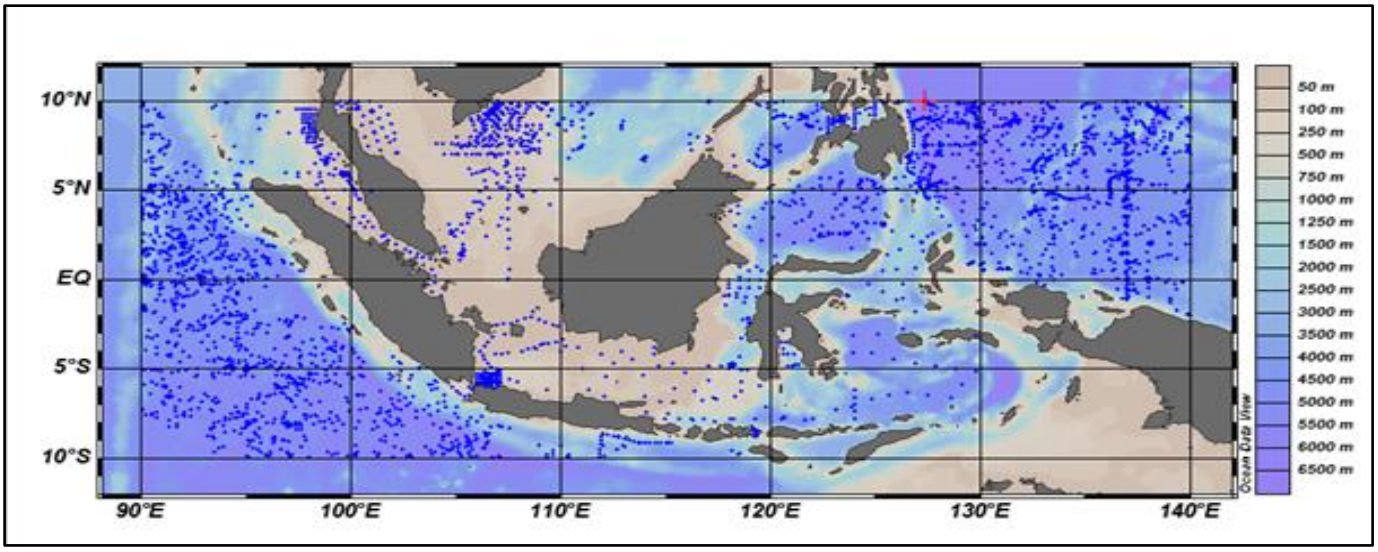

Fig 2. Spatial distribution of WOD 13 in January

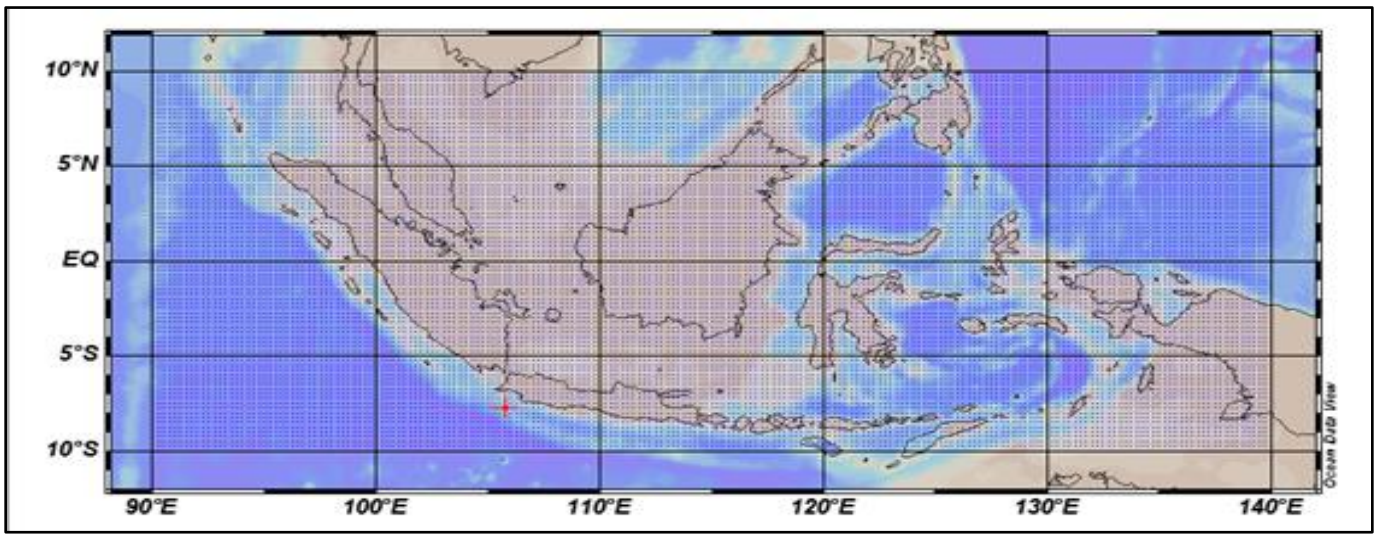

Fig. 3 Spatial distribution of Indonesian AML IWC in January

A pictorial comparisons of the input and output file plotting are also conducted to check the validity of the output file. surface plotting temperature at depth 0 metre for January are compared for WOD13 and Indonesian AML IWC as follows.

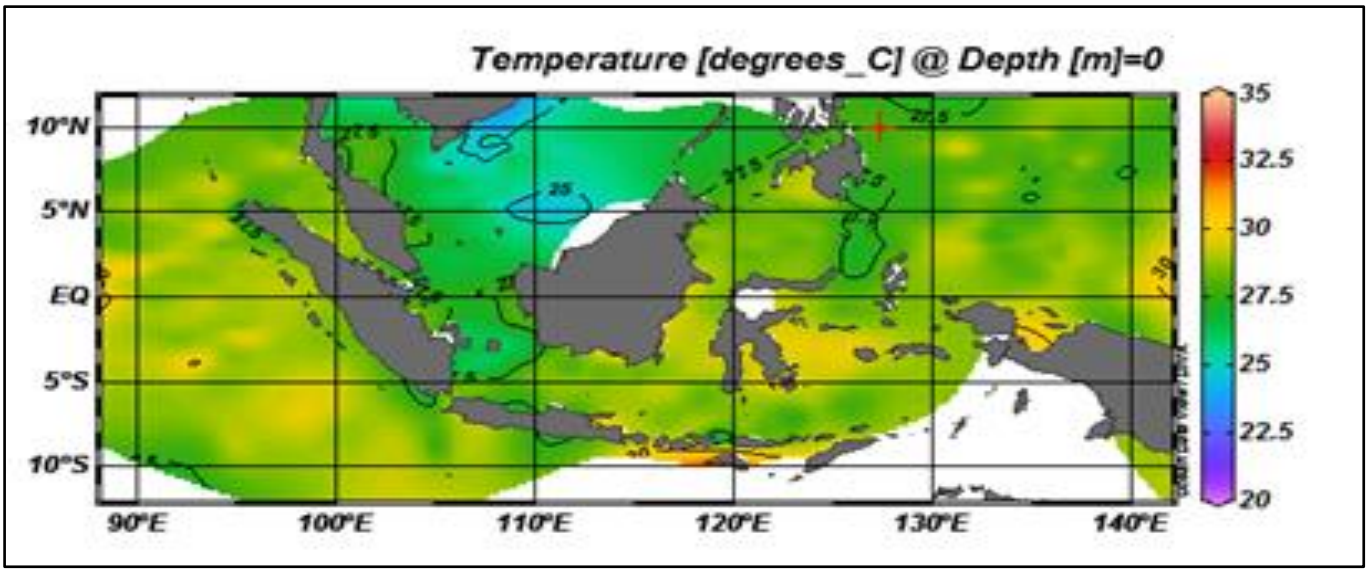

Fig 4. Surface plot of WOD 13 in January

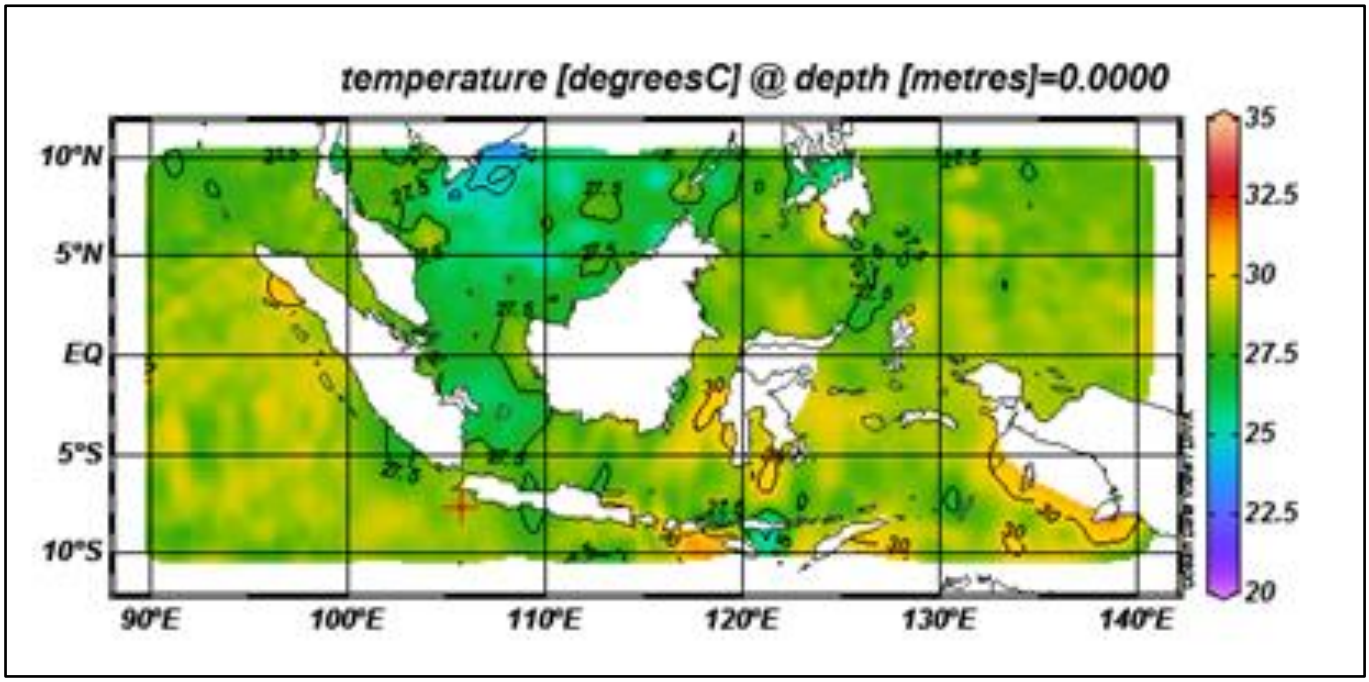

Fig 5. Surface plot of Indonesian AML IWC in January

For station comparison authors take sample of observation point located at 106° E and 8° S. Both temperature data with the same point location from WOD 13 and Indonesian AML IWC then plotted on the station plotting window with the a very similar profile.

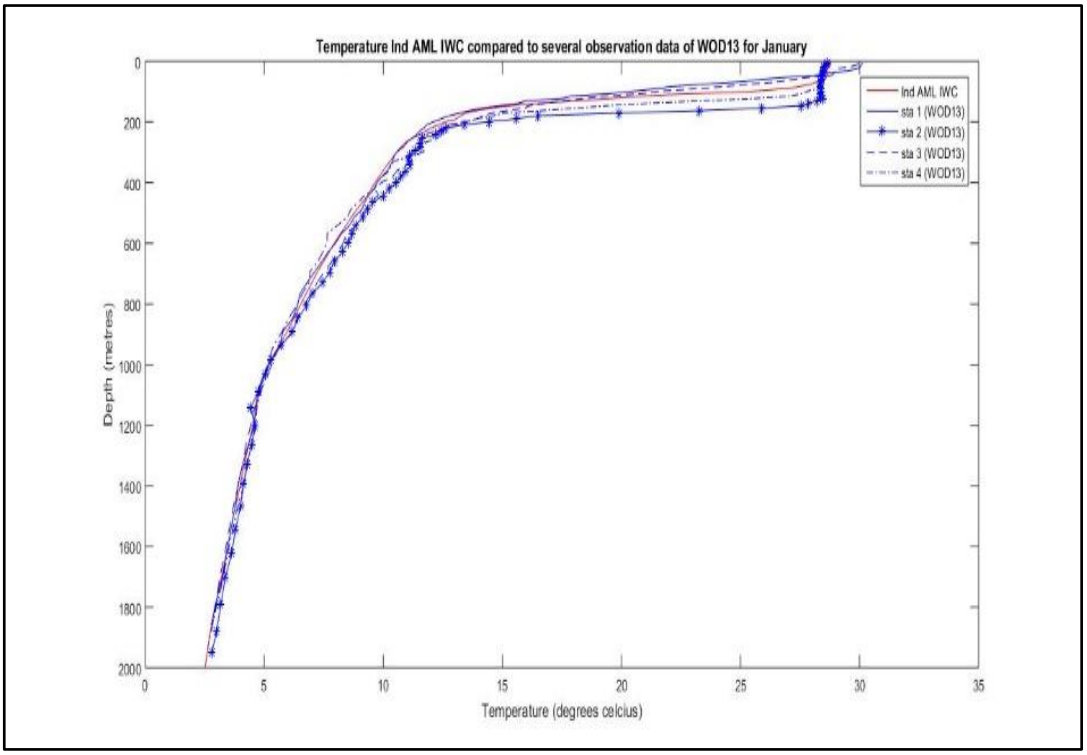

Fig 6. Station plot comparison between WOD13 obs and Ind AML IWC on January at about 106 E and 8 S

3.4. Outlook

Validation is a working process in an experiment to compare a result to another tipically same product. In this experiment validation of Indonesian AML IWC will be compared to World Ocean Atlas 13 (WOA13) temperature and salinity climatology product of NODC/OCL. General production method of WOA is described in WOA 13 tutorial with the title of WORLD OCEAN ATLAS 2013 Volume 1 : Temperature (R.A. Locarnini et al., 2013). Generally the production concept is the same for both products. But, off course each institution has copyright and details that is not published. For that reason there will be some differences between WOA 13 and Ind AML IWC.

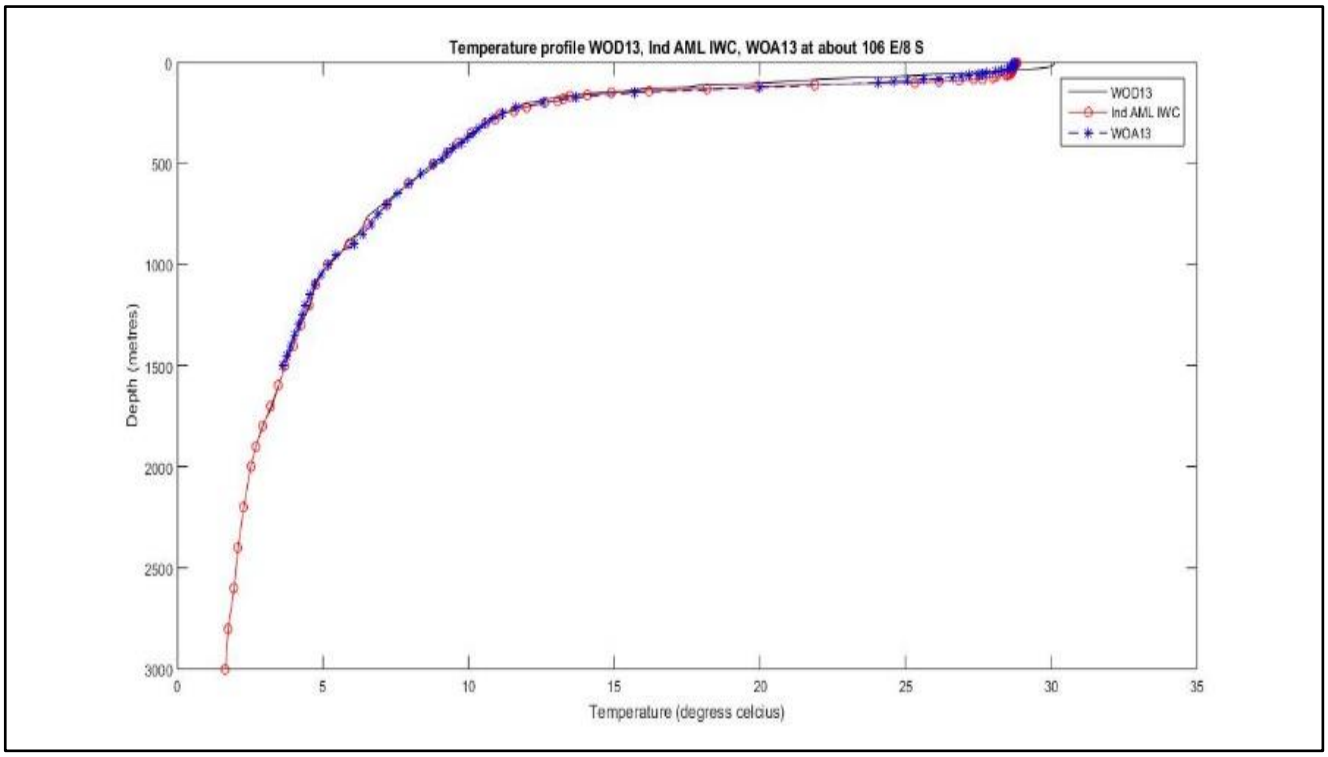

Fig. 7. Station plot comparison between WOD13 obs, Ind AML IWC, WOA 13 on January at about 106 E and 8 S

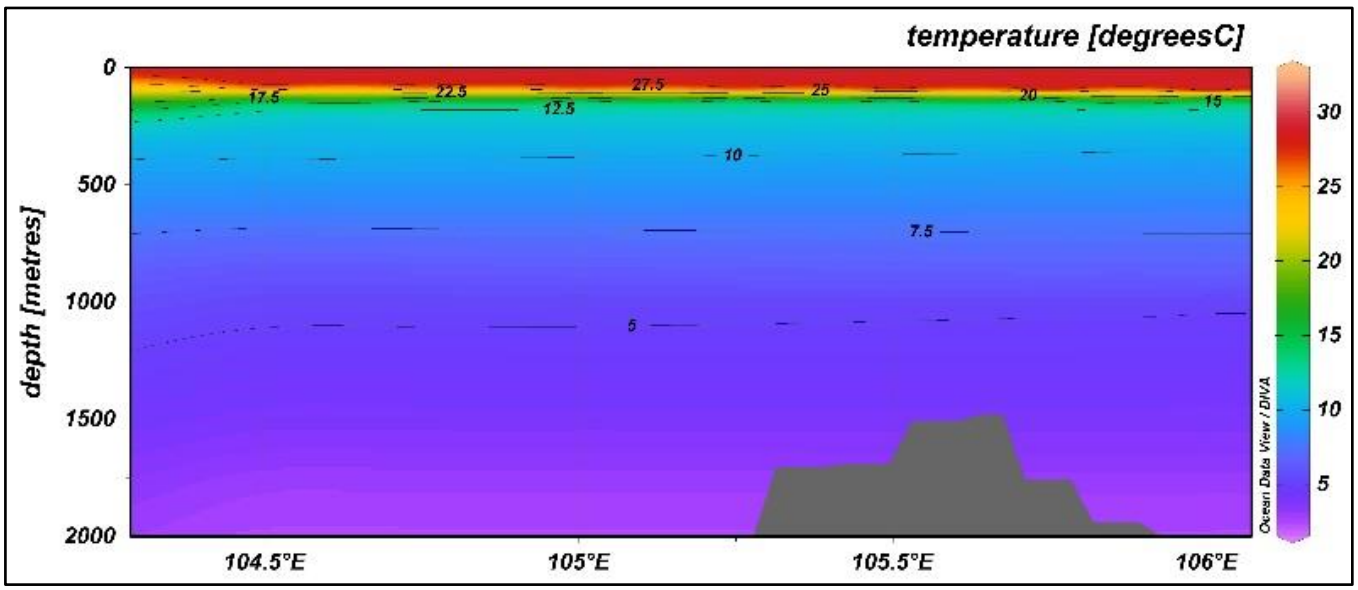

Fig. 8. Section plot Ind AML IWC on January at south of West Java

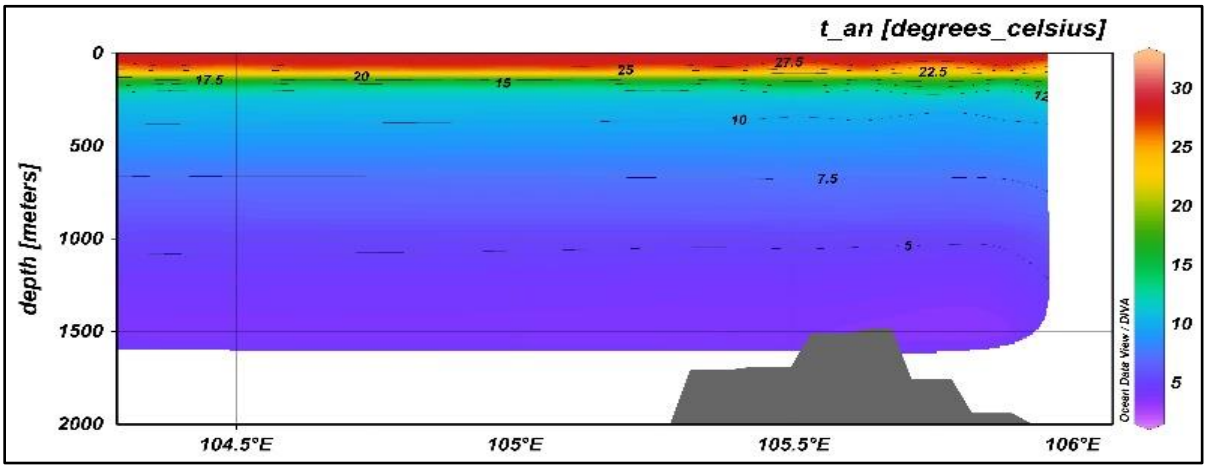

Fig. 9. Section plot WOA 13 on January at south of West Java

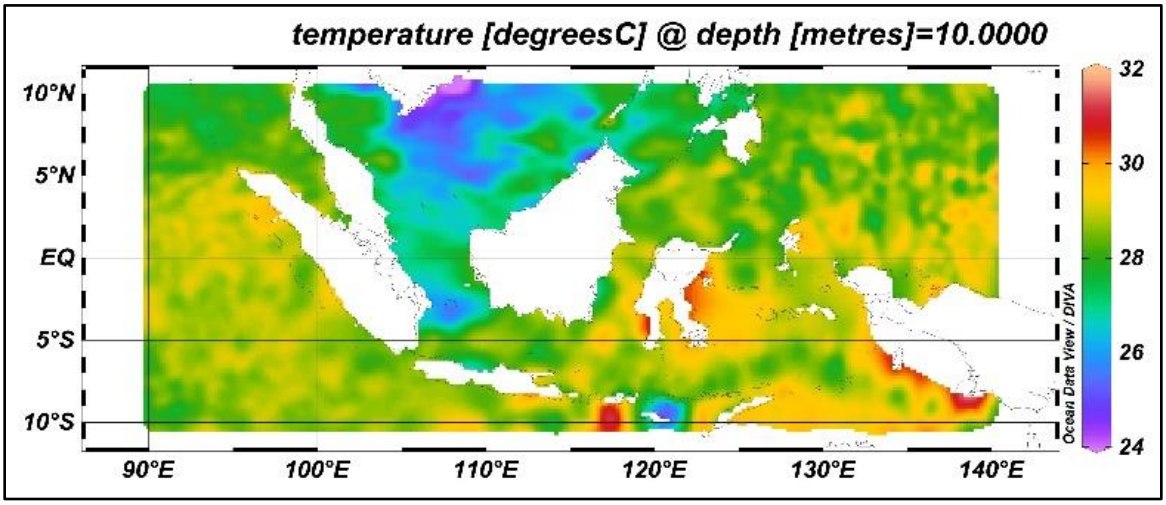

Fig. 10. Surface plot Ind AML IWC on January at 10 m

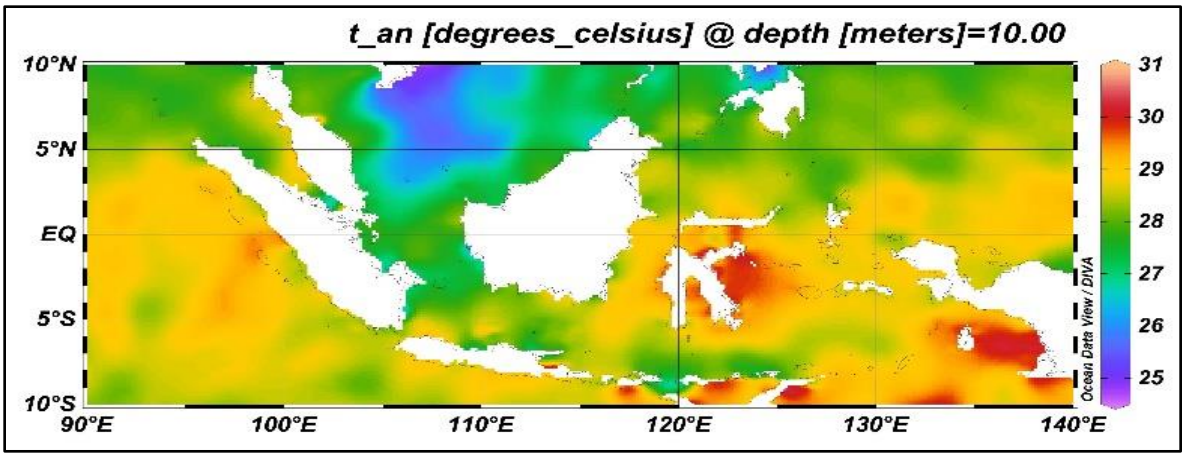

Fig. 11. Surface plot WOA 13 on January at 10 m

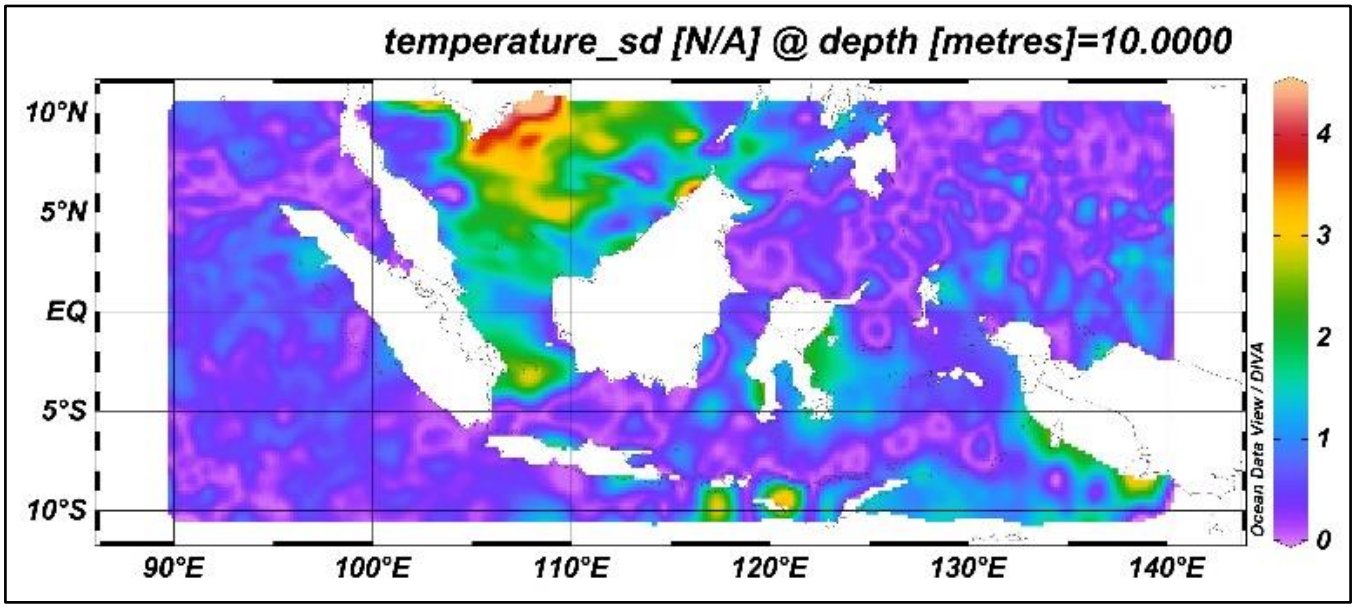

Fig. 12. Surface plot Ind AML IWC temperature standard deviation on January at 10 m

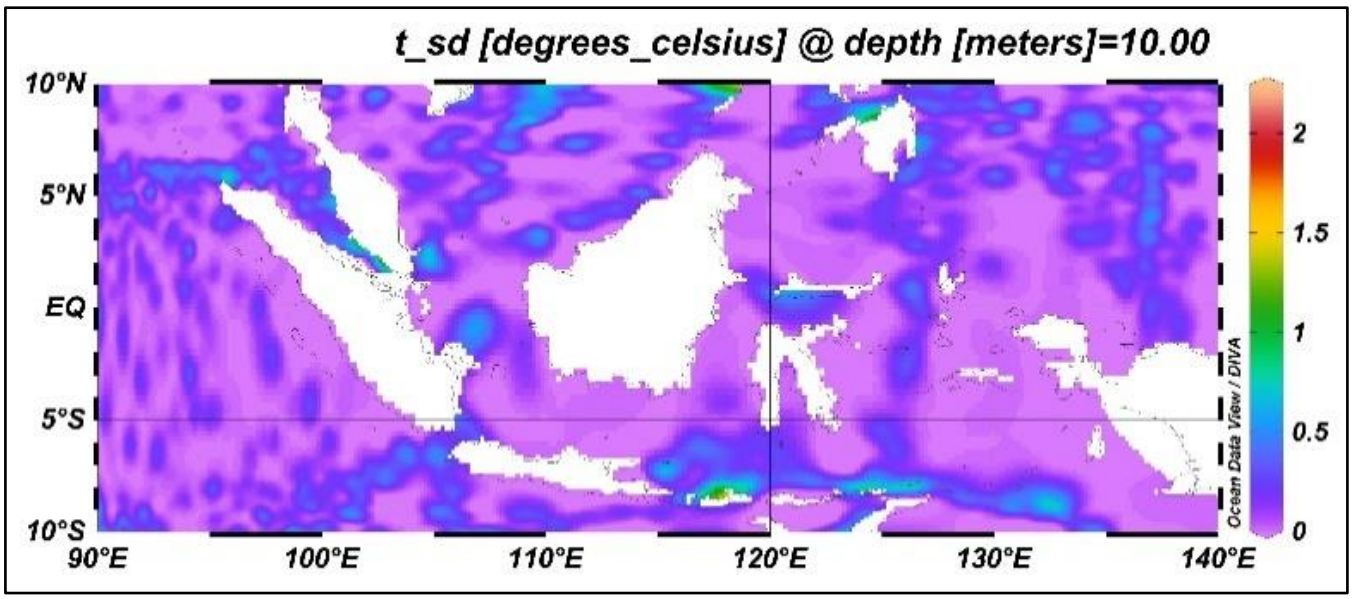

Fig. 13. Surface plot WOA 13 temperature standard deviation on January at 10 m

4. CONCLUSION

In conclusion, the proposed hypothese of this paper that Indonesian AML IWC netCDF file could be constructed from WOD13 database utilizing some already available function in ODV and netCDF package in mathlab has been successfully tested and can be accepted. This experiment has resulted Indonesian AML IWC, a gridded data set products in the form of netCDF file that has been tested its representation and data extraction in ODV software.

The experiment conducted by the authors utilizing raw observation temperature and salinity data set from WOD13 with the support of ODV and Mathlab software resulted a netCDF file containing temperature and salinity profiles regularly distributed geographically in monthly temporal resolution. This file basically has the same product specification with NATO AML IWC Component 1.

The Indonesian AML IWC plotting pictorial comparison with raw WOD13 data showed both files are similar. Therefore it is valid for presentation of likely condition in an environment or profile data extraction for further calculation, prediction or simulaton concerning military operation in the sea such as anti submarine warfare operation.

This paper may contribute to the production initiation of gridded data products of AML by Indonesian Navy Hydrograpy and Oceanoraphy Centre for the support of Indonesian Navy Military Operation. As this file existence onboard a ships may prevent the ships to launch CTD or XBT to get temperature and salinity profiles in particular sea area. Since in the time of war, decision oftenly should be made in a split seconds. In the other hand we don't have enough time to get the information we need such as launching CTD. In such particular situation AML IWC could help the officer in charge to make the right battle manoevres to gain advantages from the environment.

5. ACKNOWLEDGEMENT

This work was supported by ODV Software and Mathlab Software. Raw data was extracted from WOD13 and validation product WOA 13 are products of NODC Ocean and Climate Laboratory. 4 dimension netCDF data writing sample was downloaded from unidata website. Bathymetri was downloaded from GEBCO.

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THE DESIGN OF WEAR AND TEAR ON SHIP AN ALTERNATIVE MATERIALS IN PLACE OF TAIL SHAFT

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ABSTRACT

The propeller shaft is a ship propulsion that must be repaired when undergoing a shape change, in which case the shaft is subjected to wear and tear, it must be replaced immediately if it can not find the same material to replace its axis then sought material that has a characteristic like the previous axis. To obtain the same propeller axle characteristic then the research will be carried out in the material used. The method used is by using tensile, bending, impact, hardness, microscopic, and chemical composition test using ASTM A370 and ASTM E23 standard which prior to heat treatment testing. The results of the test material research that can be done to replace the material that experienced the previous wear. Material 4340 has the highest ultimate tensile strength value 1097, 51 N/mm$^{2.}$ Material 4340 has the highest curvature value 308, 73 N/mm$^{2.}$ ·Material 4140 has the highest impact value 2,281J/mm^{2}. Material HQ 705 has the highest hardness value 350,3 N/mm$^{2..}$ In the third microscopic test the material contained perlite and ferrite where the ferrite contained is more dominant. Observation of ANOVA on tensile testing can't affect the material but in bending, impact, and hardness testing may effect but not significantly.

KEYWORDS : *Propeller, heat treatment, Anova.*

1. INTRODUCTION

On a ship propulsion system, the propeller shaft is one of the most important parts of ship. If there is damage to the form in this case experiencing wear, bent and broken so that the ship can still go steadly and in the future does not cause more harmful impact then the shaft must be carried out replacement and repair on the material. The shaft part consists of : thrust shaft, intermediate shaft and tail shaft.

If the propeller shaft is cracked or even broken, then the shaft must be replaced immediately, if not able to find the same material to replace the shaft it must be sought material that has characteristics such as the previous axle heat treatment.

In this research, takes the problem of a propeller shaft of a ship that has been used for more than 25 years and the propeller shaft has undergone a mechanical or welding process to repair the propeller shaft, because it has aged and experienced wear and often find alternatives that are suitable or even better.

And until now there has been no research on alternative material as a replacement for broken shafts on the ship. So, in this case it is necessary to test the material that can be used as an alternative material whose characteristic properties as the same or even better that the material used previously. By using the testing of some material and the sought the most approaching characteristic properties that we would recommend to replace the material weary tail shaft.

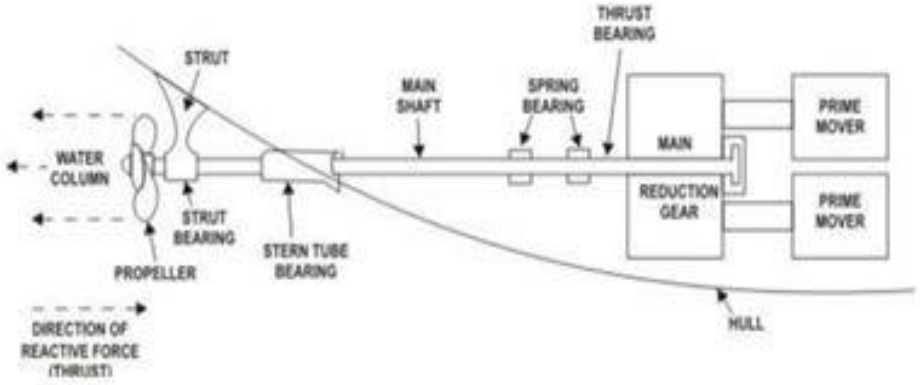

Fig. 1 General Principle Of Geared Ship Propulsion (Boddapati et al., 2015)

Method used for testing shaft propeller material is by using tensile, bending, impact, hardness, microscopic and chemical composition test using ASTM A370 and ASTM E23 standard prior to heat treatment testing. Some of the conventional heat treatments procedure chosen include: annealing, normalizing, quenching (in automobile engine oil and water) and tempering after water quenching. Two other sample were also set aside to serve as control for the assessment of the heat treated ones (Momoh et al., 2013)

In this research, there are some literature used among other journals with the title Design and Materials Selection for Environmentally Friendly Ship Propulsion System (Roldo et al., 2013). Shaft Line Alignment Analysis Taking Ship Construction Flexibility And Deformations Into Consideration (Murawski, 2005). Study on Performance of a Ship Propeller Using a Composite Material (Taketani et al., 2013). Propeller Excitation of Longitudinal Vibration Characteristics of Marine Propulsion Shafting System (GanboZhang et al., 2014). Propeller Induced Structural Vibration Through The Thrust Bearing (Pan et al., 2002). Reliability Improvement of Stern Tube Bearing Considering Propeller Shaft Forces during Ship Turning (Kuroiwa et al., 2007). Design and Development of Composite/ Hybrid Propeller Shaft (Khan et al., 2013). Vibration Analysis On A Propeller Shaft (Harish et al., 2015). Modeling and Analysis of a Shaft Blade for its Strength (Dinesh & Mani, 2016). Performance evaluation of composite marine propeller using L8 orthogonal array (Raj & Reddy, 2011). Model identification and dynamic analysis of ship propulsion shaft lines (Jalali & Ahmadian, 2015). Effect of heat treatment on mechanical properties of H11 tool steel (Qamar, 2009). Effect of tempering behavior on heat treated medium carbon (Murugan & Mathews, 2013).

This reseach sought and selected alternative materials instead of tail shafts that experienced wear on the ship. The purpose of this paper is to know the comparism of mechanical properties of the results of some suitable materials to replace tail shafts that wear and tear. The benefits of such writing as literature and reference standards for ship owners in the selection of materials on propeller shaft as suitable alternatives to replace wear-affected tail shafts.

In writing this scientific paper presented systematic as follows, part 1 introduction, part 2 on the material and methodology used, part 3 result and discussion of research, part 4 is the conclusion of research.

2. MATERIALS AND METHODOLOGY.

2.1. Shaft

The shaft line alignment consists of determining the location of the main engine driving axis, intermediate bearing axis. Propeller shaft has a function as the main mechanical power from the main engine to the propeller so that it can generate thrust on the ship. In general the propeller shaft is divided into 3 parts namely : thrust shaft, intermediate shaft and tail shaft. (Boddapati et al., 2015)

2.2. Heat Treatment

Heat treatments procedure chosen include: annealing, normalizing, quenching and tempering after water quenching. Annealing, normalizing and quenching are the most important heat treatments often used to modify the mechanical properties of

engineering materials particularly steels (Tanwer, 2014).

2.3. Hardness Measurements

The hardness of the untreated and post-treated welded samples was evaluated using a Vickers Hardness (LECO AT700 Microhardness Tester). Brinnel hardness testing aims to determine the hardness of a material resistance to the indentor that is emphasized on the surface of the test material (Arasu et al., 2013). Brinell hardness testing using a steel ball with a diameter of 10.

2.4. Tensile Testing

Tensile testing conducted to determine the yield point force, yield point stress, max force, max stress (ultimate tensile strength), max strain (break elongation), break force, reduction of area, strain, and modulus young). (Momoh et al., 2013)

2.4.1. Reduction of Area

Reduction of area that is in the area broken will happen reduction of cross-sectional area (Ghazi & Mashloosh, 2015). Where the percentage of the reduction of cross-sectional area can be formulated as follows :

$$ROA = \frac{Ao-A1}{Ao}\ x\ 100\% \quad (1)$$

Where :

A_0 = First cross-sectional area (mm^2)

A1 = Cross-sectional area after tensile test (mm^2)

2.4.2. Strain

Strain that is on the broken area will be an extension of material. Strain can be calculated by the following formula:

$$\varepsilon = \frac{L1 - Lo}{Lo}\ x\ 100\% \quad (2)$$

Where :

ε = strain (%)

L_1 = the length of the end of the test rod (mm)

L_0 = the initial length of the test material (mm)

2.4.3. Modulus young

Elastic modulus is required for calculating the elasticity of the test material and its non-fixed properties. The magnitude of elastic modulus can be calculated by the following formula:

$$E = \frac{\delta\mu}{\varepsilon} \quad (3)$$

Where :

σ = *ultimate tensile strength* (Kg/mm^2, psi, MPa)

E = Strain (%)

2.5. Bending Test

Figure obtained after implemented bending test, when the maximum load fiven can be seen visually is material test bent or broken when pressed by tool. To find the curve stress can be calculated by the following formula:

$$T = \frac{\frac{1}{2}P \times \frac{1}{2}L}{\frac{\pi}{32} \times d^3} \quad (4)$$

Where :

P = Maximum load acceptable for test material

L = Length of material support

d = The diameter of the material test

2.6. Impact Test

To find the Impact value can be calculated by the following formula:

$$HI = \frac{w}{a} = \frac{m.g.R(\cos\beta - \cos\alpha)}{A} \quad (5)$$

Where :

HI = Impact Value

m = mass pendulum

g = gravity

R = Length of pendulum arm

A = Cross-sectional area material under the impact

2.7. Micro Test

The microstructures were then examined using metallurgical microscope Model- Axio at magnification of 100xx. (Seidu & Kutelu, 2013). Micro testing is the examination of the material by looking at the surface structure of the etching section which has been etched with 400 time magnification (Sharma et al., 2013). In this test will be known the existence of material crack.

2.8. Testing the chemical composition

Testing the chemical composition conducted to determine the content of any existing in each material and to be used as a comparism one of the material. And if these materials given the heat treatment is the chemical composition of the material will be changed or remain.

2.9. Research Methods

This research display data from secondary data of the material wear out. As well as the primary data the research is the material in doing test The next two data will be compared so it can be found the results. The first step is the identification of a problem, book study, data validation, data analysis, and withdrawal conclusion.

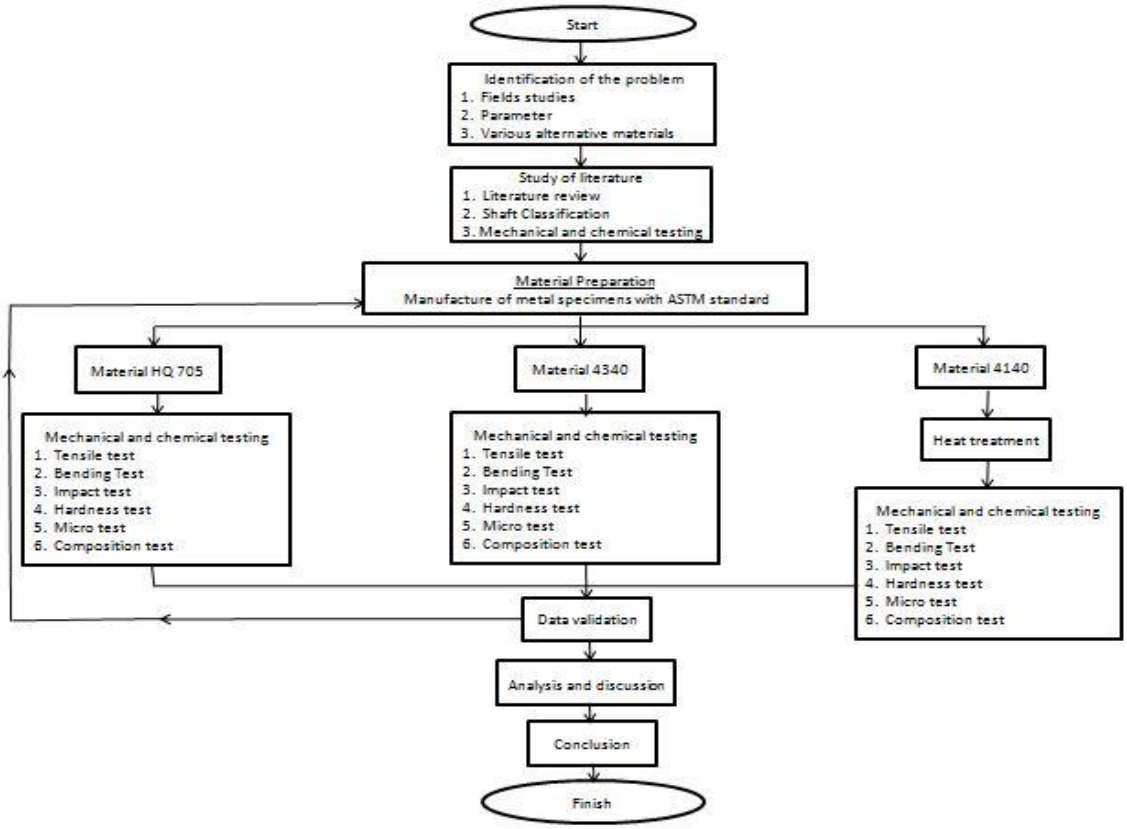

Fig. 2 Flowchart diagram of research

2.10. Analysis of Variance (ANOVA)

In this research, the data processing is done by comparing the data of tensile test and then compare the value of ultimate tensile strength (UTS), curve stress, impact, and hardness.

Data analyzing using ANOVA, is needed as a first steep to be able to see the difference value of each material variation test the following is an observation table with a single factor data analysis process (one way anova) *software* IBM SPSS *Statistics v16*.

With assumption:

a. If $F_{count} < F_{table}$, then H_o accepted and H_1 rejected, which means the variation of the test material after material preparation process can not affect the mechanical properties of the material.

b. If $F_{count} > F_{table}$, then H_o rejected dan H_1 accepted, which means the variation of the test material after the material preparation process can affect the mechanical properties of the material.

2.11. Experimental calculation of test specimens

a. Data collection.

The data supporting both primary and secondary data, used to compile this research are as follows:

Primary data

Data research conducted by doing procedure, varying the material aalternative and the test one of the material is given heat treatment on material 4140.

Secondary data

Data test result material wear out used as a reference and comparism in the selection of material to be tested, Reference and theory Associated with this research can be obtained through journals, books, and others.

b. Data specimens

Specimens used in this research the material based on the type of material, composition of the material and tensile strength of these materials. As for the material obtained: the HQ 705 from PT. Tira Austenit Surabaya while the other material that is: 4340 dan 4140 from PT. Assab Surabaya.

c. Equipment used.

Equipment used to research, among others testing machine tensile, teting machine bend, test equipment impact, test equipment hardness, test equipment micro, testing machine composition, testing machine metallography, lathe, grinding, miserly, calipers, glasses and gloves.

d. Planning.

e. Testing Phase.

3. RESULT.

In this section the results show from this chapter discusses the results of research and perform the processing of data obtained from the results of testing the material alternative as a replacement tail shaft that experienced wear on the ship. So get the results from data processing which include:

Primary data:

3.1. Tensile Test

Table. 1 Material prior to tensile test

No.	Variation	Material	D (mm)	Ao (mm^2)	Lo (mm)
1	Material HQ 705	A1	12,6	124,62	50
		A2	12,7	126,61	50
		A3	12,8	128,61	50
		Total	**38,1**	**379,84**	**150**
		Average	**12,7**	**126,61**	**50**
2	Material 4340	B1	12,5	122,65	50
		B2	12,6	124,62	50
		B3	12,6	124,62	50
		Total	**37,7**	**371,89**	**150**
		Average	**12,56**	**123,96**	**50**
3	Material 4140	C1	12,5	122,65	50
		C2	12,5	122,65	50
		C3	12,5	122,65	50
		Total	**37,5**	**367,95**	**150**
		Average	**12,5**	**122,65**	**50**

D = diameter, Lo = *Gauge Length*

In table 1 is the dimensions of the material test before tensile testing which will be conducted in Labinkimat using tensile testing machine automatically. After obtained the size of the of the ddimensions of the beginning of the material before testing of each material, testing will be made as much as 9 times consisting of 3 material HQ 705, material 4340 and 3 material 4140. From the tensile test obtained data used to compare each material test with material tail shafts who wear out on the ship or compare between material HQ 705, 4340 and 4140. So later terms of tensile test it can be concluded material closest of data ship wear out even material test has the results tensile better.

3.2. Bending Test

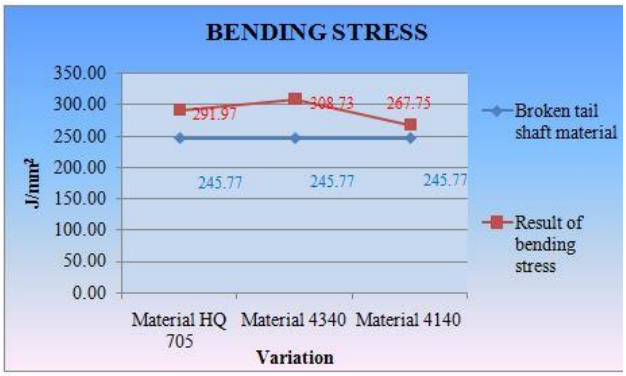

Fig 3. Graph of the bending stress

In Figure 3 can be seen various results of the curvature of each material, where the HQ 705 material produces a curved stress of 291.97, 4340 material produces a curved value of 308.73, 4140 material produces a curved value of 267.75 and the largest curvature value contained on 4340 material of 308.73.

3.3. Impact Test

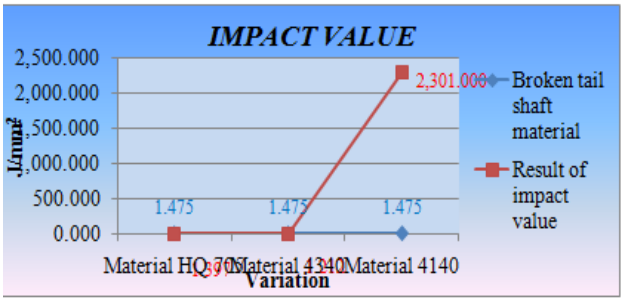

Fig. 4 Impact value graph

In Figure 4 can be seen the various results of the impact value of each material, where the material HQ 705 produce impact value of 1.397 J / mm2, 4340 material results in an impact value of 1,212 J / mm2, 4140 material produces an impact value of 2.301 J / mm2 and value the biggest impact value is found on 4140 material of 2,301 J / mm2. From the results of the test, the impact value of each material varies, the HQ material 705 and 4340 are below the value of the tail shaft material under the wear and tear. While the material 4140 is above the value of tail shaft material that experienced wear on the ship.

3.4. Hardness Test

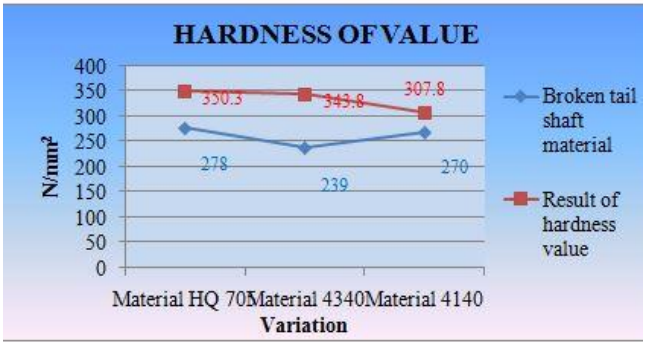

Fig 5. Hardness of value graph

In Figure 5 we can see the hardness values of each material, where the HQ 705 material yields a hardness value of 350.3 N / mm2, the 4340 material yields a hardness value of 343.8 N / mm2, 4140 material yields a hardness value of 307.8 N / mm2 and the largest hardness value is found in 4140 material of 350.3 N / mm2. From the test results obtained, the hardness value of each material is above the hardness value of tail shaft material that experienced wear on the ship.

3.5. Micro Test

Fig. 6 Results of microstructure test

In Figure 6 is a test result of HQ 705 material, 4340 material and 4140 material with 400 times magnification. On the surface of the material there is a content of pearlite or ferrite where the content of ferrite more than the pearlite content indicates when the material is soft.

3.6. Chemical Composition Test

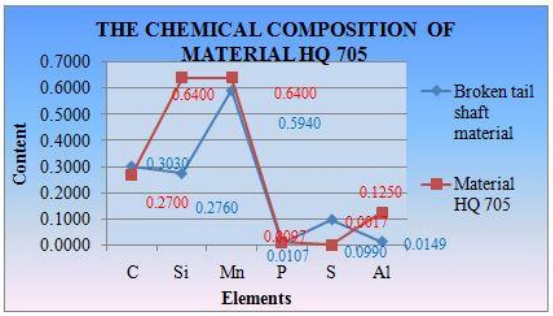

Fig. 7 Graph of chemical composition of HQ 705 material

In Figure 7 can be the result of testing of chemical composition and some of the main elements used the basic reference for material selection. In the carbon element, the phosphorus and sulfur materials of HQ 705 are under the chemical composition of wear-worn tail shaft material. But other elements such as silicon, manganese and aluminum are above the composition of the comparative material.

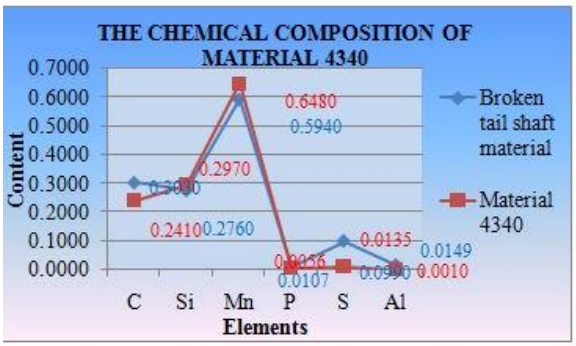

Fig. 8 Graph of chemical composition of material 4340

In Figure 8 can be the result of testing of chemical composition and some of the main elements used the basic reference for material selection. In the element carbon, phosphorus and sulfur 4340 materials are under the chemical composition of wear-resistant tail shaft material. But other elements such as silicon, manganese and aluminum are above the composition of the comparative material.

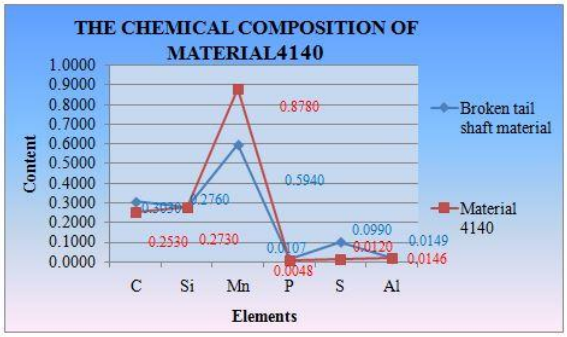

Fig. 9 Graph of chemical composition of material 4140

In Figure 9 can be the result of testing of chemical composition and some of the main elements used the basic reference for material selection. Judging from the above graphic image on the 4140 material only the manganese elements are on top of the tail shaft material that is wearing, the rest is underneath. This may happen because previously the material is given heat treatment.

3.7. Results of Data Engineering Analysis of Variance (ANOVA)

3.7.1. The result of tensile test variant analysis *(tensile test)*

At this stage is the stage of data processing taken from data analysis for Ultimate Tensile Strength (UTS).

Table. 2 Anova data one-way ultimate tensile strength

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	8733,318	2	4366,659	4,991	0,053
Within Groups	5249,110	6	874,852		
Total	13982,428	8			

From Table 2 it can be known that the F_{count} each calculation result gets the value of 4.991, known F_{Table} = 5.14 with the df of the numerator 2 and the df denominator 6 of the odds of 0.95 (1-α) where α = 0.05. It turns $F_{count} < F_{Table}$ then Ho is accepted and H1 is rejected which means variation of test material after material preparation process can not affect material mechanical properties due to significant probality (0.0053)> 0.005.

3.7.2. The result of bending test variant analysis (bending test)

At this stage is the stage of data processing taken from data analysis for curved stress

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Table 3. Anova data one-way curve stress

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2547,686	2	1273,843	1473,578	0,000
Within Groups	5,187	6	,864		
Total	2552,873	8			

From Table 3 it can be known that the F_{count} on each calculation result gets the value of 1473,578, known F_{Table} = 5.14 with the df of the numerator 2 and the df denominator 6 of the odds of 0.95 (1-α) where α = 0.05. It turns $F_{count} > F_{Table}$ then Ho is rejected and H1 is accepted which means the variation of test material after material preparation process can affect material mechanical properties but not significant because probality (0,000) <0.005.

3.7.3. The results of the test variant of the impact test

At this stage is the stage of data processing taken from data analysis for Impact Value.

Table. 4 Anova one-way Impact value data

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2,000	2	1,000	444,366	0,000
Within Groups	,014	6	,002		
Total	2,014	8			

From Table 4 it can be known that F_{count} on each calculation result get value equal to 44,366, known F_{Table} = 5,14 with df of numerator 2 and df denominator 6 from probability 0,95 (1-α) where α = 0,05. It turns out that $F_{count} > F_{Table}$ then Ho is rejected and H1 accepted which means variation of test material after material preparation process

can affect material mechanical properties but not significant because probality (0,000) <0,005.

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Table. 5 Anova data one-way hardness

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3141,236	2	1570,618	258,656	0,000
Within Groups	36,433	6	6,072		
Total	3177,669	8			

3.7.4. Result of analysis of hardness test variant (hardness test).

At this stage is the stage of data processing taken from data analysis for the value of hardness From Table 5 it can be known that the F_{count} on each calculation result gets a value of 258,656, known F_{Table} = 5.14 with the df of numerator 2 and df denominator 6 of the odds of 0.95 (1-α) where α = 0.05. It turns $F_{count} > F_{Table}$ then Ho is rejected and H1 is accepted which means variation of test material after material preparation process can affect material mechanical properties but not significant because probality (0,000) <0,005.

3.8. The data of the tail shaft test material which become the reference as the comparative data of the wearing material is as follows:

3.8.1. Tensile test results (*tensile test*), UTM Shimadzu, Cap. 1000 kNi

Table. 6 Result of tensile test material wearing wear

No.	Test parameters	I	II	III	Test results average
1.	*Yield point force* (kN)	100,594	103,500	101,137	101,744
2.	*Yield point stress* (MPa)	819,712	843,394	824,143	829,08
3.	*Max force* (kN)	116,813	117,281	116,838	116,977
4.	*Max Stress*/UTS (MPa)	951,874	955,694	952,078	953,215
5.	*Max strain/elongation* (%)	19,925	17,187	24,119	20,410
6.	*Breaking force* (kN)	71,594	49,844	74,000	65,146

In Table 6 is the result of tensile test (tensile test) material of propeller shaft which is wear and used for basic comparator. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that has been accredited by KAN.

3.8.2. Result of bending test, UTM Tokyokoki Seizosho, Cap. 30 kNi

Table. 7 Result of bending test material

No.	Test parameters	I	II	III	Test results average
1.	Max force, P_{max} (kg)	3625	3650	3600	3625
2.	Curved stress, τ (kg/mm^2)	245,77	247,77	244,08	245,77

In Table 7 is the result of bending test propeller shaft material that experienced wear and used for basic comparators. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that has been accredited by KAN.

3.8.3. Result of impact test, Tokyokoki Seizosho, Cap. 30 kgm

Table. 8 Result of impact test material

No.	Impact Value, HI	I	II	III	Test results average
1.	*Specimen tail shaft*	0,789	1,805	1,831	1,475

In Table 8 is the result of an impact test propeller shaft material that experienced wear and used for basic comparators. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that has been accredited by KAN.

3.8.3. Result of impact test, Tokyokoki Seizosho, Cap. 30 kgm

Table. 8 Result of impact test material

No.	Impact Value, HI	I	II	III	Test results average
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In Table 8 is the result of an impact test propeller shaft material that experienced wear and used for basic comparators. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that has been accredited by KAN.

3.8.4. Result of hardness test, Brinell Hardness (HB)

Table. 9 Result of hardness test material

No.	Specimen test point	I	II	III	Test results average
1.	A	277	273	283	278
2.	B	236	237	245	239
3.	C	262	274	273	270

In Table 9 is the result of hardness test (hardness test) material propeller shaft that experienced wear and used for basic comparators. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that have been accredited by KAN

3.8.9. Result of chemical test, Foundry-master Pro

Table. 10 Result of chemical test material

Testing	Fe	C	Si	Mn	P	S	Cr	Mo
1	95,2	0,309	0,278	0,595	0,0111	0,0120	0,900	0,441
2	95,2	0,303	0,274	0,594	0,0106	0,0092	0,907	0,430
3	95,2	0,297	0,276	0,592	0,0105	0,0084	0,0891	0,428
Average	**95,2**	**0,303**	**0,276**	**0,594**	**0,0107**	**0,099**	**0,900**	**0,433**
Testing	**Ni**	**Al**	**Co**	**Cu**	**Nb**	**Ti**	**V**	**W**
1	1,92	0,0156	0,0339	0,132	0,0015	0,0018	0,104	<0,0050
2	1,96	0,0150	0,0333	0,133	<0,0010	0,0015	0,102	<0,0050
3	1,97	0,0143	0,0334	0,133	0,0012	0,0017	0,101	<0,0050
Average	**1,95**	**0,0149**	**0,0335**	**0,133**	**0,0012**	**0,0017**	**0,102**	**<0,0050**
Testing	**Pb**	**Sn**	**B**	**Ca**	**Zr**	**Zn**	**Bi**	**As**
1	0,0050	0,0083	0,0007	0,0008	<0,0010	0,0035	<0,0010	0,0097
2	0,0050	0,0081	0,0006	0,0007	<0,0010	0,0031	<0,0010	0,0097
3	0,0050	0,0077	0,0006	0,0006	<0,0010	0,0033	<0,0010	0,0094
Average	**0,0050**	**0,0080**	**0,0006**	**0,0007**	**<0,0010**	**0,0033**	**<0,0010**	**0,0096**
Testing	**N**	**Se**	**Sb**	**Ta**				
1	0,0109	0,0063	0,0022	0,0245				
2	0,0082	0,0057	0,0032	0,0270				
3	0,0090	0,0062	0,0012	0,0258				
Average	**0,0094**	**0,0061**	**0,0022**	**0,0258**				

Table 10 is the result of chemical test material propeller shaft that experienced wear and used for basic comparators. The tests were conducted at the Chemical and Materials Master Laboratory (LABINKIMAT) under the auspices of the Navy that has been accredited by KAN.

4. CONCLUSION.

a. From the results of testing data and data analysis that has been done, the results of suitable alternative material as replacement of worn-out tail shaft is HQ 705 material with physical properties of microstructure of surface structure dominated by ferrite phase indicating the material is soft and mechanical properties of tensile testing, bending testing, hardness testing, and chemical testing of HQ 705 material has a high value.

b. All three alternative materials are suitable and can be used instead of tail shafts that wear and tear. However it is more advisable to choose the HQ 705 material as the main choice.

c. The observation of ANOVA on tensile testing can not affect the material but on bending test, impact and hardness may effect but not significantly.

5. Reference.

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THE ZINC ANODE PERFORMANCE FOR SACP AN INVESTIGATION OF WARSHIP UNDERWATER STRUCTURES

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ABSTRACT

Today's majority of Indonesian Warship (KRI) uses Zinc as Sacrificial Anode for corrosion control, but quality of zinc is under expectation. The aim of paper is to investigation of Zinc Anode Performance on underwater structure of KRI using chemical composition test and corrosion potential measurement test. This paper uses three speciments of zinc anode as a comparison. The result of dry chemical composition test showed that speciment A have 99,8% (Zn), 0,121% (Al), 0,0141% (Cd), 0,0004% (Cu), 0,002% (Fe), 0,0087% (Pb), 0,0007% (Si). Speciment B showed that 99,9% (Zn), 0,0045% (Al), 0,0001% (Cd), 0,0026 % (Cu), 0,002% (Fe), 0,0111% (Pb), 0,0005% (Si). Speciment C showed that 99,6% (Zn), 0,102% (Al), 0,0023% (Cd), 0,077 % (Cu), 0,0272% (Fe), 0,042% (Pb), 0,0008% (Si). The result of wet chemical composition test showed that speciment A have 1,4502% (Zn), 0,163% (Al), 0,00311% (Cd), 0,0000276 % (Cu), 0,00005% (Fe), 0,000056% (Pb). Speciment B showed that 1,4723% (Zn), 0,0096% (Al), 0,0002% (Cd), 0,000018 % (Cu), 0,0016% (Fe), 0,00007% (Pb). Speciment C showed that 1,456% (Zn), 0,0896% (Al), 0,00065% (Cd), 0,005 % (Cu), 0,0156% (Fe), 0,00428% (Pb). The result of corrosion potential test showed that 1,005V for speciment A, 0,977V for speciment B, 0,994V for speciment C. Zinc with Mild steel A showed 0,83V for speciment A, 0,87V for speciment B, 0,829V for speciment C. Based of chemical composition test, speciment A and B is accomplished from US Military Specifications standard, but speciment C doesn't accomplish. Based of corrosion potential measurement test, all of speciment can used for sacrifice anode.

KEYWORDS : *Cathodic Protection, Zinc Anode, Composition Test, Corrosion Potential Test, Indonesian Warship.*

3. INTRODUCTION.

Indonesian Warship (KRI) is the main component from Indonesian Navy (TNI AL) to secure maritime area. At sea, KRI have many activities for Maritime Security and Defence such as basic training, warfare alert and operation (Susilo et al. 2017). Largely, KRI made from metal material which easy to corrosion attacked, particulary on underwater structure. So that, the underwater structure of warship needs protection from corrosion. Corrosion can be defined as the deterioration of material's properties due to its interaction with its environment (Al-Sultani & Nabat 2012). Corrosion is a malicious chemical or electrochemical reaction between the metal surface and the surrounding environment (Javadi, J.Javidan & Salimi 2104). Since, seawater has significant effect on marine vessels and offshore steel structures because it is highly corrosive media, which leads to the formation of different types of corrosion cells such as dissimilar metal corrosion cells and differential aeration cells (Rogers 1974). There are three primary reasons for

concern about and the study of corrosion-safety, economics, and conservation (Emami 2012).

Different methods are used for corrosion protection of steel in corrosive solution (Panah & Ajani 2016). Basically, there are five methods of corrosion control such as change to a more suitable material, modification to the environment, use of protective coating, design modification to the system or component, and the application of cathodic or anodic protection (Roberge 1999).

Cathodic Protection (CP) is a proven method of controlling corrosion in reinforced concrete through the application of a small Direct Current (DC) (Nguyen et al. 2012). The method has widely used in many areas such as for storage tanks, offshore structures, platforms and ship hulls (Hafizh et al. 2015). There are two types of applying cathodic protection system, namely Sacrificial Anode Cathodic Protection (SACP) and Impressed Current Cathodic Protection (ICCP) (Al-Himdani, Mahdi & Khuder 2005).

Majority of KRI used Zinc as Sacrifice Anode for corrosion control on underwater structure. Today's, the quality of Zinc Anode on KRI is under expectated. The aim of this paper is to present an investigation of Zinc Anode performance on underwater structure of KRI. There a two method for evaluating performance of Zinc Anode, one is chemical composition and another is based on corrosion potential measurement test (Mahasiripan, Tangtermsirikul & Sancharoen 2014). Boundary of problem in this paper is Zinc as sacrificial anode applied in US Military Specification Standard, Zinc divided by 3 speciments as a comparison.

The inscriptive benefit from this paper is a literature for Indonesia Navy about corrosion control on KRI underwater Structure. Second, it uses for academic contribution to Indonesian Naval Technology College.

To support the research, this paper has many literatures. Literature of paper about corrosion control likes Numerically Analysis of Corrosion Resistance and Control Plate (Kumar, Rajalingam & G.R.Kannan 2014). Corrosion Protection System in Offshore Structure (Ivanov 2016). Synergic effect of Thiomalic acid and Zinc ions in Corrosion control of Carbon Steel in Aqueous Solution (Ramesh & Periasamy 2014). Study on Corrosion Properties of plasma Nitried Pure Aluminium (Yazdani, Soltanieh & Aghajani 2009). An Investigation on the Performance of an Imidazoline Based Commercial Corrosion Inhibitor on CO2 Corrosion of Gas-well Tubing steel by EIS Technique (Khavasfar, Moayed & Attar 2007).

Paper literature about cathodic protection such as Efficiency of Corrosion Inhibitors on Cathodic Protection System (Briggs & Eseonu 2014). Cathodic Protection of Steel in Concrete Using Conductive Polymer Overlays (A.S.S.Sekar, V.Saraswathy & G.T.Parthiban 2007). Interaction Between Cathodic Protection and Microbially Influenced Corrosion (Masli 2011).

Paper literature explains about Sacrificial Anode (SACP) is The effect of Cathodic Protection System by Means of Zinc Sacrifial Anode on Pier in Korea (Jeong & Jin 2014). Numerical Analysis Result of The Cathodic Protection for The Underground Steel Pipe by Anode Installation Method (Jeong et al. 2014). Impact of Galvanic Anode Dissolution on Metal Trace Element Concentrations in Marine Waters (Deborde et al. 2015). Electrocoagulation of Textile Wastewater with Fe Sacrificial Anode (Ajjam & Ghanim 2012). Sacrificial Protection Method During Disinfection to Avoid Corrosion (Rehman, Amin & Abbasm 2014)

This paper is organized as follows. Section 2 reviews the methods and materials of this paper. Section 3 gives result and discussion. Finally, in section 4 presents this paper conclusion.

4. MATERIAL/METHODOLOGY.

2.1. Sacrificial Anode.

Sacrificial anode is the main component of Cathodic protection system used to protect form corrosion. Sacrificial anodes have become a standard practice for the protection of vessels and offshore hull structures against corrosion (Baere et al. 2013). Sacrificial anodes are made in various shape using alloys of zinc, magnesium and alumunium (Loto & Popoola 2011). Sacrifical zinc anodes is used to protect bare steel in commercial and military vessels, in hot waters, water storage tanks and steel reinforcing bars in concrete structurres located in marine environment (McCafferty 2010). The underwater structure of ship is protected by painting for the main protection and zinc as sacrifial anode used to control the rate of dissolution in seawater (Talbot & Talbot 1998).

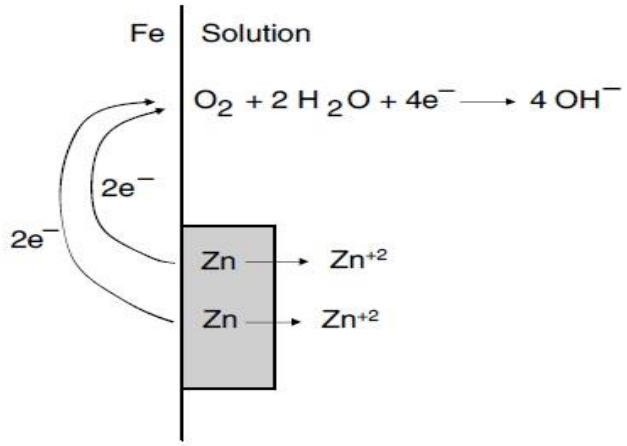

Fig. 1. Process of Sacrificial Anode (Roberge 1999).

In the sacrificial anode method, electrical potential is created by attaching a dissimilar metal in electrolyte, when different metals are coupled together, the anode material will release electrons and protect the cathode from corrosion (Hafizh et al. 2015). The electrode potential of low alloy steel in seawater is approximately -0,6 V vs SCE. The electrode potential of zinc is -1,0 V, thus when zinc is coupled to steel zinc will be the anode and steel will be the cathode.

The advantages are associated with sacrificial anode CP systems (Roberge 1999):

a. No external power sources required.
b. Ease of installation.
c. Unlikely cathodic interference in other structures.
d. Low-maintenance systems.
e. System is essentially self-regulating.
f. Relatively low risk of overprotection.
g. Relatively uniform potential distribution

These limitations that have been identified for ICCP systems (Roberge 1999):

a. Limited current and power output.
b. High-resistivity environments or large structures may require excessive number of electrodes..
c. Anodes may have to be replaced frequently under high current demand.
d. Anodes can increase structural weight if directly attached to a structure.

2.2. Zinc Anode.

Zinc anode are commonly available in weight from 2,27 – 113,4 kilograms (5 pounds to 250 pounds) in the form of plates, bars, and rods as shown in MIL-HDBK-1004/10. Zinc is also available as ribbon anodes in 16-millimeter by 22.2-millimeter (5/8-inch by 7/8-inch), 13-millimeter by 14.3-millimeter (1/2-inch by 9/16-inch), and 8.7-millimeter by 11.9-millimeter (11/32-inch by 15/32-inch) sizes, each with a 2.5-millimeter (1/10-inch) diameter galvanized steel wire core (Basham et al. 2003). The electrical potential of zinc anodes is approximately -1.10 volts DC to copper/copper sulfate in soil. In some fresh waters, the potential can reverse at temperatures above 58.3 ºC (140 ºF); consequently, zinc should not be used in those cases (Basham et al. 2003).

Table 1. Chemical Composition of Zinc Anode (Fontana 1987)

ELEMENT	STANDARD ALLOY	SEAWATER ALLOY
Aluminum	0.005% max	0.10% - 0.50%
Cadmium	0.003% max	0.03% - 0.15%
Iron	0.00014% max	0.005% max
Lead	0.003% max	0.006% max
Copper	-	0.005% max
Silicon	-	0.125% max
Zinc	Remainder	Remainder

Table 2. Chemical Composition with U.S Military specification (NACE 2002)

Element	Weight Content %	
	MIL-A-18001 (ASTM B-418 Type I)	ASTM B-418 Type II
Al	0.1–0.5	0.005 max
Cd	0.02–0.07	0.003 max
Fe	0.005 max	0.0014 max
Pb	0.006 max	0.003 max
Cu	0.005 max	0.002 max
Zinc	Remainder	Remainder

2.3.1 Flowchart Diagram.

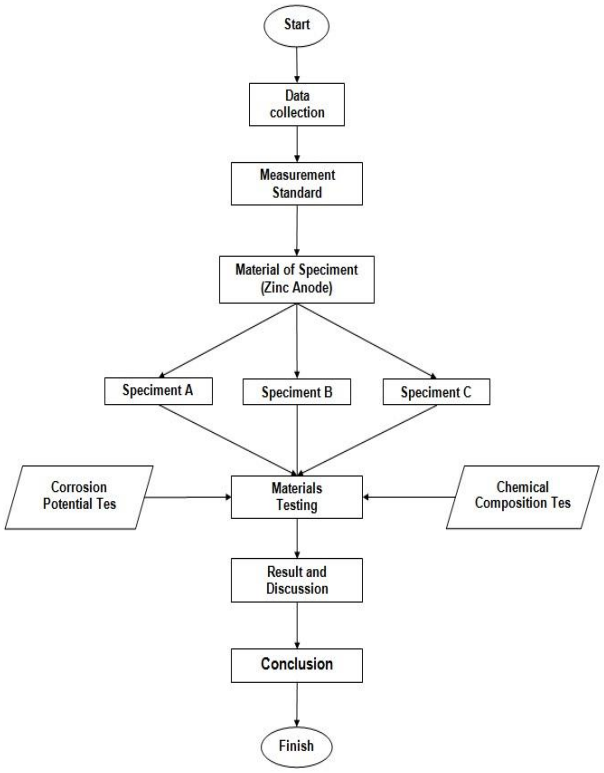

Fig. 2. Flowchart Diagram of

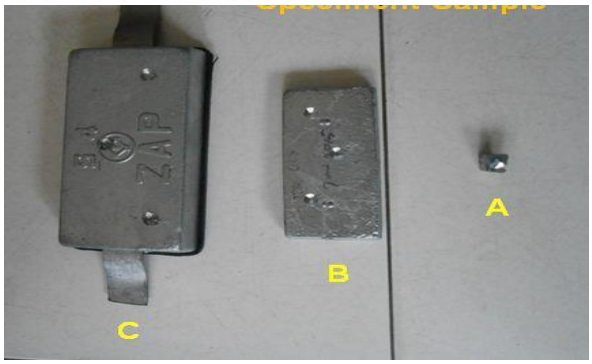

Fig. 3. Speciment Sample.

b. Tools :

1) Metal Plate, Mild steel Grade A.
2) Referensial Anode.
3) Multitester.
4) Inductively Couple Plasma (IPC) for wet composition test.
5) Foundry Master Pro for dry composition test.

Fig. 4. Foundry Master Pro

2.3.2 Data Collection.

a. Materials speciment.

1) Speciment A : Zinc made from Naval Laboratory.

This machine contains a solid state spark source, a vacum system, an optical system and output system. The sample was positioned on the spark stand for chemical composition analysis (Cassinath 2013).

Fig. 5. Inductively Couple Plasma

ICP is an effective method of measuring multiple trace metals involves using an inductively coupled plasma-atomic emission spectrometer (Ryan & Clark 2010). The fundamental characteristic of this process is that each element emits energy at specific wavelengths peculiar to its chemical character (Kumar, I. & Ajitha 2014). ICP instrument employs argon plasma (ICP) as the ionization source and a mass spectrometer (MS), usually with a quadrupole mass filter, to separate the ions produced (A.A & W.L.O 2011)

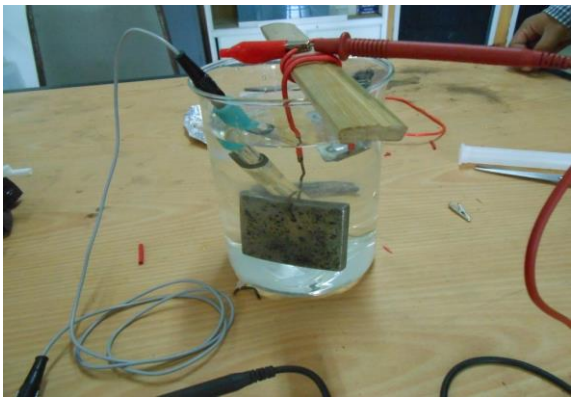

Fig. 6. Potential Corrosion Test.

Corrosion potential test is measured as a potential difference against a reference electrode at different points on a structure and is used to determine the likehood of reinforcement corrosion (Trejo, Reinschimdt & Halmen 2009). The numerical value of the measured potential difference between the steel in concrete and the reference electrode will depend in the type of reference electrode used and on the corrosion condition of the steel in concrete (Andrade et al. 2003).

5. RESULT AND DISCUSSION.

3.1 Result of Dry Composition Test.

Table 3. Result of Chemical Composition (Dry Test).

Element	Zinc Anode (%) Weight			U.S Standard
	Speciment A	Speciment B	Speciment C	(Mil-A-18001-H)
Zn	99,8	99,9	99,6	Remainder
Al	0,121	0,0045	0,102	0,1-0,5
Cd	0,0141	0,0001	0,0023	0,025-0,15
Cu	<0,0004	0,0026	0,0777	Max 0,005
Fe	<0,002	<0,002	0,0272	Max 0,005
Pb	0,0087	0,0111	0,0422	Max 0,006
Si	0,0007	0,0005	0,0008	Max 0,015

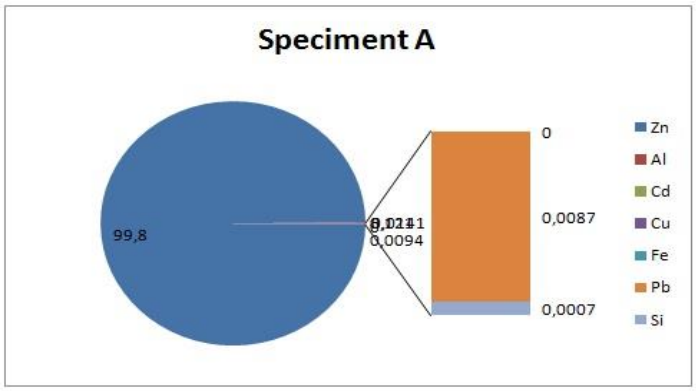

Fig. 7. Composition of Speciment A

The result of dry chemical composition test showed that speciment A have 99,8% (Zn), 0,121% (Al), 0,0141% (Cd), 0,0004% (Cu), 0,0020% (Fe), 0,0087% (Pb), 0,0007% (Si).

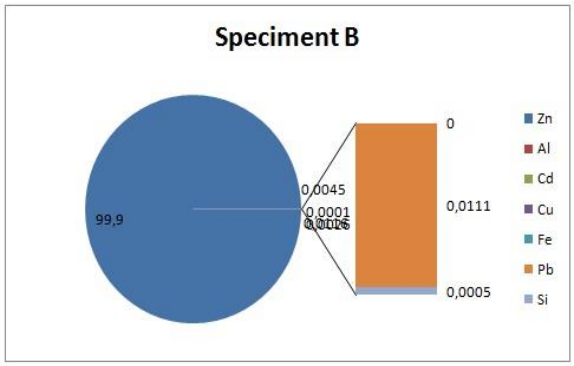

Fig. 8. Composition of Speciment B

Speciment B showed that 99,9% (Zn), 0,0045% (Al), 0,0001% (Cd), 0,0026 % (Cu), 0,0020% (Fe), 0,0111% (Pb), 0,0005% (Si).

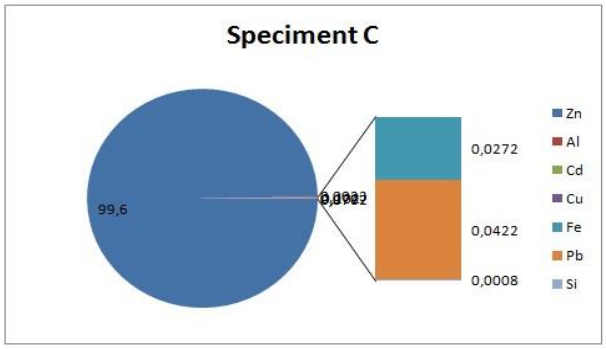

Fig. 9. Composition of Speciment C

Speciment C showed that 99,6% (Zn), 0,102% (Al), 0,0023% (Cd), 0,077 % (Cu), 0,0272% (Fe), 0,042% (Pb), 0,0008% (Si).

3.2 Result of Wet Composition Test.

Table 4. Result of Chemical Composition (Wet Test)

Element	Zinc Anode (%) Weight			U.S Standard
	Speciment A	Speciment B	Speciment C	(Mil-A-18001-H)
Zn	1,4502	1,4723	1,456	Remainder
Al	0,163	0,0096	0,0896	0,1-0,5
Cd	0,00311	0,0002	0,00065	0,025-0,15
Cu	0,0000276	0,000018	0,005	Max 0,005
Fe	0,00005	0,0016	0,0156	Max 0,005
Pb	0,000056	0,00007	0,00428	Max 0,006
Si	-	-	-	Max 0,015

The result of wet chemical composition test showed that speciment A have 1,4502% (Zn), 0,163% (Al), 0,00311% (Cd), 0,0000276 % (Cu), 0,00005% (Fe), 0,000056% (Pb).

Speciment B showed that 1,4723% (Zn), 0,0096% (Al), 0,0002% (Cd), 0,000018 % (Cu), 0,0016% (Fe), 0,00007% (Pb).

Speciment C showed that 1,456% (Zn), 0,0896% (Al), 0,00065% (Cd), 0,005 % (Cu), 0,0156% (Fe), 0,00428% (Pb).

3.3 Result of Corrosion Potential Test.

Table 5. Result of Corrosion Potential

	Element	Potential (V)
1	Speciment A	-1,005
2	Speciment B	-0,977
3	Speciment C	-0,994
4	Fe Mild Steal	-0,463
5	Speciment A	-0,83
6	Speciment B	-0,87
7	Speciment C	-0,829

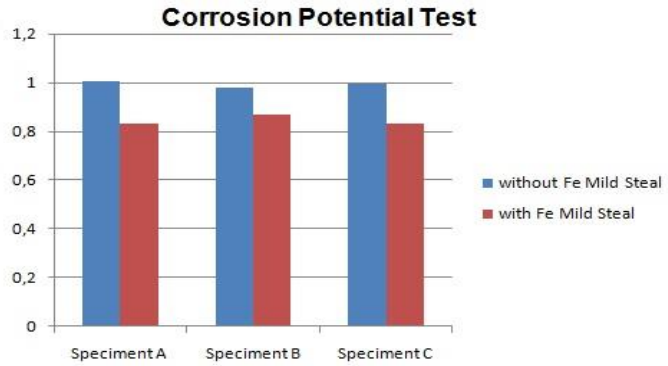

Fig. 10. Result of Corrosion Potential Test.

The result of corrosion potential test without Mild Steel showed that 1,005V for speciment A, 0,977V for speciment B, 0,994V for speciment C. Zinc with Mild steel A showed 0,83V for speciment A, 0,87V for speciment B, 0,829V for speciment C.

3.4 Comparison of Element Composition.

3.4.1 Zinc (Zn) Element

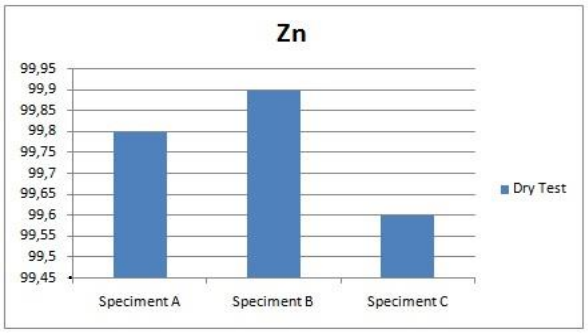

Fig. 11. Zinc Element.

Base of theoritic graphics for Zinc (Zn) element (fig.11), showed that specimen A has 99,8%, speciment B has 99,9%, speciment C has 99,6%. Speciment B has highest value in Zinc element and speciment C has lowest.

3.4.2 Aluminium (Al) Element.

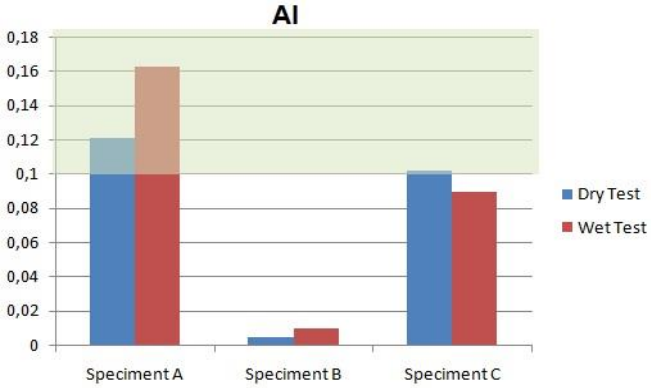

Fig. 12. Aluminium Element

Base of theoritic graphics for Aluminium (Al) element (fig. 12), showed that specimen A has 0,121% in dry test and 0,163% in wet test. Speciment B has 0,0045% in dry test and 0,0096% in wet test. Speciment C has 0,102% in dry test and 0,0896% in wet test. Speciment B has highest value in Zinc element and speciment C has lowest. Based of grey parameters, speciment A in category for dry and wet composition test.

3.4.3 Cadmium (Cd) Element.

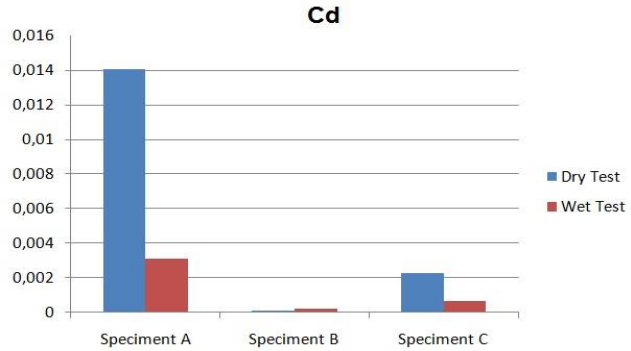

Fig. 13. Cadmium Element

Base of theoritic graphics for Cadmium (Cd) element (fig. 13), showed that specimen A has 0,141% in dry test and 0,00311% in wet test. Speciment B has 0,0001% in dry test and 0,0002% in wet test. Speciment C has 0,0023% in dry test and 0,00065% in wet test. All speciment is not in category.

3.4.4 Copper (Cu) Element.

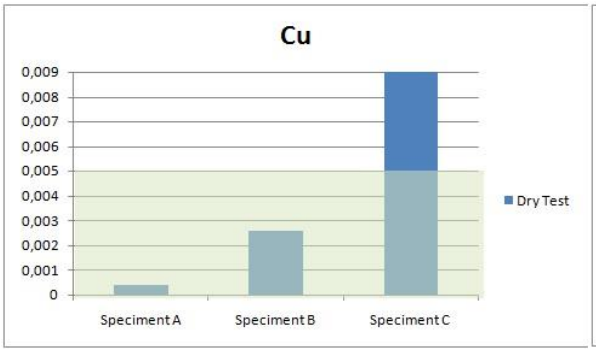

Fig. 14. Copper Element (dry test)

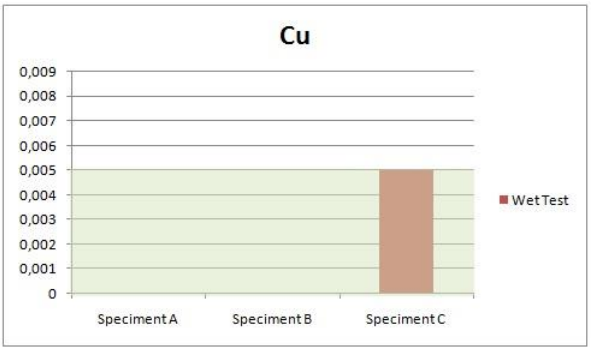

Fig. 15. Copper Element (wet test)

Base of theoritic graphics for Copper (Cu) element (fig. 14,15), showed that in dry test specimen A has 0,0004%, Speciment B has 0,0026%, Speciment C has 0,0777%. In wet test, specimen A has 0,0000276%, Speciment B has 0,000018%, Speciment C has 0,005%. In dry test, Speciment A and B include in category, but Speciment C not in category. In wet test, All of Speciment include in category.

3.4.5 Ferrum (Fe) Element.

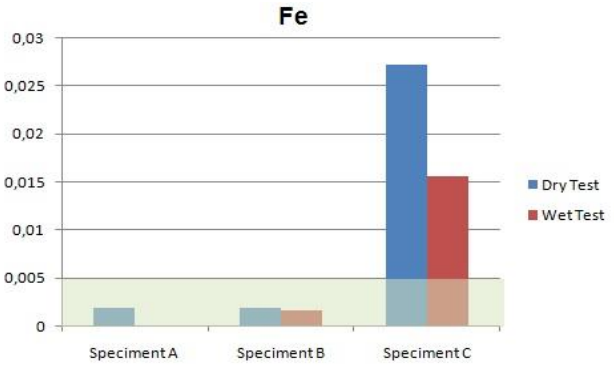

Fig. 16. Ferrum Element

Base of theoritic graphics for Ferrum (Fe) element (fig. 16), showed that specimen A has 0,002% in dry test and 0,00005% in wet test. Speciment B has 0,002% in dry test and 0,0016% in wet test. Speciment C has 0,0272% in dry test and 0,0156% in wet test. Speciment A and B include in category, Speciment C not in category

3.4.6 Plumbum (Pb) Element.

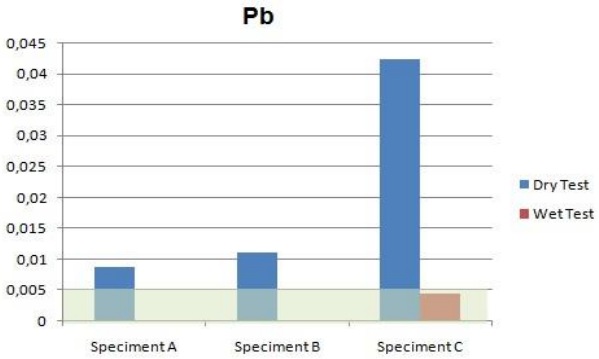

Fig. 17. Plumbum Element

Base of theoritic graphics for Plumbum (Pb) element (fig. 17), showed that specimen A has 0,0087% in dry test and 0,000056% in wet test. Speciment B has 0,0111% in dry test and 0,00007% in wet test. Speciment C has 0,0422% in dry test and 0,00428% in wet test. In dry test, all of speciment not in category, but in wet test all of speciment include in category.

6. CONCLUSION.

a. The result of dry chemical composition test showed that speciment A have 99,8% (Zn), 0,121% (Al), 0,0141% (Cd), 0,0004% (Cu), 0,002% (Fe), 0,0087% (Pb), 0,0007% (Si). Speciment B showed that 99,9% (Zn), 0,0045% (Al), 0,0001% (Cd), 0,0026 % (Cu), 0,002% (Fe), 0,0111% (Pb), 0,0005% (Si). Speciment C showed that 99,6% (Zn), 0,102% (Al), 0,0023% (Cd), 0,077 % (Cu), 0,0272% (Fe), 0,042% (Pb), 0,0008% (Si).

b. The result of wet chemical composition test showed that speciment A have 1,4502% (Zn), 0,163% (Al), 0,00311% (Cd), 0,0000276 % (Cu), 0,00005% (Fe), 0,000056% (Pb). Speciment B showed that 1,4723% (Zn), 0,0096% (Al), 0,0002% (Cd), 0,000018 % (Cu), 0,0016% (Fe), 0,00007% (Pb). Speciment C showed that 1,456% (Zn), 0,0896% (Al), 0,00065% (Cd), 0,005 % (Cu), 0,0156% (Fe), 0,00428% (Pb).

c. The result of corrosion potential test without Mild steel showed that 1,005V for speciment A, 0,977V for speciment B, 0,994V for speciment C. Zinc with Mild steel A showed 0,83V for speciment A, 0,87V for speciment B, 0,829V for speciment C

d. Based of chemical composition test, speciment A and B is accomplished from US Military Specifications standard, but speciment C doesn't accomplish.

e. Based of corrosion potential measurement test, all of speciment can used for sacrifice anode.

7. ACKNOWLEDEMENT.

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FIELD III

POLICY & STRATEGY

THE MODEL OF POLICY EVALUATION ON NAVY PERSONNEL ; AN ASSESSMENT OF PERFORMANCE ALLOWANCE BY SYSTEM DYNAMIC METHODS

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ABSTRACT

This study aims to build a model in order to evaluate the performance allowance policy by assessing the welfare aspects, profesionality and state-public services of navy personnel. Nowadays, the performance allowances policy which given to the Navy Personnel has not significantly affected at the performance, professionality and capabilities of Navy Personnel. The methods of policy evaluation model in this research use a system dynamic method development. Identification of variables on the aspects of welfare, profesionality and public service has been done and including the relationship of interaction between all aspects as a system. Each aspect has interrelated variable or criteria which interacting each other in the system dynamics relationships.The output of the policy evaluation model is a score model or the evaluation index of each of the assessed variables. This policy evaluation index serves as an indicator that indicates the variable needs to be evaluated at the performance allowances of navy personnel as a system, and according to the value of the conversion index and the strategic meaning it gains. Based on the evaluation and the results of the model analysis conducted on the scenarios, the policy scenario is Enhancement of Profession Capability of Navy Personnel. The MOdel of Scenario is focused on increasing the competence of the navy personnel advanced skills.

Keyword: Policy Evaluation Model, Performance Allowance, Navy Personnel, System Dynamic.

1. INTRODUCTION

The development of the human resources force of the Navy and the modernization of weapons systems should be implemented in a planned, gradual, and sustainable manner by keeping in mind the state capability or budget available. The priority of the object of strength development, among others, focuses on the field of organization, Human Resources Development (HRD), material of defense equipment, bases and stock materials. Especially for the development of HRD, the Navy has implemented various policies in the field of performance management to improve the professionalism of personnel, one of them is by giving performance allowance. The policy is in line with the Government's commitment as stated in the 2008 National Defense White Paper mentioned that the increase of professionalism cannot be separated from the improvement of welfare through the adequacy of salaries, the provision of residential facilities, health insurance, educational improvement and the preparation of the term life insurance scheme. Improving the welfare of navy personnel is the task of the Government to keep the professionality of the Navy.

Based on the Regulation of the Minister of Administrative Reform and Bureaucracy Reform No. 63 of 2011 on Guidelines for Structuring the Performance System of Civil Servant Performance, it can be explained that performance allowance is a function of the successful implementation of bureaucratic reform. Employee performance allowance is given based on the performance achieved by an individual employee. The performance of each individual employee must be in line with the performance to be achieved by the agency.

Provision of performance allowances or remuneration or compensation has a positive impact on the achievement of job satisfaction,

performance improvement, and decreased absenteeism. Compensation can improve job satisfaction and employee performance. Remuneration can improve employee performance, so it can support the success of the bureaucratic reform program. Conceptually, giving performance allowance is actually one of the right steps to improve the performance of Navy Personnel.

The development of Indonesia Navy posture is essentially oriented towards the achievement of the main task of the Navy in order to support the national interest. The tasks of the Navy in the future will still be faced with limited defense budget and limited human resources, on the other hand the rapidly changing strategic environment in global competition will further add to the complexity of the problem, mainly in law enforcement and security efforts and in maintaining the sovereignty of the Unitary State of the Republic Indonesia.

The purpose of this study is to make a model comprehensive evaluation of the performance policy scenarios of performance alignment within the Navy by considering the interaction between influential variables within it as a dynamic system, so that the selected policy can be sustainable to be adapted as input for the improvement of the Presidential Regulation No. 87 the Year 2015 on Employee Performance Allowance in the Navy Institution, so in the Presidential Regulation is set the number of performance allowances are given based on achievement, burden, and level of work risk. Evaluation of the provision of performance allowances within the Navy will give birth to a recommendation related to the improvement of performance allowance system in order to improve the quality of human resources that is adjusted to the dynamics of the system and the development of the Navy sustainable.

In detail, the focus of this study can be reviewed from five sub-focus, as follows:

1. Identify the factors that influence the program and the implementation of performance allowance policy within the Navy as a system that interacts.
2. Preparation of program evaluation model of the system of giving performance allowances in the environment of the Navy sustainable.
3. Preparing performance policy scenarios in the Navy's performance environment along with analyzing the impacts and effects of those scenarios on aspects of:
(a) The welfare of Navy Personnel.
(b) The Professionality of Navy Personnel
(c) State & Public services of Navy Personnel.
4. Comprehensive analysis and evaluation of policy scenarios applied to the system of determining performance allowances
5. Determination of the best sustainable policies on the determination of performance allowances, based on a thorough evaluation of the impact of factors and criteria as an interacting system.

Based on this it is necessary to analyze, study and in-depth research on how the application of the policy of giving performance allowance for Navy Personnel in naval unit work and its impact to the welfare of Navy Personnel, Professionality, and State-public service. In-depth analysis, study, and research are conducted by considering the dynamics of the upcoming system so as to obtain the results and the real impact of the best policy evaluation in the field of Human Resources so that it can be used to improve the performance allowance system within the Navy.

This paper has many literatures to support the research, such as : A New Method for Modeling System Dynamics (Youssefi et al, 2011), System Dynamics-based Modeling and Analysis of Greening the Construction Industry Supply Chain (Balan et al, 2014), The Politics of Public Policy and Problems of Implementation in Africa (Imurana et al, 2014), Leadership, Governance and Public Policy Implementation Competencies in the Broader Public Sector (Muhammad F, 2014), Establishing the Location of Naval Base Using Fuzzy MCDM and Covering Technique Methods (Suharyo O.S. et al, 2017), Applied of Impressed Current Protection Design Network At Naval Base (Susilo A.K et al, 2017).

2. BASIC THEORY

2. 1. The Professionality of Navy Personnel

The professionality carried out by the Navy Personnel is regulated in Law No. 34 of 2004 on the TNI, which affirms the main task of the Navy, namely to carry out Military Operation of War (OMP) and Military Operation non War (OMSP) to protect the entire nation and the entire country from the threat of Indonesia and disruption of the integrity of the nation and state. Especially for OMSP, the form of implementation, consists of:

1. Destroying armed separatist organizations,
2. Destroying an armed rebellion,
3. Destroying acts of terrorism,
4. Securing border areas,

5. Securing national vital objects that are strategic,
6. Carry out the task of world peace in accordance with foreign policy,
7. Secure the president and vice president and his family,
8. Empower the region of defense and its supporting forces early in accordance with the defense system of the universe,
9. Assisting the task of government in the region,
10. Assisting the police of the Republic of Indonesia in the framework of the security and public order stipulated in the law,
11. Assist in securing the country's head-level guests and representatives of foreign governments residing in Indonesia,
12. Helping to cope with natural disasters, displacement and humanitarian assistance,
13. Assist search and rescue in search and rescue,
14. Assist the government in securing shipping flights to piracy, piracy and smuggling.

2.2. The Welfare of Navy Personnel

The term welfare is an ambiguous meaning, it is used to refer to the well-being of individuals and to systems designed to be given to society (Moyano, 2008). At a certain level, the function of social welfare is to provide the same social order for each set of orders on the individual. Provisions in welfare include health care, housing, social security, education and social work (Sandfort, 1999). In the context of the welfare of TNI AL soldiers, the happiness, prosperity, satisfaction, quality of life of Navy soldiers can be achieved as a reward for performance in order to serve the country and nation.

There are many indicators of welfare that can be achieved by a Navy Personnel. The researcher identified, among others:
1. Salary and income/take-home pay is enough.
2. Gaining clothing and food and adequate housing, so that soldiers can live safely no need to feel anxious in the face of life in the future;
3. Obtain health facilities including medical personnel, medicines, hospitals and health centers of Navy Personnel with adequate equipment and personnel at a reasonable cost for the purchasing power of Navy Personnel;
4. Gain the education of both the soldier himself and his family at all levels of either general or professional education;
5. Getting old age guarantees, so the soldier feels calm and secure in facing his old age or when he can not earn a living;
6. Getting adequate means of transportation, so that the Navy Personnel easily, quickly and cheaply to move in the face of all its affairs;
7. Getting job descriptions according to their desires and abilities;
8. Gain opportunities to develop and enjoy culture, perfecting the life of religious morals and intellectual life;
9. Getting the possibility to rest or leave and enjoy entertainment

2.3. The State and Public Service of Navy Personnel

Public services are prepared and carried out by public service providers, which are the work units of public service providers residing in the state institutions, corporations, and independent institutions established by the law (Hasenfeld, 1993).

The Indonesian Navy is one of the institution of state organizing state and public service. Public services carried out by the Navy as stipulated in Law No. 34 of 2004 on the Indonesian Navy, which affirms the main task of the Indonesian is to carry out Military Operations for the War (OMP) and Military Operations Other Than War (OMSP) to protect the entire nation and the entire spill of Indonesia from the threat and disruption of the integrity of the nation and state.

Based on the decision of Indonesian Navy Commander Number: Kep / 1035 / XII / 2014 dated 31 December 2014 on Road Map of Bureaucratic Reform of Indonesian Navy, the Year 2015-2019, public service carried out by the Navy focused on activities:
1. Operation of PPRC (The Quick Reaction Safety Forces),
2. Operation of PPRC (The Quick Reaction Security of Support Force),
3. Border Security Operations and Outlying Islands,
4. Procurement of goods and services,
5. Public health services,
6. Optimizing the active role of the TNI in the life of nation and state to assist the acceleration of national development.

Citizens are very hopeful of public services made by the state apparatus including The Navy Personnel. Good public services will increase public confidence. According to the researchers, there are several important elements in the process of public service in general which must be considered, namely:
1. The service provider is a party that can provide a certain service to the public, either in the form of provision and delivery of goods or services.

2. Recipients of services are those who are referred to as consumers or customers in this society/public who receive various services from service providers/government apparatus.
3. Type of service is a service that can be provided by service providers (government apparatus) to parties that need service (public).
4. Satisfaction of public/society, in giving service provider service must refer to the main purpose of service, that is public satisfaction or society. This is very important because the level of satisfaction obtained by the public/community is usually very closely related to the quality standards of goods and or services that they enjoy. This should also apply to public service policies by members of the Navy.

There are some basic points in the delivery of public services by government officials to be considered (Bryson J, 1995) include:
1. Empathy with the community. Government apparatus including The Navy Personnel serving the affairs of the service provider agencies should be able to empathize, concern and be sincere with the public or the public of the service user.
2. Prohibition of procedures. Public service procedures should be designed as short as possible, so the concept of a one-stop shop is really implemented.
3. Clarity of public service procedures. The service procedure should be designed as simply as possible and communicated to the public service users.
4. Minimization of service requirements. Requirements in administering services should be limited as little as possible and as much as is absolutely necessary.
5. Clarity of authority. The authority of the state apparatus serving the community of service users should be formulated as clearly as possible by creating a task chart and distribution of authority.
6. Transparency of costs. The service charge should be set as minimum and as transparent as possible.
7. A certainty of schedule and duration of service. Schedule and duration of service must also be sure so that people have a clear picture and not restless.
8. Clarity of the rights and obligations of state apparatuses, including The Navy Personnel and the public or the public as customers. Rights and obligations both for the state apparatus and for the community as customers must be clearly defined and supplemented by sanctions and provisions of indemnification.
9. The effectiveness of complaint handling. Good service wherever possible should avoid complaints. However, if a complaint arises, a mechanism must be designed to ensure that complaints are handled effectively so that the issues can be resolved promptly (Thornhill C, 2009).

3. THE METHODOLOGY

3.1. System Dynamic Approach

The System Dynamics methodology basically uses causal relationships in constructing a complex system model. It is the basis for recognizing and understanding the system's dynamic behavior. In other words, the use of system dynamics methodology is more emphasized to the goals of increasing our understanding of how the behavior of the system arises from its structure. Issues that can be appropriately modeled using dynamic methodology are systems that have dynamic properties (changing over time); of its phenomenon structure contains at least one feedback structure (J. W. Forester, 1997). The System Dynamic Model is a comprehensive policy evaluation model that views each issue holistically, systematically and integratively. By using system dynamic model, expected process and problem-solving result expected to be executed effectively and efficient (Forrester J.W, 1997).

According to Sterman (2000) the principles for creating dynamic models with the characteristics as described above are as follows:
1. The desired conditions and actual circumstances must be differentiated in the model.
2. The existence of stock and flow structures in real life must be represented in the model.
3. Different streams conceptually, within the model must be differentiated.
4. Only information that is actually available to actors within the system should be used in decision modeling.
5. The structure of the rules of decision making within the model should be appropriate (fit) with managerial practices.

There are seven interlocking problem-solving steps forming a loop in the dynamic system methodology (Stermann 2000):
1. Identification and definition of the problem,
2. Conceptualization of the system,
3. Model formulation,
4. Simulation and validation of models,
5. Policy analysis and improvement,
6. Understand and distinguish,
7. Implementation of policies.

The loop shows that each subsystem is interconnected and continuously connected never ends. This indicates that every problem has an ever-evolving system dynamics (Tsolakis, 2017).

3.2. System Dynamic Model Diagram

In the development of system dynamic model there are 2 model diagrams:

A. Causal Loop Diagram

The causal loop diagram is the disclosure of a causal relationship into a particular image language. The image language is an interconnected arrow, thus forming a causal loop where the arrowhead reveals the cause and tip of the arrow expressing the effect. Both, the elements of cause or effect, or one of them (cause or effect only) must refer to measurable circumstances, both qualitatively for perceived and quantitative circumstances for actual circumstances. The process of causal loop diagrams is simple, or the process of structuring is arranging the causal relationship into a closed system, resulting in loops. They can be positive or negative. Called positive if the variable change at the beginning of the flow causes the increase of the variable value at the end of the flow. Conversely, it is called negative if changes in the variable at the beginning of the flow cause the reduced flow value. (Stermann, 2000). The sample of simple causal loop diagram as follows :

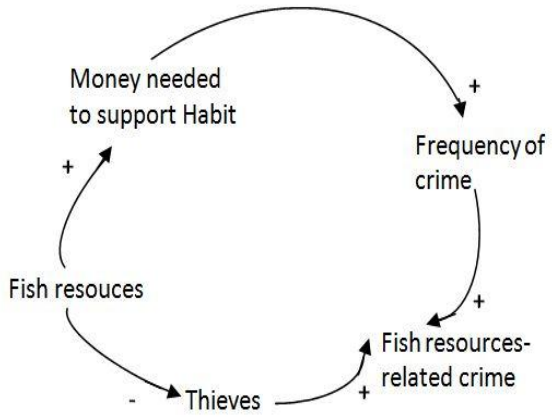

Figure 1. Example of Simple Causal Loop Diagram

B. Stock & Flow Diagram

Stock & Flow Diagrams represent flow structures in detail, so it can be used to construct mathematical models. The simulation flow diagram illustrates the relationship between variables and is expressed in the form of feedback structure symbols. The sample of simple stock & flow diagram as follows :

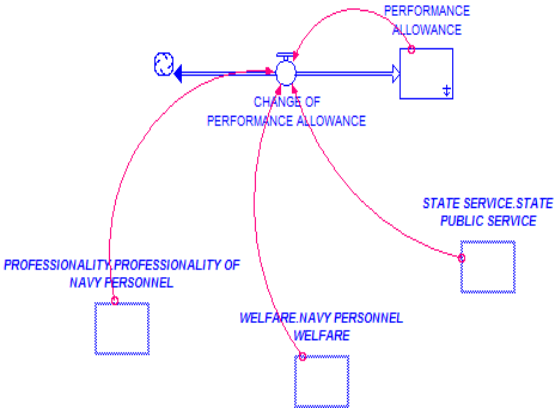

Figure 2. Example of Stock and Flow Diagram

4. THE RESULT OF STUDY

4.1. Identification of Variable

Based on the observation and understanding of the performance allowance system within the Navy, it can be identified that all the variables which can be categorized into 3 (three) main aspects are:

1. The Professionality of Navy Personnel Aspects
2. The Welfare of Navy Personnel Aspects
3. The State Public Service of Navy Personnel Aspects

Every main aspect of performance allowances in the police of evaluation has interrelated variables or criteria interacting in the system as shown in Figure 5. Causal Loop Diagram Model Interaction between the main aspects.

In this study, more details will be identified on the Welfare Aspects, Profesionality, and State & Public Service Navy Personnel Aspects. Based on the results of the identification of performance allowance system of the Navy personnel, there are significant variables as shown in Table 1, Table 2 and Table 3, as follows:

Table 1. Welfare Aspects Variable

Welfare Aspects Variable :	
a.	Salary / Income
b.	Education
c.	Health
d.	Housing
e.	Social Status
f.	Public Recognition
g.	Institution Recognition

Table 2. Profesionality Aspects Variable

Professionality Aspects Variable :	
a.	Navy Personnel Performance
b.	Discipline
c.	Work Target
d.	Motivation
e.	Violation
f.	Capability
g.	Basic Performance
h.	Profession Ability
i.	Physics
j.	Spirituality
k.	Assigment Risk
l.	Work load

Tabel 3. State & Public Service Aspects Variable

State & Public Service Aspects Variable	
a.	Navy Main Task
b.	Military Operation / War
c.	Military Operation / Non-War
d.	Maritime Territorial
e.	Public Sociality
f.	Risk Assignment
g.	Work Load

Each variable on the aspect of welfare and public service aspect of the Navy soldiers has interrelated values and forms an interaction in the Evaluation of Performance Allowances System.

Index of Evaluation

Each variable in the Evaluation of Performance Benefit System is assessed and scored (rating) on the dynamic system model, namely: (1) Very Low, (2) Low, (3) Medium, (4) High and (5) Very High by using parameters measurable. The evaluation index serves to show that these variables need to be given special attention in the evaluation of performance allowance systems, according to the value of the conversion index and the strategic significance of very safe, secure, moderate, warning and alert. The higher the value of the conversion index the higher the variable is evaluated. The Evaluation Index can be shown in Table 3 as follows :

Table 3. Index of Evaluation Performance Allowances Variable

Evaluation of Performance Allowance Variable	**Index Conversion**	**Strategic Meaning**
Very Low	1.00 – 2.99	Very Safe
Low	3.00 – 4.99	Safe
Medium	5.00 – 6.99	Moderate
High	7.00 – 8.99	Warning
Very High	9.00 – 10.00	Alert

A. The Grand Diagram Model

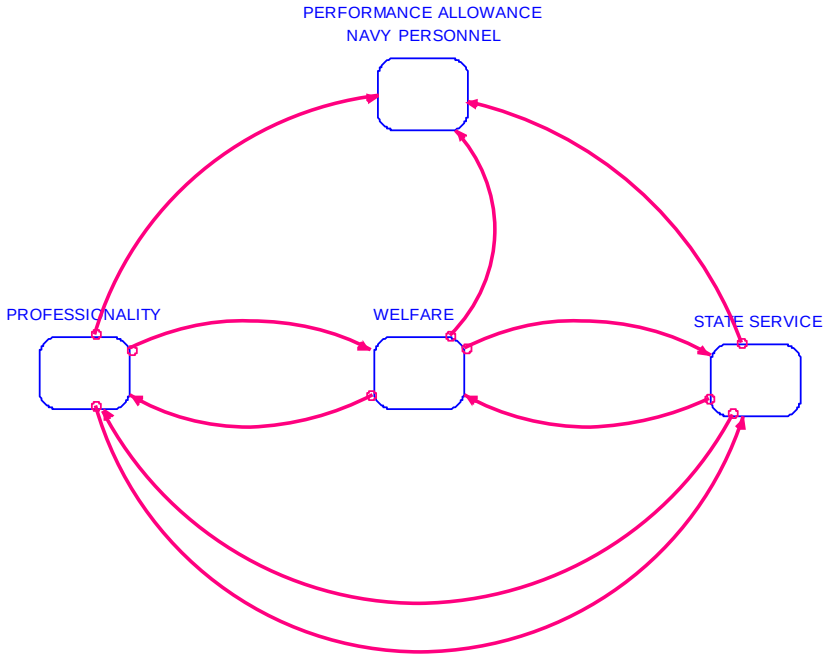

Figure 4. The Interaction Model of Performance Allowances System

B. The Causal Loop Diagram Model on Performance Allowances System

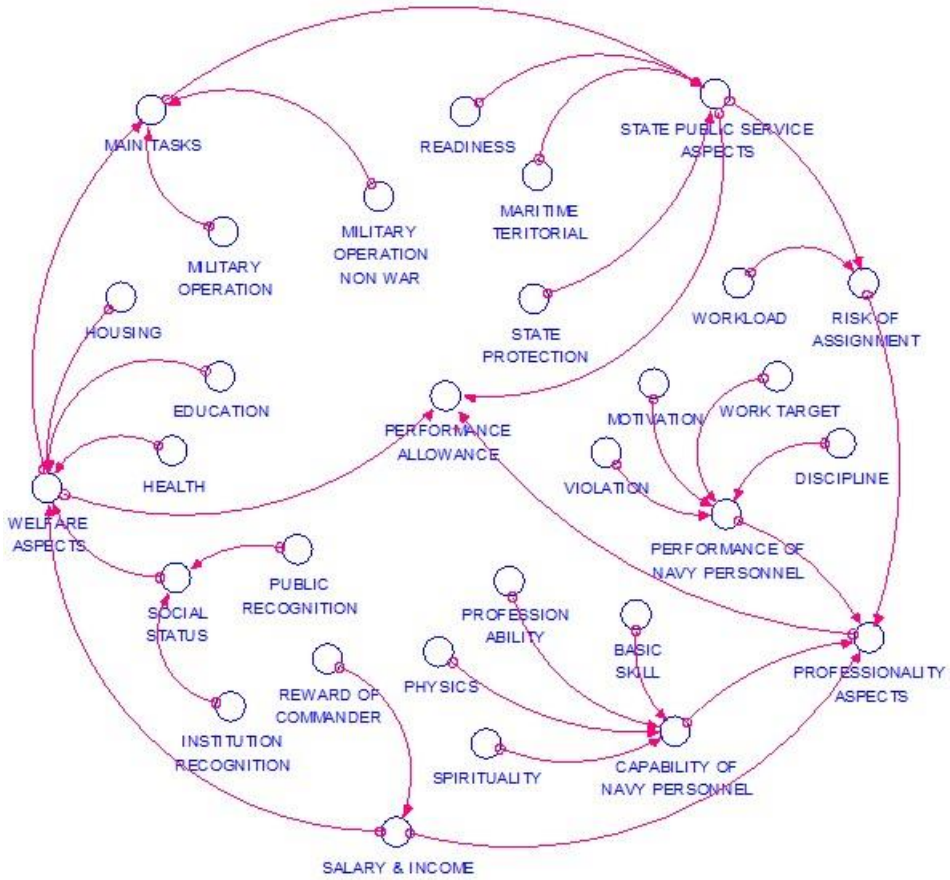

Figure 5. Causal Loop Diagram of Interaction Model on Performance Allowances System

B. Stock and Flow Diagram of Main Aspect

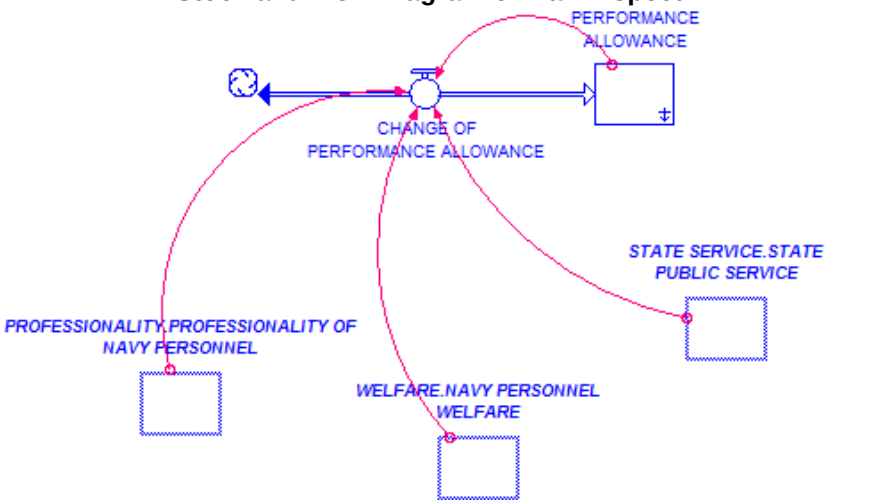

Figure 6. Stock and Flow Diagram of the Main Aspects of the Performance Allowances

The Formulation

```
PERFORMANCE ALLOWANCE NAVY PERSONNEL:
PERFORMANCE_ALLOWANCE(t)              =
PERFORMANCE_ALLOWANCE(t    -    dt)    +
(CHANGE_OF_PERFORMANCE_ALLOWANCE) * dt
INIT PERFORMANCE_ALLOWANCE = 5
INFLOWS:
CHANGE_OF_PERFORMANCE_ALLOWANCE      =
((0.342*STATE_SERVICE.STATE_PUBLIC_SER
VICE+0.353*WELFARE.NAVY_PERSONNEL_WELF
ARE+0.305*PROFESSIONALITY.PROFESSIONAL
ITY_OF_NAVY_PERSONNEL))-
PERFORMANCE_ALLOWANCE
```

C. Welfare Aspect Model ; Stock and Flow Diagram

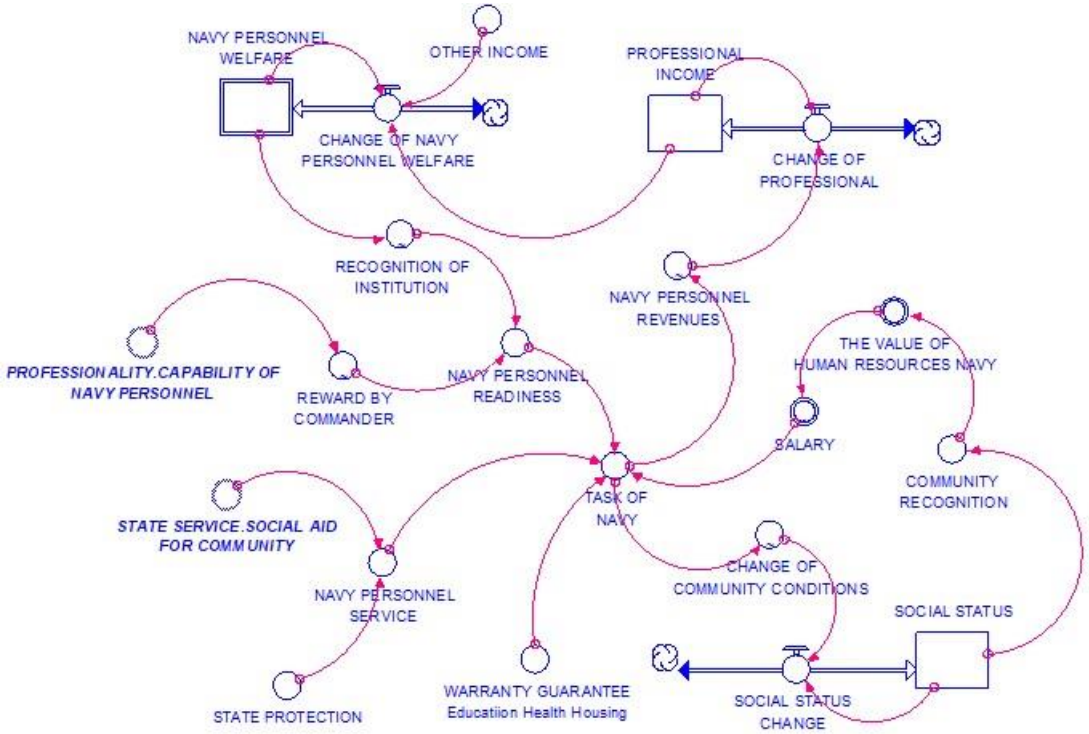

Figure 7. Stock and Flow Diagram of the Welfare Navy Personnel Aspects

D. Professionality Aspect Model ; Stock and Flow Diagram

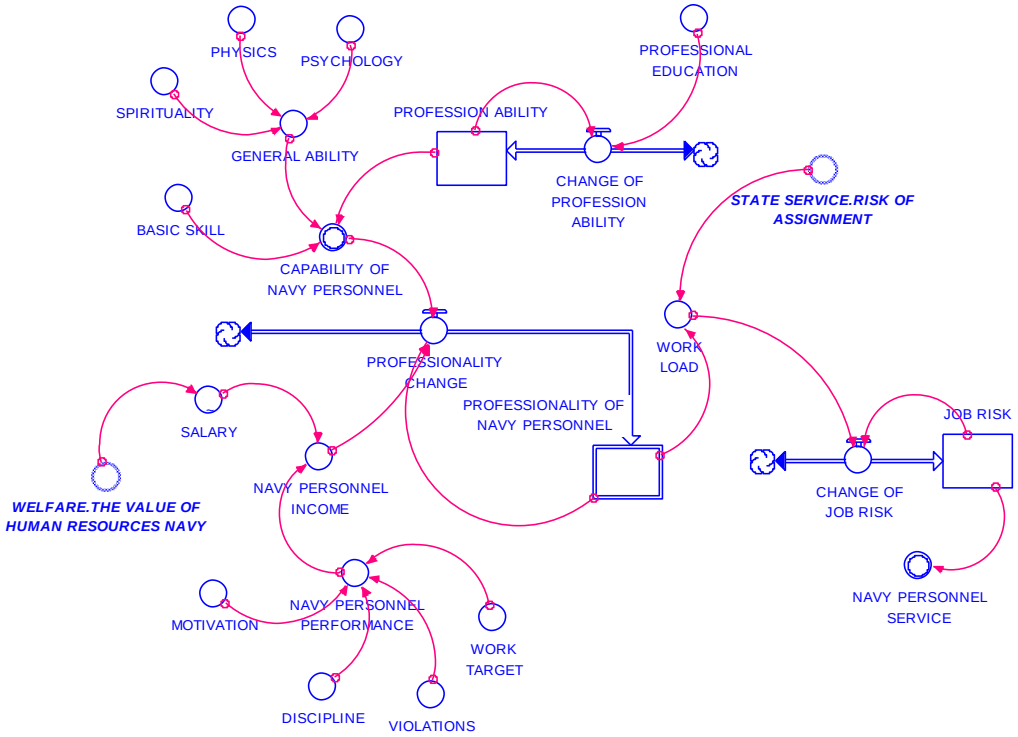

Figure 8. Stock and Flow Diagram of the Profesionality of Navy Personnel Aspects

E. State & Public Service Aspect ; Stock and Flow Diagram

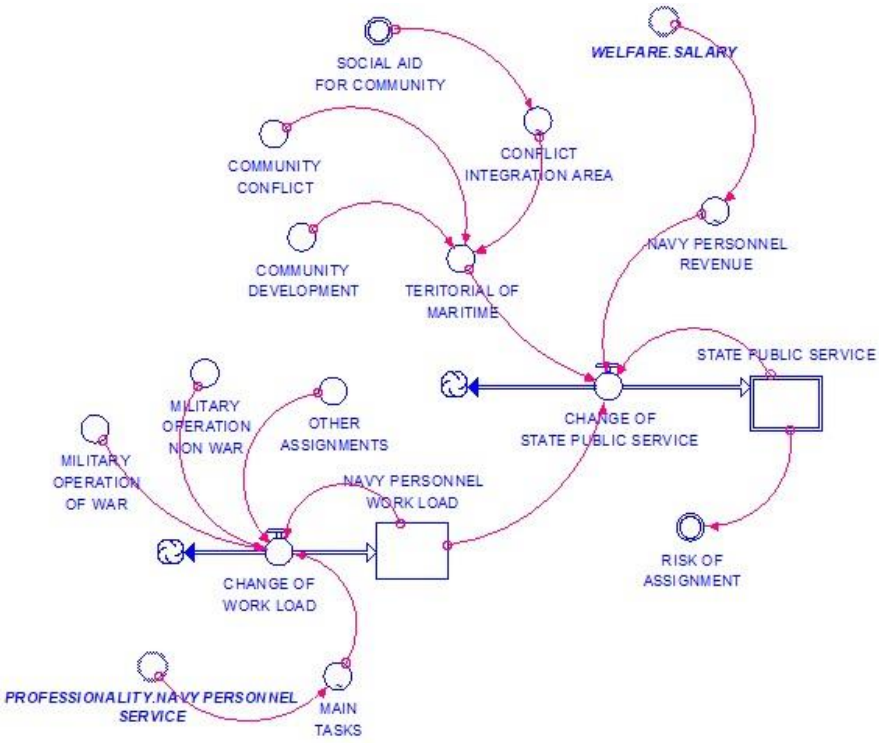

Figure 9. Stock and Flow Diagram of the State & Public Service Navy Personnel Aspects

4.2. The Policy Scenario & Model Simulation

The next step is to develop a policy scenario in the performance evaluation system model of performance allowance. These policy scenarios as follows :

Scenario 1: On the Welfare Aspect, the Professional Income Enhancement Policy for Navy Personnel.

This policy is carried out gradually every year for inflation, and include it in the performance allowance structure. Furthermore, this scenario runs on the model and will see its impact on the welfare aspect of the navy personnel and its effect on the performance allowance system. The objective is to obtain a policy evaluation score which is an indicator of the evaluation of the policy parameters. Another goal is to get a score or index on the navy personnel welfare aspect along with all the criteria that have a significant effect on the performance allowance system. The score is an indicator for a comprehensive evaluation of the performance allowance system within the Navy.

Scenario 2: On the Professionality Aspect, Improvement of Profession Capability / Special Skill of Navy Personnel which is focused on increasing the special skill competence or advanced skill of the soldier who professionally and potentially can influence the capability of a soldier, which in the end will have an impact on the Professionality aspects. The purpose of this scenario is to find out how the influence of the criteria of the professional ability of the soldier to the soldier capability and the professionality aspect of navy personnel as a system.

Scenario 2: On the State & Public Service Aspect, the Workload Improvement Policy that impacts on the increased Risk of Assignment.

This policy is focused on the work or tasks of navy personnel who are at high risk. This work is usually done by special soldiers of navy personnel. This scenario is done with the aim to know the impact and influence of workload variable and the risk of assignment to the performance value of navy personnel as a system. Increased workloads based on special expertise or advanced expertise that will professionally affect the risk of assignment, which in turn may impact the Performance Allowances of navy personnel.

Furthermore, a model simulation was conducted to obtain a policy evaluation score which is an indicator of the evaluation parameters of the navy personnel allowance

system. In addition, to get the value or score on the aspect of state public service and all the criteria that have a significant effect on performance allowance system. The score is an indicator for evaluation.

The following figure is a Graph of the simulation results on the Performance Allowances evaluation model on the navy personnel Welfare Aspects and State & Public Service Aspects.

Figure 10 shows the relationship between professional income, social status and welfare values of navy personnel.

Figure 11 shows the relationship between workload, the risk of assignment and the value of state & public service of navy personnel.

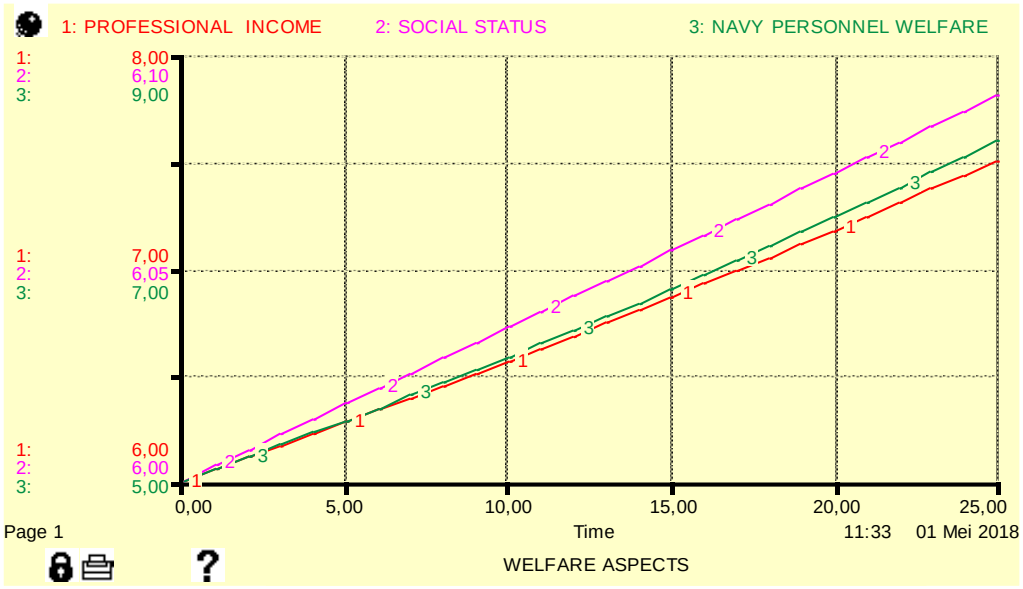

Figure 10. Relationships of Professional Income, Social Status, and Personnel Welfare

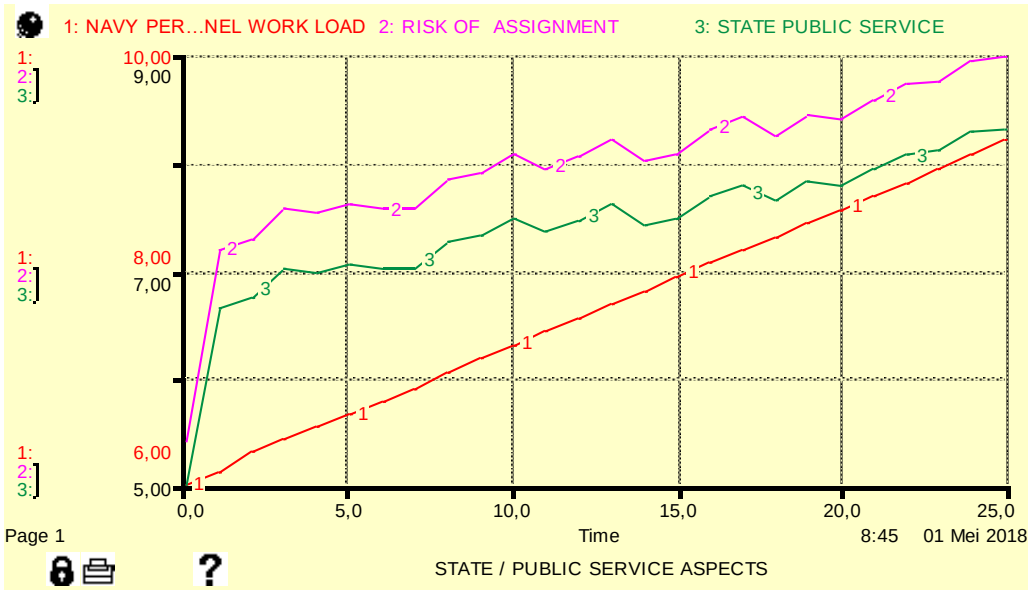

Figure 11. Relationships of Workload, Risk of Assignment and State Public Services

In Figure 10. Relationships Graph of Professional Income, Social Status, and Personnel Welfare, it can be analyzed that the three variables have a significant linear relationship, it's meaning that the higher of the value of professional income the higher the impact on improving social status of navy personnel, and the higher as well as its impact on improving the welfare aspect of navy personnel. The navy personnel welfare aspect is also strongly influenced by Performance Allowance variables as a system that interacts. The evaluation score obtained on the aspect of navy personnel welfare are as follows:

*Evaluation Score of Performance Allowance: 8.31
*Evaluation Score of Personnel Welfare Aspect: 8.20
*Evaluation Score of Professional Income: 7,51
*Evaluation Score of Social Status: 6.09

In Figure 11. Relationships Graph of Workload, Risk Assignment and State Public Services, it can be analyzed that if the scenario Increasing the workload of Navy soldiers performed then it will have a significant impact on the risk of assignment. At the time of workload increased gradually per year then the risk of assignment will also rise, similarly, the value of state & public service aspects will also go up, meaning that the variable workload of navy personnel soldiers significantly affects both aspects and variables. The evaluation scores obtained on the aspects of state public services are as follows:

*Evaluation Score of Performance Allowance: 8.31
*Evaluation Score of State & Public Service: 8.32
*Evaluation Score of Navy Personnel Workload: 9.22
*Evaluation Score: Risk of Assignment: 8.99

5. CONCLUSION

The Evaluation Model of performance allowances policy in the Navy has been done with the system dynamic modeling. System dynamic modeling of performance allowances policy evaluation is a model to describe the interaction of all aspects and criteria affecting evaluation of performance allowances. This model generates a score or indekx of policy evaluations, which used as indicators, based on dimensions of aspects, criteria and time. The score is an indicator of the importance of a policy, which represents the policy being run or not, and to determine which variables are most significantly influential.

The model for policy evaluation on welfare professionality and state-public service aspect of navy personnel has been done with system dynamic system. Based on the model evaluation result, it is found that the policy of increasing professional allowance and the policy of increasing the workload of the Navy Personnel has a significant impact on the performance of navy personnel which further improves the welfare aspect and the state public service aspect. So, in the end, this policy scenario must be programmed and executed to achieve the desired professionalism of the troops as a necessity to increase the performance allowance of the Navy Personnel.

6. ACKNOWLEDGMENT

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A CASE STUDY OF STRATEGIC DECISION OF NAVAL BASE STATION DEVELOPMENT IN A BORDER AREA

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ABSTRACT

The world economy path that uses Indonesian sea lanes can make Indonesia as the world's maritime axis. The construction of Naval Base in the border area has been prioritized to increase the strength of maritime defense as an important pillar of Indonesia's development. Due to the current conditions of necessity in some border areas, it is necessary to formulate a strategy of Navy Base development. The use of Borda-SWOT combination methods can measure the priority of a strategic value decision. The result of analysis showed that the development in the boundary area using S-T strategy was the weight of 10.66% where the Navy base had Strength's influence with the weight of 17.89%. The priority formulation of the strategy of Navy Base facility development was to build facilities Command Headquarters - Housing Facilities and Mess - Service Facilities - Port Facilities and Communication Facilities.

KEYWORDS : Naval Base, Priority Strategic Decision, Border Area

1. INTRODUCTION

Indonesia's archipelago territory located on the crossroads of continents and oceans make Indonesia as a regional economic crossing paths of various countries. More than 40% of the world's economic pathways use Indonesian maritime or maritime lanes including using path that pass through the territory of the Indonesian Archipelagic Sea Pass (ALKI) (Ismah Rustam, 2016). Vessel of foreign countries whether commercial vessels or warships that are through the ALKI can pass without having to ask permission first to the Indonesian government. The existence of ALKI gives security consequences in Indonesian waters mainly because many of the economic crossing lines are also the border of Indonesia with other countries.

Joko Widodo as Indonesian President has launched the national strategic policy of Indonesia as the World Maritime Axis. This strategic policy brings Indonesia's ideals towards the excellence in the maritime field. The excellence of the maritime state as expressed by the President is performed through development based on the 5 main pillars of building maritime culture, maintaining and managing marine resources, building maritime infrastructure and connectivity, strengthening maritime diplomacy and building maritime defense forces (Murniningtyas, 2016).

Building maritime defense forces becomes one of the important instruments to maintain the situation and stability of the region on the border of the country. One of the role of the military force presence in the border of the country is to support the smoothness and sustainability of the wheels of the country's economy. In addition, the presence of Indonesian maritime defense forces serves as a unit of state interest to observe the dynamics of the surrounding region (Adhira, 2017). This is because

the conditions in some border areas of Indonesia which is also the path of the world economic path still requires a lot of attention. Some of the strategic aspects that need to get important attention are sovereignty aspect, defense aspect and economic aspect.

Therefore, the Navy as one of the defense components will deploy the power of the Integrated Fleet Weapon System (SSAT) throughout Indonesia including the cross-sea route on the state border (Santoso et al., 2013). Thus, the development of Navy Base in Indonesian maritime territory bordering with other countries is an important priority (Saputra & Nadlir, 2016). However, the declining budget outlook (Figure 1) and the ever-changing geostrategic environment have urged the Navy's institution to change its decision-making strategy to build a Naval Base (Russell et al., 2015) (Trisutrisno, 2016) (Wicaksono & Asmara, 2017)

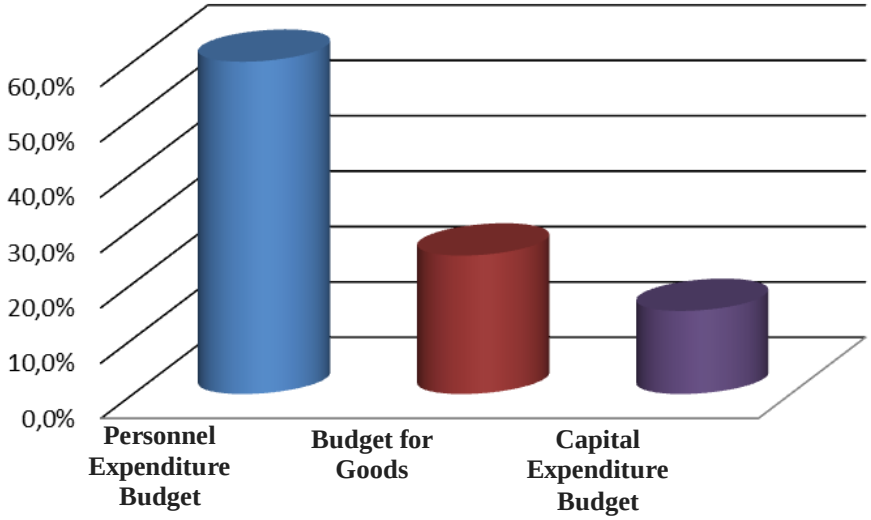

Fig 1. The Expenditure of Indonesian Defense Budget (Trisutrisno, 2016)

Therefore, every planning and implementation of the Navy's development is always based on policies that sharpen and strengthen the Navy's development program toward Minimum Essential Force (MEF). The preparation of programs and activities along with budget allocations is implemented realistically and prioritizing the priority principle. The development of the Navy Base on the border prioritizes the construction of facilities and basic infrastructure facilities on strategic islands (Kemhan, 2017). It is expected that the acceleration of Naval Base development in the border area can help the development goals in the border areas. The targets of border area development are prosperity, security and environment (Sholihah, 2016).

Thus, in order to measure the strategic decision of Naval Base development in Indonesian border area, the Borda method and SWOT method is used. The Borda method can show which alternatives are better in pairwise comparisons. The decision-making is based on an alternative choice of various Naval expert respondents by making the criteria into a numerical calculation (Garcia-Lapresta et al., 2008). While the SWOT method analysis is useful to create strategic formula by conducting an overall evaluation of the strengths, weaknesses, opportunities, and threats. The end result of the SWOT approach is to obtain a decision which shows the variable along with the added value or less value (Wang, 2007).

By combining Borda-SWOT method in measuring the strategic of decision-making process, a precise ranking of strategic variables in the development plan of Naval Base in the border area will be generated. Furthermore, this strategic planning can be used as a tool of the organization to start and manage its main tasks. Strategic planning is part of a research operation based on a multi-criteria decision-making (MCDM) process. MCDM-based research operations are a series of alternatives evaluations in a set of criteria to achieve optimal strategic formulation (Triantaphyllou et al., 1998).

The benefit of this study is the development plan of Naval Base that has the benefit and great contribution in the border region. The order of development priorities is part of the strategy formulation in order to enhance the benefit of Naval Base development to be perceived immediately by the border community development target. In addition, it also provides a case study for the development of the Naval Base and its facilities in the future.

In this paper, the Methodology used would be described in Section 2, Research Results in Section 3, Discussion in Section 4, and Conclusions in Section 5.

2. METHODOLOGY

2.1. Naval Base Development

The functions of the Naval Base Station are classified into 5Rs including Base as Replenishment/Refueling, a Repairing Place, a Resting Place, a Refreshing Place, and a Resistance (Base for Defense) (Suharyo et al., 2017). In order to carry out the function, the main facility that must be built in an Naval Base, including Port facilities, Maintenance and Repair facilities, Supplies facilities, Personnel maintenance facilities and Base building facilities. While the supporting facilities of the main facilities consist of Housing and Messing facilities, Command Headquarters facilities, Public facilities, Communication facilities, Defense facilities, Service facilities, and Operating and Training facilities (Indonesian Navy Headquarters, 2013). The following Figure 2 is the amount of budget for the construction of Naval Base facilities

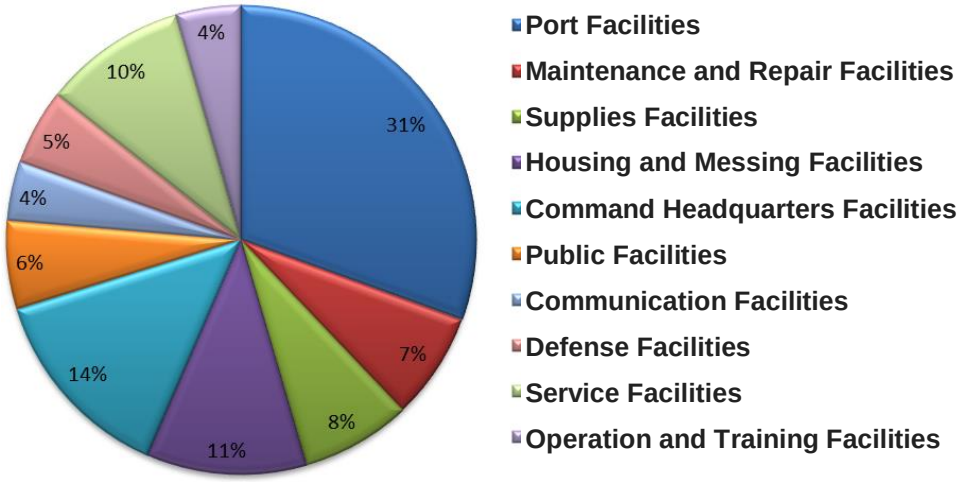

Fig. 2 The Amount of Navy Base Facilities Budget Development (Indonesian Navy Headquarters, 2013).

2.2. Indonesian Maritime Power Development

Indonesia as an archipelagic country has a geo-strategic aspect that demands the development of naval power as the main theme in the development of Indonesia's defense force (Perwita & Komeini, 2012). In Indonesia maritime development, the policy is strongly influenced by political policy, economy, defense, and state interest (Vertzberger, 1984). The Navy's development program towards MEF is performed not only with the modernization of defense to ensure Indonesia's territorial sovereignty and marine resources to be maintained, but also to keep the navigation path and maritime trade safe. In the development of naval power, the Naval Base development is based on six characteristics that influence the condition of national naval power such as geography, natural resources, climate, land area, community character and character of local government (Gindarsah & Priamarizki, 2014).

2.3. Borda Method

De Borda's voting method is used to rank out problems with multicriteria (Costa, 2017). The measurement steps with Borda method are as follows:

a) Evaluator determination, decision makers, judges or members of the jury sourced from experts

b) The elements determination or alternatives to be classified

c) Assessments collection from each evaluator in the form of perceptual assessments to form alternative sequences

d) A ranking score association for each alternative, as well as evaluate the main purpose of the problem

e) For each alternative, add up the rank rank rankings

f) Getting the final ranking of the alternatives.

In Borda's rule, it is known that the points given or ratings to each alternative is based on voter preferences or experts. In this method if there are (n) alternatives, then the first choice score has a weight of (n-1), the second choice score has a weight of(n-2) and so on until the last option, which is 0 points. Based on the measurement of the voter number on the criteria, the Total Frequency (Rt) can be calculated with the following formula

$$Rt = \sum_{j=1}^{m} R_1 \quad (1)$$

$$R1 = \sum_{j=1}^{n} R_{1j} \quad (2)$$

; where *j* = (n-1), (n-2), ..., (n-n)

As for knowing Weight (W*i*) on each choice variables, it is formulated into:

$$W_i = \frac{R_i}{\sum_{i=1}^{m} R_1} \quad (3)$$

; where *i* = variable option

So, the priority rank of variable option is

$$W_{i1} > W_{i2} > W_{i3} \ldots > W_{in} \quad (4)$$

; where *n* is the amount of variable option.

The theoretical characteristic of Borda's measurement is to determine the value of the majority of variables whose median value is consistent. While the ranking of variables is defined as the majority as well as the highest weight among the chosen various options (Mohajan, 2011).

2.4. SWOT Method

SWOT approach Analysis is a simple way to communicate an idea or policy. This technique is very effective because it is structured, objective, and focused on strategy with strong goals (Heyer, 2004). The information obtained has been systematically represented in the matrix, in which the combination of the four matrix factors is a tool in determining strategy. SWOT can build optimal strategies by relying on strengths and reducing their weaknesses, while also taking advantage of opportunities and determining plans to eliminate threats to be faced (Živković et al., 2015). By maximizing Strengths and Opportunities, and simultaneously minimizing *Weaknesses* and *Threats*, it will result in strategic decisions of several factors or variables (Jyrki Kangas, 2016). Some strategies that can be used in the SWOT matrix (Table 1) is the S-O (Maxi-Maxi) Strategy, W-O (Mini-Maxi) Strategy, S-T (Maxi-Mini) Strategy, and W-T (Mini-Mini) Strategy (Gretzky, 2010).

Table 1. SWOT Matrix

(Gretzky, 2010)

SWOT Matrix	**Strength (S)** Existing internal conditions and can be strengthened in planning.	**Weakness (W)** Internal conditions that can be improved in planning.
Opportunity (O) External conditions that can be taken advantage of.	**S-O Strategy** Utilizing Internal strength to take advantage of opportunities	**W-O Strategy** Fixed internal flaws by taking advantage of opportunities
Threat (T) External conditions that can not be controlled and have a negative impact.	**S-T Strategy** Use the power to avoid or reduce the impact of threats	**W-T Strategy** Defensive strategy to reduce internal weakness and avoid threats

2.5. Conceptual Framework

A research flow diagram integrating Borda and SWOT methods (Figure 3) will help to measure strategic decision making processes. The Borda-SWOT method is a simple alternative to present another explanation that priority decisions have a widespread impact in society (Ishida & Oguro, 2017). In addition, the construction of Naval Base in the border area is a strategic decision that has a wide impact on the maritime environment to make Indonesia as a maritime axis of the world.

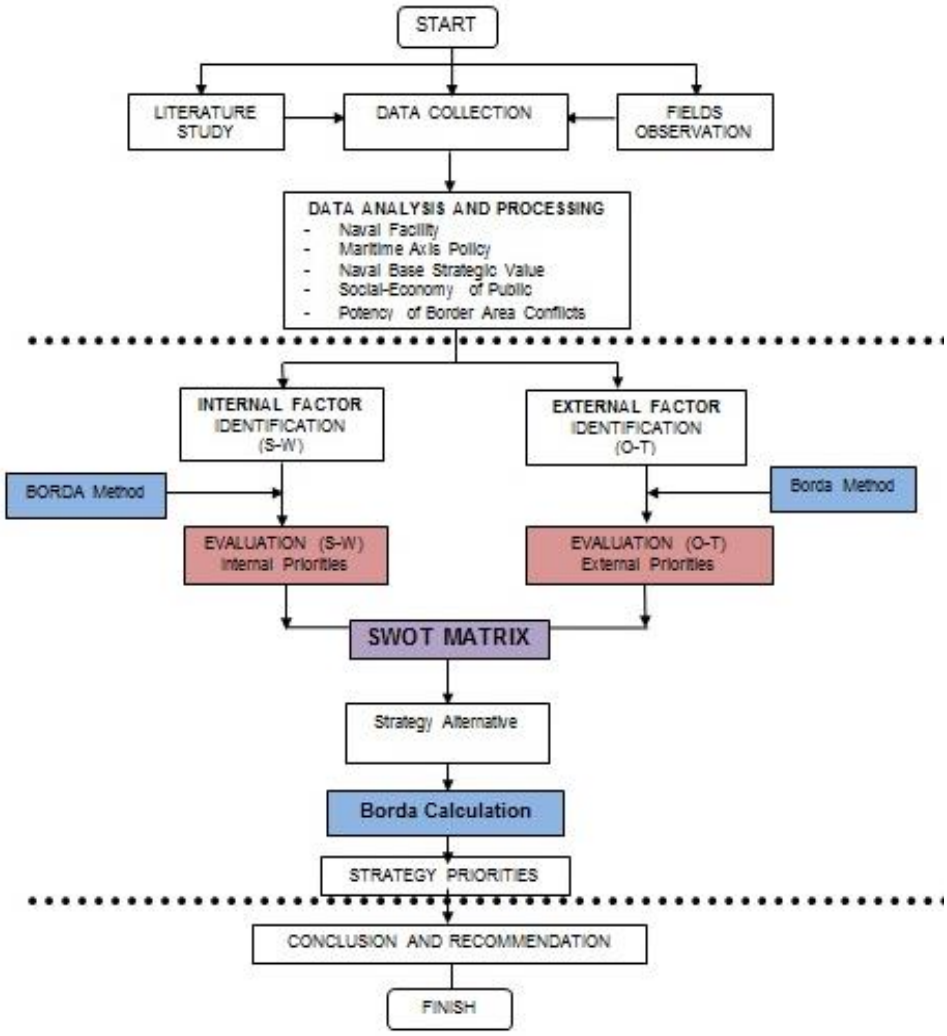

Fig. 3. Research Diagram of Borda-SWOT Integration

(Ishida & Oguro, 2017)

3. RESULT OF RESEARCH ANALYSIS

3.1 Numerical Calculations Design

Borda-SWOT primary data processing was conducted by interviews and questionnaires to officers of officials within the Naval Base Area, Naval Base Facilities Office, and Navy officers who have both technical and strategic expertise. Placement of SWOT criteria was shown on SWOT Analysis Software sourced from expert data. Interview data and questionnaires were subsequently processed using Excel to get weighted calculations according to numerical design calculations with the the priority ranking strategy as the final results.

Tabel 2. Primary Data of Strength and Weakness

Source: Expert Data Processing and Questionnaire

Internal Criteria	***Strengths***		
	S.1	World Maritime Axis Policy	85
	S.2	Strategic Location	68
	S.3	Naval Base	51
	S.4	Operation Area	46
	S.5	Defense System Readiness	35
	Weaknesses		

3.1.1. Internal Criteria

	W.1	Development Center	74
	W.2	Supporting Facilities	64
	W.3	Availability of Shipyard	55
	W.4	Availability of Area Logistics	54
	W.5	Availability of Public Facilities	38

3.1.2. External Criteria

Table 3. Primary Data of Opportunities and Threats
Source: Expert Data Processing and Questionnaire

External Criteria			
	Opportunities		
	O.1	National Patriotism	69
	O.2	Availability of Fields	65
	O.3	Geostrategic and Geo-economy	56
	O.4	Resident Population	56
	O.5	Area Supports	39
	Threats		
	T.1	Illegal Act	71
	T.2	Shipping Safety	66
	T.3	Separatism	55
	T.4	Sailing Lane Volume	54
	T.5	Social Cultural Insecurity	39

3.1.3. SWOT Diagram of Border Maritime Area Development

Using the Borda method in accordance with Tables 2 and 3 above, it was found that existence of Naval Base had a Strength effect to maritime development of border area with weight of 17,89% and rating score of 0.0447 from the whole variable. While the internal factor weight (S-W) was greater than the external factor (O-T) which indicated that maritime development in the border area could be done well if there wass strong commitment from the government despite many challenges faced (Figure 4).

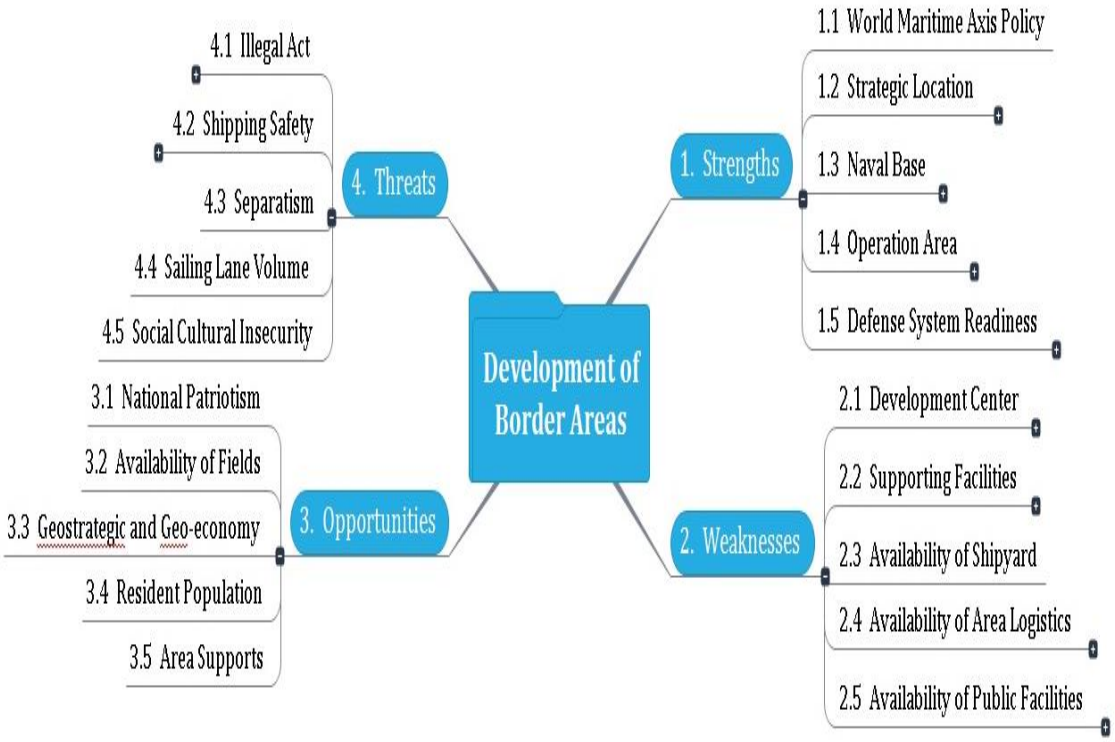

Fig. 4. Research SWOT Diagram
Source: *SWOT Analysis Software*

3.1.4. SWOT Matrix of Border Maritime Area Development

Table 4. Research SWOT Matrix

Internal Factor / External Factor	***Strengths***	***Weaknesses***
	S1. World Maritime Axis Policy S2. Strategic Location S3. Naval Base S4. Operation Area S5. Defense System Readiness	W1. Development Center W2. Supporting Facilities W3. Availability of Shipyard W4. Availability of Area Logistics W5. Availability of Public Facilities
Opportunities O1. National Patriotism O2. Availability of Fields O3. Geostrategic and Geo-economy O4. Resident Population O5. Area Supports	**S-O Strategy** Maritime becomes national policy which provides the power to improve maritime security capabilities to protect resources in certain region. **(S1) (S3) (O3) (O5)**	**W-O Strategy** Strong human resources potentially make the economic power in the border region supported by the construction of facilities and infrastructure **(W1) (W4) (O2) (O4)**
Threats T1. Illegal Act T2. Shipping Safety T3. Separatism T4. Sailing Lane Volume T5. Social Cultural Insecurity	**S-T Strategy** The Naval base conducts maritime security operations to prevent illegal activities and keep the shipping lines safe **(S3) (S4) (T1) (T4)**	**W-T Strategy** The facility develompment can reduce the various conflicts of society, especially separatism and other socio-cultural vulnerabilities **(W2) (W5) (T3) (T5)**

Based on the SWOT matrix(Table 4), the maritime development in the border area was using S-T strategy. With a weight of 10.66%, this strategy was implemented with the establishment of Naval Base that serves to provide support for maritime security operations of the Navy to prevent illegal activities and keep the shipping lines safe.

4. DISCUSSION

4.1. Strategy Priority Weighing of Naval Facility Development

In order to implement the S-T strategy of the SWOT matrix and to build the Naval base, the development of necessary facilities was performed. The objective of the analysis in 10 Naval base facility using the Borda method was to obtain priority facilities (Figure 5).

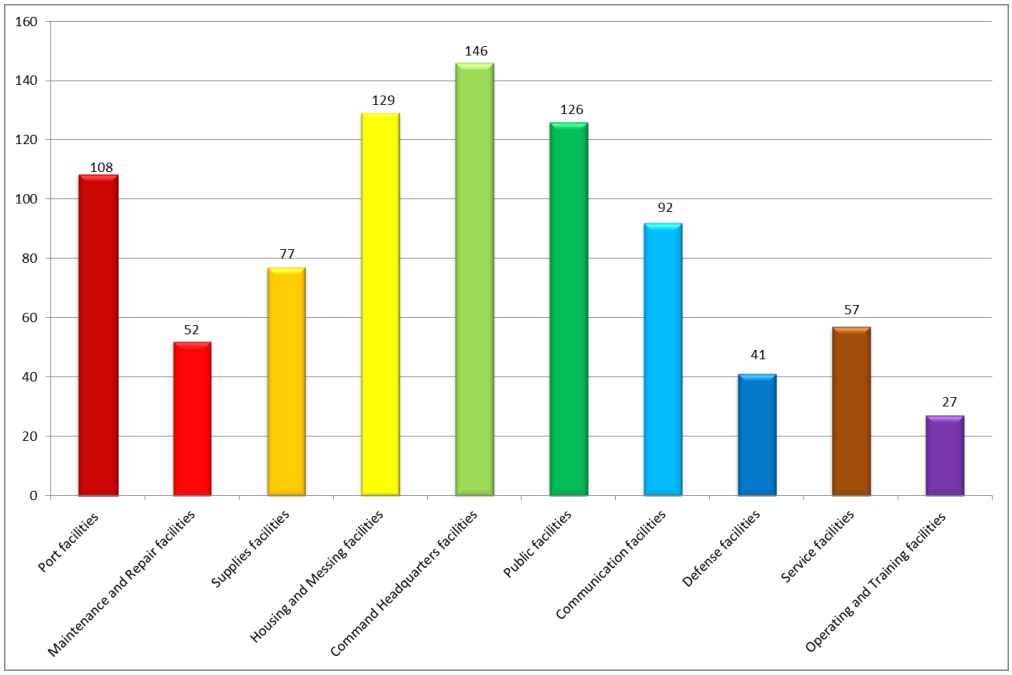

Fig. 5. Diagram of Priority Weinging in Research Strategy

4.2. Strategic Priorities Formulation

The strategic decision formulation of Naval Base Development in border area was obtained from weight calculation from each facility that would be built. The ranking of weighted rankings was a priority order of facility construction required in border areas(Figure 6).

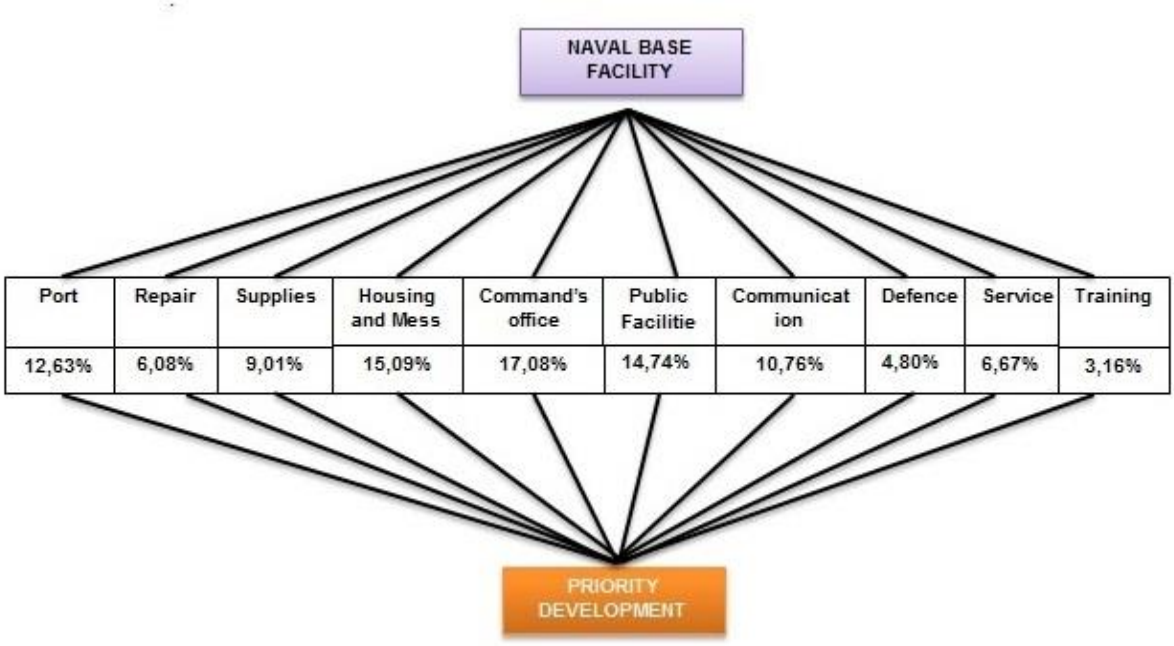

Fig. 6. Diagram of Research Strategy Priority Formulation

5. CONCLUSION

Strategic decisions measurement of the Naval Base Development in the border area using the Borda-SWOT method is one of the quicker ways of conveying the idea of multi-criteria decision-making. The S-T strategy approach is the best strategy to develop a challenging border region. While the development of the Naval Base is an important part of Indonesia's maritime development which has an impact on the security of international shipping lines. Based on the strategy priority formula, it can be known that Naval Base Facilities which have a major impact on the border region is Command Headquarters Development - Housing Facilities and Mess - Service Facilities - Port Facilities and Communication Facilities. It is expected that this research can be continued in the future to know the ability of logistics and administrative support for sea security operations in the border region.

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THE MODEL ELECTION OF MENTAWAI NAVAL BASE LOCATION BY THE APPROACH OF BORDA AND PROMETHEE METHODS

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ABSTRACT

Padang Naval Base plans to establish an naval base at the type of "C". Following this matter, the Regional Government of Mentawai Islands District provides 3 (three) alternative places namely in Semabuk Bay, Siuban Bay and Semebai Bay for the location of dock and office. In the selection of Mentawai base this method using Borda and Promethee, this is used because the method can consider alternative evaluation based on factors that are qualitative and quantitative (Pavic, 1991). Based on research of Borda method calculation on 16 base selection criteria, it is found that criteria (K1) of Sailing Flow has the highest weight value that is equal to 10.9% and for the lowest criteria weighted value is occupied by criterion (K14) that is Political Condition of 2%. For the results of ranking against the alternative using Promethee method obtained Semebai Bay is the best location to serve as the location of the base of the Mentawai Naval Base. From the research results can be concluded that the model of decision making by combining Borda and Promethee method is a way to develop the logical relationships that underlie the problem of decision making into a mathematical model that reflects the relationships that occur between the criteria involved.

Keywords: Naval Base, Decision Making, Borda, Promethee.

1. INTRODUCTION

Indonesian navy as the main component of state defense in the sea seeks to always maintain sea security (Indonesian Navy Headquarter, 1996). The Naval Base is the spearhead of the power in carrying out support for the task of combat operations, especially as a supporter for war ship operations (Indonesian National Army, 2010). The Mentawai Islands Regency is the outermost archipelago of the West Sumatra Province which lies along the westernmost part of Sumatra island which is surrounded by the Indian Ocean (Indonesian Navy Headquarter, 2007). This area has abundant marine potentials such as fish wealth, marine tourism potential and front row of islands that face to face with neighboring country.

Given the geographical condition and the potential of natural resources, it often triggers illegal fishing practices and cross-border violations committed by foreign ships passing around the Mentawai islands, in addition to this area is an area prone to earthquakes (National Development Planning Bereu, 2016).

In order to suppress the rampant illegal fishing practices, supervision of foreign ships and support the disaster relief operations that may occur in the Mentawai Islands, the Padang naval base plans to form a naval base. Thus, the Navy in cooperation with the local government of Mentawai Islands

District has provided 3 (three) alternative places or location options to be selected as Base (in this case as dock and office location), as shown in Figure 1.

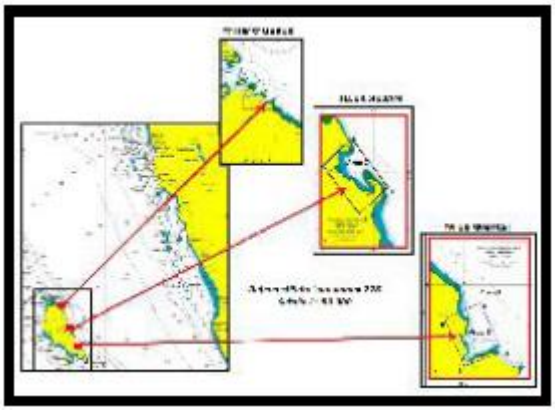


Fig. 1 The Naval Base Plan

In order to select the location of the base, it is necessary to analyze the three alternatives in order to be selected as the best base location. This is very important because the best base is a base that can ensure the implementation of combat support, logistical support and administrative support to each navy operation unit in the framework of marine control and can ensure continuous operation of Fleet Weapons System Integrated/SSAT component operation (Indonesian Navy Headquarter, 2005).

So far, the method used in determining the location of the naval base is based on the results of the team's decision which is the result of qualitative brainstorming and sometimes in the elements of subjectivity of the people in the team. In addition, problems that often occur sometimes tops as decision makers know the criteria that affect the decision, but can not let where the criteria are very influential and which are lacking.

Decision-making will be complex if each alternative has advantages over different criteria (Saaty, 2001). Suppose the alternative of Semabuk Bay is superior in terms of criteria of social condition of society and supporting facilities of staple food, Siuban Bay alternative is superior to the criteria of the shipping channel and health and education facilities, while the third alternative of Semebai Bay is superior in criteria of amphibious landing location and coastal morphology condition. Taking into account the advantages of each alternative will make it difficult for a decision maker to determine which alternatives will be selected.

In this research, it is proposed the use of a method that can consider alternative evaluation based on qualitative and quantitative criteria, and also attempt to facilitate decision making by conducting analysis on criteria that significantly influence the base determination by using Borda method, so we will get the criterion weight which has significant influence in determining the base selection policy (Paun, 2014). According to (Brans Roy, 1986) Promethee (Preference Ranking Organization Method for Enrichment Evaluation) method is able to fix Borda method to rank the alternatives based on the assessment of survey data with the weighting obtained from the Borda method (Mareschal B, 2008), so it is hoped to be able to get the best Mentawai naval base selection model.

Formulation is based on the description above then the problem that can be formulated is "How to model decision making in location selection of Naval Base of Mentawai by using combination of Borda and Promethee method (Preference Ranking Organization Method for Enrichment Evaluation) so get best location fulfilling criterion based on standardization Base" .

The purpose of this research is to first model the decision-making problem to select the location of the Mentawai naval base based on the standardization of the naval base and analyze the criteria that affect significantly. The second applies a decision-making model using a combination of Borda and Promethee methods to get the best of naval base location from three alternate locations: Semabuk bay, Siuban and Semebai bay.

While the benefits of this research is first to make a significant criteria analysis and influential towards the system in the selection of the location of the Mentawai naval base and the second as a reference navy chief in considering the policy in choice of location of Mentawai naval base.

2. METHODOLOGY

2.1. Flowchart Diagram

This research flowchart uses BORDA and PROMETHEE integration. Research begins with field observation / location and collects data from the literature.

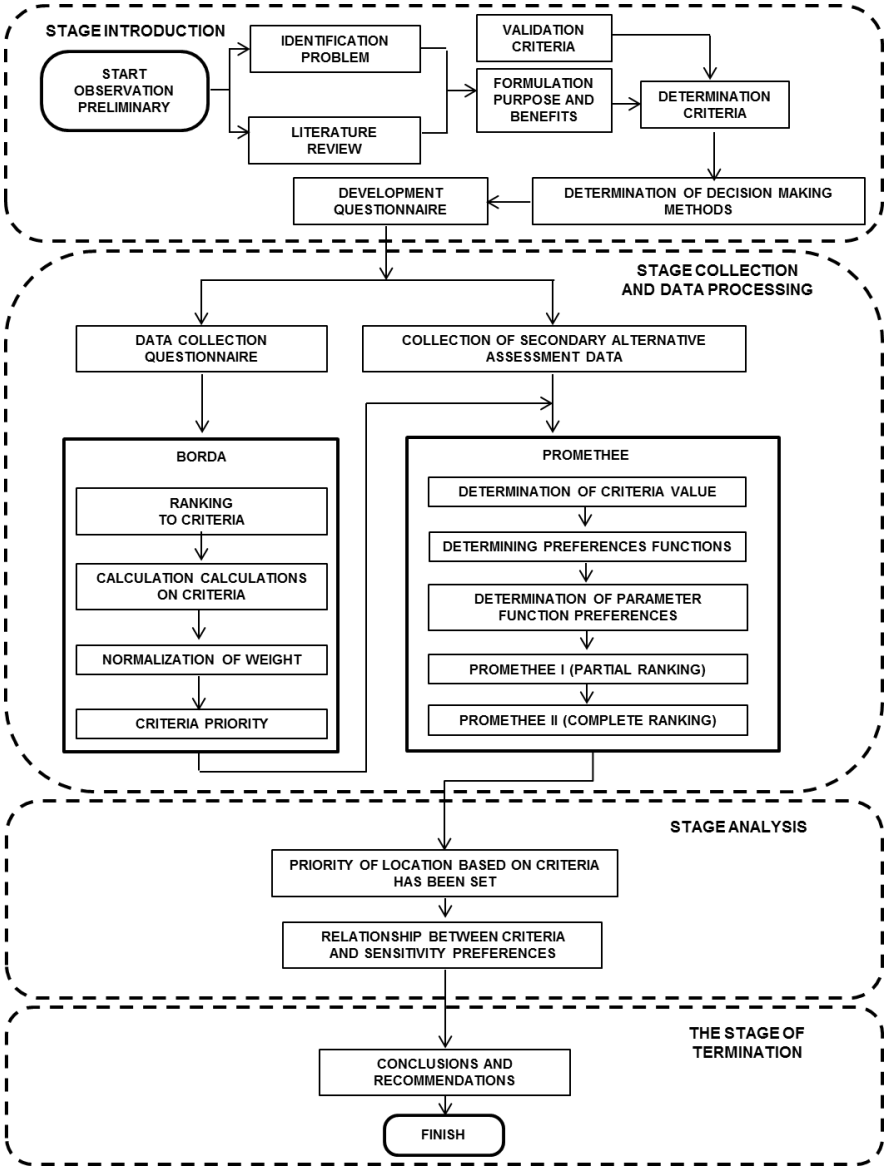


Fig. 2 Flowchart Diagram

2.2. Criteria Determination

Indonesian Naval Base requirements include Port Facility, Maintenance and Repair Facility, Supplies or Logistics Facility, Personnel Care Facility, and Training Base Facility (Indonesian Navy Headquarter, 2013). Then it can be formulated about the criteria that will serve as the determinant criterion in the selection of the location of the Naval base of Mentawai as shown in figure 3

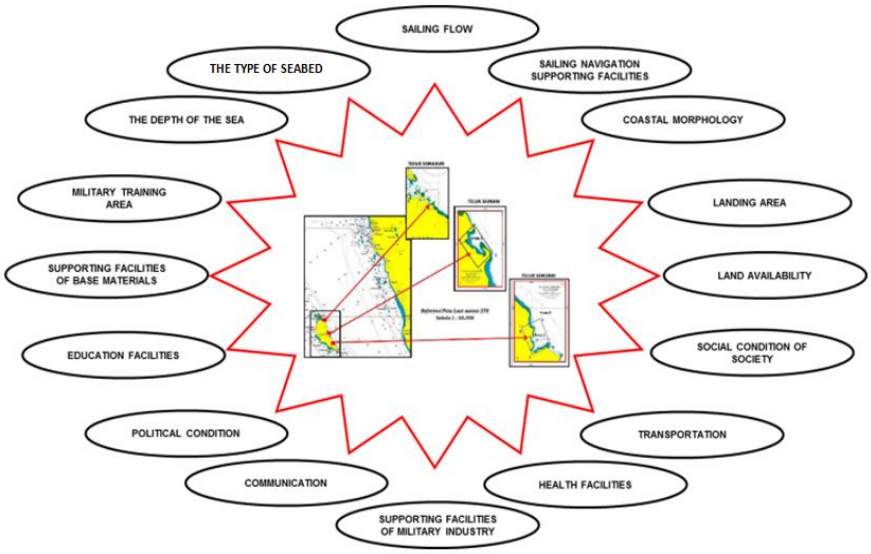


Fig. 3 Model Selection Criteria Location of Naval Base Selection

2.3. Borda Method

The Borda method invented by its discoverer Jean Charles de Borda in the 18th century. The privilege of this method can overcome the difficulties of other methods where people / things that are not in the first rank will be automatically eliminated (W. D. Keyser, 1996). The basic idea in the Borda method is to give weight to each of the first ranking criteria, second rank, and so on. In the explanation of the criteria importance assessment (Paun, 2014), described as equation 1 as follows:

$$R_1 \sum_{j=1}^{n} R_{ij} \quad (1)$$

Where:

R1: The sum of rankings is weighted for all criteria 1

Rij: The rank evaluated by j for criterion 1

As for the weight obtained as:

$$W_1 = \frac{R_1}{\sum_{i=1}^{m} R_1} \quad (2)$$

Where:

W1: weighting criterion 1 for evaluator n.

2.4. PROMETHEE (Preference Ranking Organization Method For Enrichment Evaluation)

According to (Brans Roy, 1986), (Macharis, 2004) Promethee is a method of determining the order (priority) in multicriteria analysis (Salvatore Corrente, 2012). The key issues are simplicity, clarity and stability. The alleged predominance of the criteria used in Promethee is the use of value in outranking relationships (Gothner, 2009). All the parameters that are stated have a real influence according to the economic view.

The principle used is an alternative priority assignment which has been set based on consideration $(\forall \dashv | / \mathrm{fi}(.) \rightarrow \Re[\mathrm{Realword}])$, with the basic rules:

Max{f1(x), f2(x), f3(x),….. fj(x),…. Fk(x) / x□ □} (3)

Where K is a set of alternatives, and fi (I = 1,2,3, ..., K) is the relative value / size of the criteria for each alternative. In its application a number of criteria have been set to explain K which is an assessment of $\Re$ (real word). Promethee belongs to the family of outranking methods developed by (Brans Roy, 1986) which includes two phases:

a. Building an outranking relationship from K.
b. Exploitation of this relationship provides an optimization answer of the criteria in the paradigm of multicriteria problems.

In the first phase, the value of outranking relationships based on the consideration of the

dominance of each criterion. The Preference Index is set and the outranking values are graphically presented based on the preferences of the decision maker. Preferences structure built on the basis of criteria (as seen in equation 4):

$$\forall\, \partial, b \varepsilon A \rightarrow F(a), f(b) \rightarrow \begin{cases} f(a) > f(b) \Leftrightarrow aPb \\ f(a) = f(b) \Leftrightarrow a|b \end{cases} \quad (4)$$

The basic data for evaluation with the Promethee method are presented as follows:

Table. 1 Basic Data Analysis Promethee
(Brans Roy, 1986)

	$f_1(.)$	$f_2(.)$	. .	$f_j(.)$	. .	$f_k(.)$
a_1	$f_1(a_1)$	$f_2(a_1)$	. . .	$f_j(a_1)$	. . .	$f_k(a_1)$
a_2	$f_1(a_2)$	$f_2(a_2)$	. . .	$f_j(a_2)$	. . .	$f_k(a_2)$
. .	. . .	. . .	. . .	. . .	. . .	. . .
a_i	$f_1(a_i)$	$f_2(a_i)$	. . .	$f_2(a_i)$	. . .	$f_2(a_i)$
. .	. . .	. . .	. . .	. . .	. . .	. . .
a_n	$f_1(a_n)$	$f_2(a_n)$	. . .	$f_2(a_n)$	. . .	$f_2(a_n)$

The value of outranking relationships in Promethee can be explained in the form of (Rudolf Vetschera, 2012) :

a. Criteria Domination

The f value is the real value of a criterion f : K →ℜ and the purpose of an optimization procedure For each alternative a $\mathcal{E}$ k, f(a) is an evaluation of these alternatives for a criterion. When two alternatives are compared, a, b, $\mathcal{E}$ k must be determined by comparison of their preferences.

Intensity delivery (P) of alternative preferences a to alternative b such that:

1) P (a, b) = 0 means there is no indefferent between a and b, or no preferences of a more
both from b.
2) P (a, b) ~ 0 means the weak preference of a is better than b.
3) P (a, b) ~ 1 means the strong preference of a is better than b.
4) P (a, b) = 1 means the absolute preference of a is better than b.

From this method, the preference function often results in different function values between the two evaluations, so that:

P (a,b) = P (f(a) - f(b)) (5)

For all criteria an alternative will be considered to have a better criterion value determined by the value of f and from the accumulation of this value determines the preference value of each alternative to be selected.

b. Recommended Function Preferences for Application

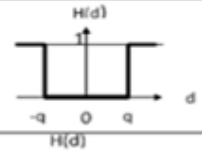
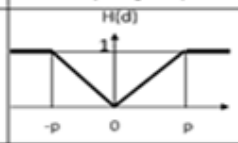
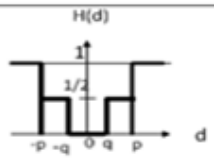
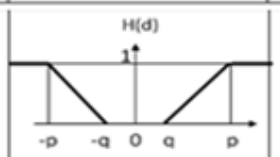
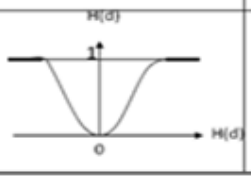
In Promethee presented six forms of criteria preference function. This is of course not absolute, but this form is good enough for some cases. To provide a better picture of unequal areas, a function of the difference between the alternate values of H (d) is used, where this has a direct relationship to the preferences function P:

$$H(d) = \begin{cases} P(a,b),\ d \geq 0. \\ P(b,a),\ d \leq 0. \end{cases} \quad (6)$$

In Table 2 summarizes the 6 (six) general types of preferences in which the decision maker can choose,

and the parameters to be made permanently. The decision maker can adjust the form of the problem with parameters that make a significant influence on the economic aspects. Table 2 Summary of the Six Common Criteria.

Table. 2 Summary of the Six Common Criteria
(Brans Roy, 1986)

The Type of criteria		Parameter
1. *Usual Criterion*		-
2. *Quasi Criterion*		q
3. *Criterion wih Linier preference*		p
4. *Level Criterion*		q,p
5.*Criterion with linier prefrence and indifference area*		q,p
6. *Gaussian criterion*		σ

As mentioned above, the process of determining the preference is an important step so that when the calculation of preference index can be representative of the problem. In helping to determine the level of preference can be seen in Table 3.

Table. 3 Determination of Preference Level
(Brans Roy, 1986)

Consideration	Function Level Preferences					
	I	II	III	IV	V	VI
Accuracy	Rude	Rude	Accurate	Rude	Accurate	Accurate
The trend is no different |d| <q	No	Yes	No	Yes	Yes	No
Absolute solid tendency |d| <q	No	No	No	Yes	Yes	No
Normal distribution	Maybe	Maybe	Maybe	Maybe	Maybe	Yes

c. Index of Multicriteria Preferences (M. Ehrgott, 2010)

The purpose of the decision maker is to set the preferences function P, and πi for all criteria f_i (i = 1, ..., k) of the compound criterion optimization problem. The weight πi is a relative measure of the importance of the criterion f_i; if all criteria have equal importance in decision making then all weight values are equal. The multi-criterion preferences index (determined by the weighted average of the P_i. preference function.

$$\wp\,(a,b) = \sum_{i=1}^{n} \pi\, Pi\,(a,b) : \forall\, a, b \varepsilon\, A \qquad (7)$$

$\wp$ (a, b) is the intensity of the decision maker's preference which states that alternative a is better than alternative b with simultaneous consideration of all criteria. It can be presented with a value of 0 to 1, subject to the following conditions:

1) $\wp$ (a, b) = 0, showing weak preference for alternative a over alternate b based on all criteria.

2) $\wp$ (a, b) = 1, shows a strong preference for alternative a over alternate b based on all criteria.

The preference index is determined based on the value of outranking relationships on a number of criteria from each alternative. This relationship can be presented as a graph of the value of outranking, the nodes are an alternative based on the assessment of certain criteria. Among the two nodes (alternatives), a and b, are curved lines having values $\wp$ (a, b) (no relation between $\wp$ (a, b) and $\wp$ (b, a) the relation can be seen in Figure 4

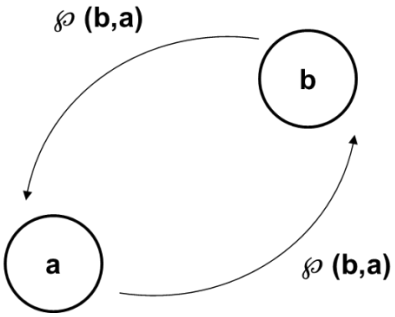


Fig. 4 Relationships between nodes (Brans Roy, 1986)

3. RESULT AND DISCUSSION

3.1. Data Processing

The steps of data processing are done as follows:

a. Conducting weighted processing on criteria based on expert questionnaire results. Processing and result of weighting Borda method as shown in Table 4 and 5.

Table. 4 Processing Borda method

		K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	K11	K12	K13	K14	K15	K16
NPS	1	15	11	13	12	14	1	2	5	6	7	3	4	9	10	0	8
	2	15	11	12	13	14	6	7	1	10	0	9	8	4	3	5	2
NOS	1	11	8	3	2	15	1	4	6	13	5	7	10	9	0	14	12
	2	13	12	5	10	11	9	8	7	6	4	3	2	1	0	15	14
NBF	1	9	8	7	6	5	4	3	2	10	11	12	13	1	0	15	14
	2	15	12	11	10	9	4	2	14	1	13	7	6	5	0	8	3
HIDROS	1	14	12	13	10	15	9	8	6	7	5	3	1	3	0	11	5
	2	13	7	12	15	14	1	2	3	11	0	4	5	10	6	9	8
TOTAL		**105**	**81**	**76**	**78**	**97**	**35**	**36**	**44**	**64**	**45**	**48**	**49**	**42**	**19**	**77**	**66**
WEIGHTING CRITERIA		0.109	0.084	0.079	0.081	0.101	0.036	0.037	0.046	0.067	0.047	0.050	0.051	0.044	0.020	0.080	0.069
THE ORDER OF CRITERIA		**0.109**	**0.084**	**0.079**	**0.081**	**0.101**	**0.036**	**0.037**	**0.046**	**0.067**	**0.047**	**0.050**	**0.051**	**0.044**	**0.020**	**0.080**	**0.069**
		1	**3**	**6**	**4**	**2**	**15**	**14**	**12**	**8**	**11**	**10**	**9**	**13**	**16**	**5**	**7**

Table. 5 Weighted Borda method

No Weight	Criteria	Code	Weight
1	Sailing Flow	K1	0.109
2	The Deep of the Sea	K5	0.101
3	Sailing Navigation Supporting Facilities (SNSF)	K2	0.084
4	Coastal Morphology	K4	0.081
5	Transportation Facilities	K15	0.080
6	Seabed Type	K3	0.079
7	Means of Communication	K16	0.069
8	Supporting Facilities of Base Materials	K9	0.067
9	Health Facility	K12	0.051
10	Education Facilities	K11	0.050
11	Supporting Facilities of Maritime Industry	K10	0.047
12	Land Availability	K8	0.046
13	Social Condotion of Society	K13	0.044
14	Military Training Area	K7	0.037
15	Landing Area	K6	0.036
16	Political Condition	K14	0.020

b. After obtaining the weight of each criterion, the next step is to process the results of alternative assessment using Promethee method using Microsoft Excels software and to facilitate the analysis of Promethee using Visual Promethee Version 1.1.0.0 which is a tool in solving Promethee method. The working order is as follows:

1) Determination of Criteria Preference Type. The determination of this type of preference is determined through brainstorming with decision makers and based on data accuracy. Guidelines for data selection based on data accuracy are presented in Table 6.

Table. 6 Type selection

Data Accuracy Rate	Seleted Type	Parameter
Accurate or Precise	Type III	p
	Type V	q,p
	Type VI	Ō
Not Accurate or Coarse Estimates	Type I	-
	Type II	p
	Type IV	q,p

2) Then the research on the tendency is not different if the appreciation of the value is below the parameter value p, if it has no tendency below the parameter value of p then the possible types are type II, type III, type IV and type V. Next is the assessment for different tendencies absolute after exceeding the parameter value q. If it has an absolute distinct tendency after it exceeds the parameter q, then the type chosen is type IV and type V. If the values | d | form a normal distribution, then the type of preferred function

selected is type IV. A complete selection of preference types is presented in Table 7.

Table. 7 Type of Preference criteria

No	Criteria	Criteria Type
1	Sailing Flow	Type III
2	Sailing Navigation Supporting Facilities (SNSF)	Type III
3	Seabed Type	Type V
4	Coastal Morphology	Type V
5	The Depht of the Sea	Type III
6	Landing Area	Type I
7	Military Training Area	Type I
8	Land Availability	Tiye III
9	Supporting Facilities of Base Materials	Tiye II
10	Supporting Facilities of Maritime Industry	Tiye IV
11	Education Facilities	Tiye III
12	Health Facility	Tiye III
13	Social Condition of Society	Tiye II
14	Political Condition	Type I
15	Trasportation Facilities	Type II
16	Means of Communication	Type II

3) Threshold Threshold Determination. The threshold value of each criterion is required as a basis to provide an assessment of outranking relationships between alternatives on a given criterion whether an alternative is preferred, not different, or preferably to a certain degree. Thus the threshold value must be given to each criterion, where the person who is considered the most important role here is the decision maker or expert. The procedure for determining the Threshold value as follows:

a) Calculate the value of the absolute difference between alternative criteria.

b) Calculating the range threshold for each criterion, calculating the absolute difference for each criterion by calculating the difference between the maximum and minimum absolute values.

c) Divide the range obtained from step (b) into three classes of the same class width to obtain indifference threshold values or q, preference threshold (p), and veto threshold (v) with rule q<p<v. The result of calculating threshold value as Table 8

Table. 8 The threshold value of the criteria

No	Criteria	Rule	Parameter		
			q	p	s
1	Sailing Flow	Max	116.667	233.333	177.858
2	Sailing Navigation Supporting Facilities (SNSF)	Max	1.333	2.667	2.000
3	Seabed Type	Max	0.333	0.667	0.577
4	Coastal Morphology	Max	0.667	1.333	1.000
5	The Depht of the Sea	Max	3.333	6.667	5.774
6	Landing Area	Max	0.333	0.667	0.577
7	Military Training Area	Max	0.000	0.000	0.000
8	Land Availability	Max	5.000	10.000	7.638
9	Supporting Facilities of Base Materials	Max	0.000	0.000	0.000

No	Criteria	Rule	Parameter		
			q	p	s
10	Supporting Facilities of Maritime Industry	Max	0.667	1.333	1.000
11	Education Facilities	Max	0.333	0.667	0.577
12	Health Facility	Max	0.333	0.667	0.577
13	Social Condition of Society	Max	0.000	0.000	0.000
14	Political Condition	Max	0.000	0.000	0.000
15	Trasportation Facilities	Max	0.000	0.000	0.000
16	Means of Communication	Max	0.000	0.000	0.000

4) The next step is the calculation of the preference value, because there are 3 alternatives then done 3 combinations of combinations of preferences.

5) And the final result of the calculation is the calculation of Preference Index from the combination of the three alternatives. The preference index of $\wp$ (a, b) is calculated on each pair on the criterion by formula (6), then the value of preference index between alternatives as shown in Table 9 follows.

Table. 9 Value of Preference Index

ΠP(a,b)	A1	A2	A3
A1	0.0000	0.0486	0.0000
A2	0.3708	0.0000	0.2407
A3	0.4720	0.1979	0.0000

6) Calculation of Preference Direction. By looking at the results akir processing then we can know the direction of preference. For the direction of preference is divided into two directions: Leaving Flow (LF) and Entering Flow (EF). LF is the size of the character outranking a, while EF is the size of a character in outrank. The positive outranking flow (F + (a)) declares to dominate the other (the power of a). The negative outranking flow (Φ ^ + (a)) states how each alternative is dominated by the other (the weakness of a). The ranking of Promethee I is based on each of the values of LF and EF. The bigger the LF value and the smaller the EF the better the alternative. The paretal ranking of Promethee I is presented in Figure 5 below

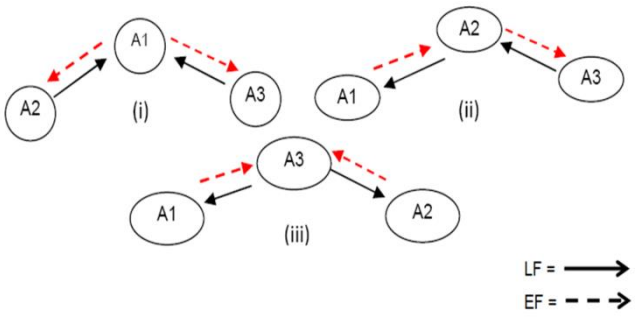


Fig. 5 Node relationship between alternative Promethee I

So the best alternative sequence in accordance with the ranking is as follows:

a) Ranking 1 Semebai.
b) Ranking 2 Siuban.
c) Ranking 3 Semabuk.

While Promethee II is based on its Net Flow (NF), the bigger the NF the higher the ranking. The ranking is shown in Figure 6.

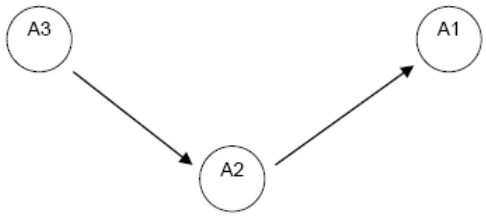


Fig. 6 Node relationship between alternative Promethee II

Based on Net Flow the best alternative sequence in accordance with the following rankings:

a) Ranking 1 Semebai.
b) Ranking 2 Siuban.
c) Ranking 3 Semabuk.

3.2. Analysis of Borda Results

Based on the result of the research, it is found that the criteria of the Sailing Channel (K1) with the weight of 10.9% is a criterion that significantly affects the determination of base site selection, and the second criterion that is the depth of the sea (K5) with weight of 10.1%. For the other criteria weighs less than 9%, while the criterion that has the lowest weight is the criterion of Political Condition (K14) of 2%.

3.3. Analysis of Promethee Results

Promethee is a method that complements or enriches the decision-making process of the preferences function (Belton, 2002). In the process of Promethee work is very dependent on the choice of type of preference conducted on each criterion, because in determining the type of preference is crucial to the end result of ranking. The result of the combination of these two methods resulted in Semebai Bay being ranked first in the selection of base sites.

3.4. Sensitivity Analysis

Sensitivity analysis is carried out to determine the extent of the decision changes that occur when the changes are made to the weight of the existing criteria. Based on data processing by Promethee II method, the result of weight sensitivity interval of each criterion is at certain value interval. For the breakdown of sensitivity values are presented in Table 10.

Table. 10 Interval sensitivity value

No	Criteria	Weight	% Interval
1	Sailing Flow	0.109	(0.00%, 16.69%)
2	Sailing Navigation Supporting Facilities (SNSF)	0.084	(0.00%, 14.31%)
3	Seabed Type	0.079	(0.00%, 100%)
4	Coastal Morphology	0.081	(3.64%, 100%)
5	The Depht of the Sea	0.101	(0.00%, 100%)
6	Landing Area	0.036	(0.00%, 100%)
7	Military Training Area	0.037	(0.00%, 100%)
8	Land Availability	0.046	(1.18%, 39.08%)
9	Supporting Facilities of Base Materials	0.067	(0.00%, 100%)
10	Supporting Facilities of Maritime Industry	0.047	(0.09%, 100%)
11	Education Facilities	0.050	(0.00%, 13.01%)

No	Criteria	Weight	% Interval
12	Health Facility	0.051	(0.00%, 13.10%)
13	Social Condition of Society	0.044	(0.00%, 100%)
14	Political Condition	0.020	(0.00%, 100%)
15	Trasportation Facilities	0.80	(0.00%, 100%)
16	Means of Communication	0.69	(0.00%, 100%)

Based on the sensitivity analysis conducted by Promethee method, the results obtained are sensitive to changes in weight at certain intervals such as changes in the weight of the criteria of Sailing Channel (K1), SNSF (K2), Coastal Morphology (K4), Land Availability (K8), Supporting Facilities Maritime Industry (K10), Health Facilities (K11) and Education Facilities (K12). On these 7 criteria it can be explained that at this stable level the alternative rankings will not change, but when outside the stable level interval there will be a change of rank on the alternative. As for the other criteria with an increase in weight value up to close to 100%, the predominance of this criterion will certainly not affect the final outcome of the sequence of alternatives. Visually seen in Figure 7 of the seven criteria that have a stable interval at a certain level.

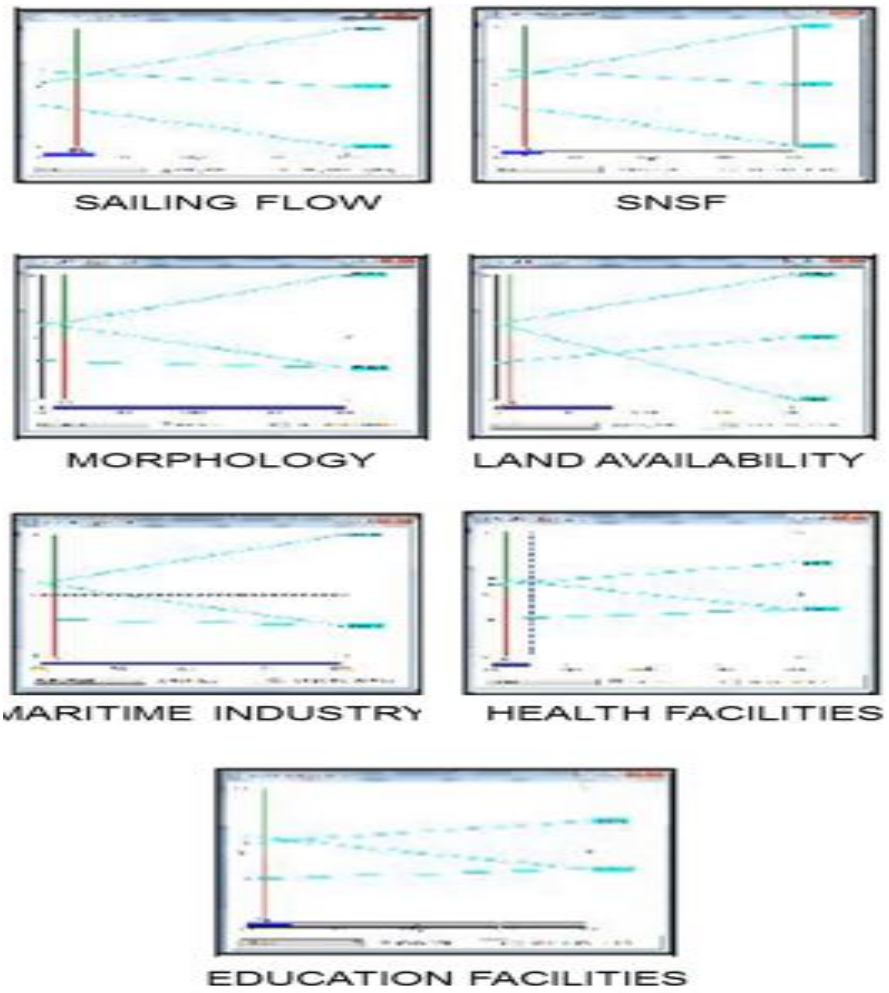


Fig. 7 Visualization of stable interval criteria

Sensitivity analysis is also done to alternative judgment value, this is done to know how big of change of rank which happened if in the future will experience change of appraise to alternative. The assessment of the criteria on each alternative is done on the criteria of SNSF, Land Availability, Support Facilities of Maritime Industry. And judgment assessment is given to alternatives that have the lowest or lowest value, to be able to know the ranking change of the existing alternatives. The result of the sensitivity analysis of the alternative does not change the ranking, it is seen in Figure 8.

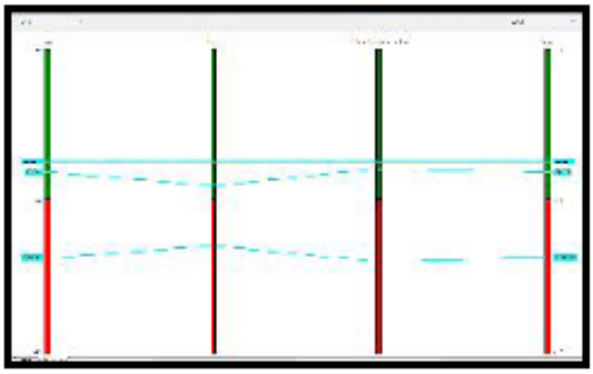


Fig. 8 Results of alternative change sensitivity analysis

4. CONCLUSION

Decision-making within an organization is the result of a continuous process of communication and participation of all members of the organization. The model of decision making by combining Borda and Promethee methods is a way of developing logical relationships that underlie the problem of decision making into a mathematical model reflecting the relationships that occur between the criteria involved. Based on the result of the research, it is found that the criteria of the Sailing Channel (K1) with the weight of 10.9% is a criterion that significantly affects the determination of base site selection, and the second criterion is the Depth of Sea (K5) with weight of 10.1%. For the other criteria weighs less than 9%, while the criterion that has the lowest weight is the criterion of Political Condition (K14) of 2%. Based on the result of research with Borda and Promethee combination method, the best base location of the Mentawai naval base, in order of priority as follows:

Sequence 1: Semebai Bay

Sequence 2: Siuban Bay

Sequence 3: Semabuk Bay

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THE APPLICATION OF DECISION MAKING TRIAL EVALUATION LABORATORY (DEMATEL) AND ANALYTYC NETWORK PROCESS (ANP) TO SELECTION OF SURFACE TO SURFACE MISSILES (SSM)

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ABSTRACT

Indonesian warship is one of the main weapon system belongs to Indonesian Navy. On this year planning programme, The Navy procure a PT PAL's Fast Attack Craft (FAC) which have much more advantages either on platform and sewaco side comparing with other convensional Warship that called Indonesian Warship Sampari Class. In order to fullfill it's warfare capabilities, this Sampari Class will be equipped with surface-to-surface missile. Selecting the type of missile requires proper method on analizing many aspects and criterias. In the procurement decision-making process, those aspects and criterias cannot be exemined in a hierarchically method as it involves interaction and dependency of the higher and lower level elements. Therefore, this study uses a method of Decision Making Trial and Evalution Laboratory (DEMATEL) and Analytical Network Process (ANP) to accommodate the link among them, which is considered as the most proper and simple method available. The results of this study based on analysis and interpretation of data processing results explained that the main subcriteria that received the highest priority weight in the selection of surface-to-surface missiles is the Accuracy subcriteria with a weighting value of priority 0.146213, Surface to Surface Missile (SSM) alternatives to the selected Indonesian warship Sampari class are those that get the greatest value from the calculation using Super Decision Software is C 705 missile with a priority weight value of 0.493386, and then sequentially the second alternative priority in the selection of surface-to-surface missiles then is the C-802 missile with a priority weight value of 0.310814 and as the last priority of the three alternatives is the Exocet MM 40 Block 2 missile with a priority weight value of 0.195800.

KEYWORDS : DEMATEL, ANP, Alternative, Surface to Surface missile, Main Criteria.

1. INTRODUCTION.

Geographically, the Republic of Indonesia is a country that is known as an archipelago (archipelagic state) the largest total area, occupying nearly two-thirds of Southeast Asia where this country has a quirk with islands - islands scattered from Sabang to Merauke, amounting to nearly 17,845 islands (Navy, 2017). Several large islands in Indonesia, among others, the island of Sumatra, Java, Kalimantan, Sulawesi and Irian Jaya island

and its islands - other smaller islands (A.Person & Weerd, 2006).

The territorial waters of the vast Indonesian government demands to build a strong sea power to maintaining the territorial integrity of the Republic of Indonesia (Defense Ministry Of The Republic Indonesia, 2015). It is in intended to keep the range of potential threats that will occur in the territorial waters of Indonesia, both potential threats from within and potential threats from outside the Homeland. Based on (Regulation of The Republic Indonesia No.34, 2004) Defence force in the field of maritime reliable and fast is the core of defense for military preparedness in general and the Navy in particular. Navy in this very direct influence in the field of maritime defense is very required to always be alert in maintaining security throughout the archipelago sea.

In addition, the position of Indonesia, located in a very strategic position at the intersection between the two continents; Asia and the Australian Continent; and 2 oceans; the Indian Ocean and the Pacific Ocean; naturally makes the territorial waters of Indonesia as one of the main lines of world trade (Laksamana, 2011). By having abundant natural resources, on the one hand to benefit the welfare of the nation, but on the other hand contains a vulnerability to the presence of the interests of other countries that may interfere with the sovereignty, integrity, security and safety of the nation. This is a challenge and a potential vulnerability in a very large and complex for Indonesia. Challenges and potential vulnerability of course, must be addressed and anticipated with the planning and development strategies as well as in the form of an act of protection and security of Indonesia to be implicated in the maritime field to strengthen the defense of the country's defense system with a strong deterrent power to melindungai all resources are in the territory of the Republic of Indonesia, both in peacetime and in wartime.

Government efforts to improve the defense must be supported by a sophisticated and modern armaments. A case we know the real condition of the existing defense equipment is very much as expected because of the limitations or shortcomings in terms of both quantity and sophistication of armaments block, impressed the way place and seemed to decline technologies. It can be seen from the average - average age of defense equipment is very old and even obsolete without regeneration defense equipment should follow a continuous and sustainable. The existence of defense equipment is a necessity for any country.

Indonesian warship Sampari Class is designed in such a way as to be able to carry out combat duties and security assistance duties. Mobility, disruption, destructive power and control system command capabilities with elements of water and aircraft vessels make this battleship an unreliable water vessel capable of carrying out marine operations tasks.

The combat capability of this Sampari class warship should be equipped with a missile weapon capable of supporting its main task. Therefore this final project research is expected to help provide advice and input to the Indonesian naval leadership in choosing missile weapons on water objectively. The method used in this reasearch is Decision Making Trial and Evaluation Laboratory (DEMATEL) and Analytic Network Process (ANP). The DEMATEL method can change the relationship between cause and effect of a criteria into an easily understood, structured model system (Fontela & Gabus, 1973). This is done to get consideration of decision making by knowing the relationship of interconnection between criteria (Saaty, Decision Making With Dependence and Feedback The Analytic Network Process, 2001).

1.1. Related Works.

(Tsaur, et al., 2002) conducting a study on Quality Evaluation of Aviation Services With the Fuzzy MCDM study describing the evaluation of aircraft service quality as a domestic and international flight in Taiwan. (Ching-HsueCheng, et al., 1999) examined the Evaluating Attack Helicopters by AHP Based On Linguistic Variable Weight a study of new methods for evaluating weapon systems by process (AHP) based on the weight of linguistic variables. Application of MCDM research methods (Aghaee & Fazli, 2012) about an improved MCDM method for maintenance approach selection: A case study of auto industry. A research entitled A Novel Approach To Incorporate Customer Preference and Perception Into Product Configuration: A Case Study On Smart Pads performed by (Wang & Hsueh, 2013). A study of management strategy (Nadali, et al., 2011) ANP-FIS Method for Determining the Knowledge Management Strategy. Research conducted by (Kuan & Chen, 2014) on A hybrid MCDM framework combined with DEMATEL-based ANP to evaluate enterprise technological innovation capabilities assessment. A study conducted by (Vanany, 2003) who raised the title of "Application of Analytical Network Process (ANP) On Performance Measurement System Design (Case Study on PT.X)". A study of surface-to-surface missiles conducted by (Zandavi, 2017) on Surface-To-Air Missile Path Planning Using Genetic and PSO Algorithms. In a study conducted by (Bashetty & Chodisetti, 2015) about Design and Analysis Of Surface To Surface Missile.

2. METHODOLOGY

2.1. Research Method

The MCDM approach in the selection of surface-to-surface missiles by proposing a decision-making based on questionnaires to Eexpert in the Indonesian Navy. The result of technological capability and innovation analysis that will be applied on the Sampari class warship by proposing 5 criteria and 36 subcriteria in this research can be seen in Table 1.

Table. 1 Criteria and Sub criteria of Surface-to-surface Missiles

Criteria	Sub criteria	Assessment Parameters
General Requirements	Operational	The degree of ease in the operation of missiles.
	Age Use	Age of missile wear for at least 10 years and can be relifing again.
	Security	Security guarantees for missile crews during shooting.
	Politis	Related to diplomatic relations both bilaterally and multilaterally
		in determining political policy in decision making.
	Strategic	Prospects for future use of missiles in the development of science and technology.
	Geography	This criterion relates to missile capability associated with geographic conditions.
Tactical Requirements	Power Destroyed	Damage assessment for destroyed targets
	Environmental conditions	Missiles are able to operate in environmental conditions in Indonesia.
	Speed	Missile capability in achieving goals
	Endurance	The missile capability begins to be fired until it reaches the target
	Range	The range of missiles against the target
	Accuracy	The precision of missiles in the target
	electronic warfare	The weapon system must have an anti-jamming system so that it can be used optimally
		even if the enemy uses the jamming system to destroy weapon system functions.
	Survivability	Ability to face opponent missile action
Technical Requirements	Altitude detection	Missile capability in sector gravity center in missile journey towards target.
	Movement Detection	The missile capability maintains speed and altitude at sea level
	Control Chain	Liaison between a computer system with a missile fin in missile exercise
	Homing Head	The missile electronic device in reaching the target
	Warhead	Parts containing explosives and missile detonators
	Propulsion	The part that contains the fuel of the missile plunger
	Guidance	The ability to control missiles before and during the course of the target to threats from
		opposing vessels (related to radar / seeker sensors)
	Voltage	The required power supply of the missile is adjusted to the availability of power
		supply on the ship (requires converter).
	Gyro	The missile capability to adjust the shifting changes and the nod of the ship corresponds to the gyro on board.
	Sensors	The ability of a missile sensor to detect a predetermined target until it reaches it.
Maintenance	Dimensions and Weights	The dimensions here include the length and width of the missile, while for this weight
		the weight of the missile will affect the MPK (Main Pushing Machine).
	Parts	The availability of spare parts and against the possible impact of the embargo
	Technician	Availability of technicians in the technology transfer process
	Maintenance Tools	Availability of equipment maintenance and maintenance support equipment
	Field maintenance	Ensuring easy weapon conditions in easy field maintenance.
Risk	Warranty	Guarantee is a service guarantee from the manufacturer if there is damage.
	Misfire	Misfire is a condition where the missile can not be fired because of the internal influence
		of the missile itself, eg: a missile, and others.
	Explode in the Container	Exploding in a Container is a condition that is the most dangerous risk of exploding in a tube
		or place of a missile (container).
	Embargo Spare Part	Spare part embargo is a condition where there is a ban on the sale of spare parts (spare parts) from
		producer country to consumer country.
	Technology Transfer Failure	Technology Transfer Failure is a situation where there is no technological delivery process from producer
		country to consumer country
	Technology unpreparedness	Technology unpreparedness is a measured or compatible state of technology between the PIT system
		(Combat Information Center) in Indonesian warship with technology systems in missiles
	Uncompounded missile crew	The unpreparedness of missile combatants is a condition where the unpreparedness of Navy soldiers in manning
		in manning missile alternatives to be installed, eg unpreparedness of science and technology of Navy soldiers.

2.2. Using DEMATEL To Know The Relationship Between Criteria or Sub criteria in Decision Making.

Based on DEMATEL literature it is useful to describe causal relationships in complex problems. Calculations from DEMATEL method (Fontela & Gabus, 1976) are generally carried out through five steps:

Step 1: Combine the direct link matrix values that the experts have filled with the average value. In the DEMATEL formulation, respondents indicate the degree of direct influence on a scale of 0, 1, 2, 3 and 4, which represent “Complete no influence (0)”, “Low influence (1)”, “Medium influence (2)”, ”High influence (3)” and “Very high influence (4)” by experts, respectively.

Step 2: Perform normalization on the linked matrix directly by multiplying the value of each column by the total value of the sum of the values of each row is acquired using Eq. (1) and Eq.(2).

$$M = k.A \quad (1)$$

$$k = Min\left(\frac{1}{\max\limits_{1\le i\le n}\sum_{j=1}^{n}|a_{ij}|}, \frac{1}{\max\limits_{1\le j\le n}\sum_{i=1}^{n}|a_{ij}|}\right) \quad (2)$$

$$i, j \in \{1,2,3,\dots,n\}$$

Step 3: Obtain the total linkage matrix by subtracting each column of identity matrix values from the normality matrix, followed by processing them with Minverse and MMULT can be obtained by using Eq.(3).

$$S = M + M^2 + M^2 + \cdots = \sum_{i=1}^{\infty} M^i$$
$$S = M\,(I - M)^{-1} \quad (3)$$

Step 4: Count the dispatcher group and receiver group. Group dispatchers and receiver groups are obtained by determining the value of D and R first. The D value is derived from the sum of the row values on the matrix processed by MMULT. While the value of R obtained from the number of columns of matrix values after the process MMULT by using Eq.(4), Eq.(5), Eq.(6).

$$S = \left[S_{ij}\right]_{nxn}, i, j \in \{1,2,3,\ldots,n\} \quad (4)$$

$$D = \sum_{j=1}^{n} S_{i,j} \quad (5)$$

$$R = \sum_{i=1}^{n} S_{i,j} \quad (6)$$

Step 5: Set the threshold value and get the impact-diagraph map. In order to obtain an appropriate impact map, the decision-maker must establish a threshold value for the level of influence. The impact-diagraph map can be obtained by mapping the values (D + R, D-R), where the horizontal axis is the value of D + R and the vertical axis is the value of D-R (Tzeng, et al., 2007).

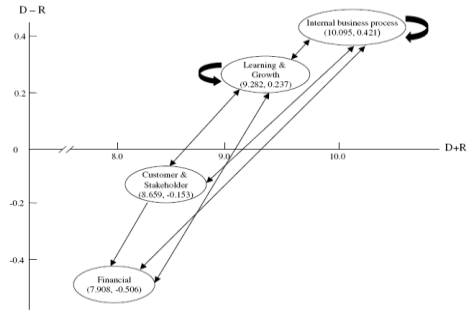

Fig. 1 Impact-Diagraph Map
(Wu & Lee, 2007)

2.3. ANP Method For The Relationship Between Sub-Criteria Innerdependence and Outerdependence.

According to (Saaty, 1996) ANP method is able to fix weaknesses AHP is the ability to accommodate linkages between criteria or alternatives. ANP data processing is done after the ANP questionnaires the experts to fill has been reassembled. Preparation of questionnaires using reference network model that has been formed. The questionnaire is based on the relationship between subcriteria both innerdependence and outerdependence and the preference relationship between the criteria and the goals by pairwise comparison between the cluster and between the cluster nodes.

The first stage performed on the ANP method to determine the priority criterion is to compile pairwise comparisons, comparing in pairs all the criteria for each hierarchical subdivision. The comparison is then transformed in the form of a pairwise comparison matrix for numerical analysis which can be seen in Table 2.

Table. 2 Pairwise Comparison Matrix (Saaty, Decision Making With Dependence and Feedback The Analytic Network Process, 2001)

C	A_1	A_2	A_3	.....	A_n
A_1	a_{11}	a_{12}	a_{13}	.....	a_{1n}
A_2	a_{21}	a_{22}	a_{23}	.....	a_{2n}
A_3	a_{31}	a_{32}	a_{33}	.....	a_{3n}
....	....	.....	.....	.....	.....
A_n	a_{n1}	a_{n2}	a_{n3}	.....	a_{nm}

The value of a_{11} is the ratio value of the A_1 element (row) to A_1 (column) stating the relationship: (a) How far the importance of A_1 (row) to criterion C is compared to A_1 (column) or (b) How far is the dominance of A_1 (row) to A_1 (column) or (c) How many properties of C criterion are in A_1 (row) compared to A_1 (column). The numerical value applied for the whole comparison is obtained from the comparison scale in Table 2. If the weight of the A_i criterion is W_i and the element weight of A_j is W_j then the base scale 1-9 is composed representing the comparison $(W_i / W_j) / 1$. The absolute numbers on the scale represent a very good approximation to the weight ratio of elements A_1 to element A_j. Shown in Table 3.

Tabel. 3 Comparative Assessment Scale (Saaty, 1996)

Level of Importance	Definition	Information
1	Just as Important	Both elements have the same effect.
3	Slightly more Important	Experience and judgment are one-sided to one's partner
5	More important	One element is well-liked and practically very dominant, compared to its partner elements
7	Very important	One element proved to be highly favored and practically very dominant, compared to its partner elements
9	Absolutely more important	One element proved to be absolutely preferred over the other, at the highest confidence level
2,4,6,8	Middle value	Given if there is any doubt between two adjacent belief levels
$A_{ji} = 1/a_{ij}$	The opposite	Given when the element in column j is preferred over the counterpart

Geometric Mean (geometric mean) is the midpoint between two or more different decision-makers. After the results of the questionnaire test of each expert is tested consistency, then the results of the filling is feasible to be unified through the geometric mean of each question. Calculation of geometric mean on ANP using Eq.7

$$\sqrt[n]{\prod_{i=1}^{n} X_i} \quad (7)$$

X_i = Decision on comparison of criterion-1

3. RESULT AND DISCUSION

3.1. Data Processing DEMATEL

This research is the object is surface to surface missiles missiles that have been offered to the Indonesian navy, among others: (a) Missile Exocet MM-40 Blok 2 (b) Missile C 802 (c) Missile C 705. The results of expert assessment who served as head of the weapon repair and maintenance workshop of the Indonesian Navy.

In this section aims to evaluate the criteria associated with surface-to-surface surface-to-surface selection of 3 alternatives already offered to the Indonesian navy. The criteria are: general requirements, sub criteria (operational, age, security, politics, strategic, and geography), criteria of both tactical requirements, sub criteria (destructibility, environmental conditions, speed, endurance, range, accuracy, electronics, survivability), the third criterion of technical requirements, sub-criteria (altitude detection, movement detection, control chain, homing head, warhead, propulsion, guidance, voltage, gyro, sensor, and dimension), the fourth criterion is maintenance, sub criteria (spare parts, technicians, maintenance tools, field maintenance,

and warranty), the last criterion is risk, sub-criteria (miss fire, burst in container, spare part embargo, technological failure, unpreparedness, unattended personnel). The expert consists of six people, one representing the procurement field, two representing armaments, and three representing the field of Indonesian naval weapons repair.

The DEMATEL method introduced in Section 2.2 serves as a guide in the decision structure. First, the matrix of direct influence for criteria. Then, the normalization matrix of direct influence for the criterion can be calculated by Eq. (1) and Eq. (2). Third, the total direct-influence matrix for criteria/dimensions was derived based on Eq. (3). The fourth counts the dispatcher group and receiver group was derived based on Eq. (4), Eq. (5), and Eq.(6) (see Table 4). Finally sets the threshold and impact digraph map which shown in Fig. 2.

Table. 4 Sub-criteria Dispatcher and Receiver

	J					
I		D	R	D+R	D-R	
GENERAL REQUIREMENTS	OPS	0,048432484	0,071653364	0,120085848	-0,02322088	Receiver
	AU	0,062450029	0,085367026	0,147817056	-0,022916997	Receiver
	SEC	0,043537395	0,082431351	0,125968746	-0,038893955	Receiver
	POL	0,030360138	0,03121756	0,061577699	-0,000857422	Receiver
	STR	0,029994158	0,043491267	0,073485425	-0,013497109	Receiver
	GEO	0,058021164	0,000597025	0,058618189	0,057424139	Dispatcher
TACTICAL REQUIREMENTS	PWR	0,125970982	0,036451792	0,162422754	0,08951917	Dispatcher
	ENVI	0,086400225	0,000303315	0,08670354	0,08609691	Dispatcher
	SPD	0,065546276	0,039293328	0,104839604	0,026252949	Dispatcher
	END	0,058877184	0,04015263	0,099029814	0,018724555	Dispatcher
	RNG	0,060256699	0,039751472	0,100008171	0,020505226	Dispatcher
	ACC	0,131527899	0,039875181	0,17140308	0,091652719	Dispatcher
	EW	0,093062652	0,013254502	0,106317154	0,07980815	Dispatcher
	SUR	0,087394792	0,024805395	0,112200187	0,062589397	Dispatcher
TECHNICAL REQUIREMENTS	ATT	0,062652633	0,019937343	0,082589977	0,04271529	Dispatcher
	MVT	0,063111931	0,019462182	0,082574113	0,043649749	Dispatcher
	CCN	0,064825842	0,006558272	0,071384114	0,058267569	Dispatcher
	HMH	0,07287745	0,012183602	0,085061052	0,060693848	Dispatcher
	WRH	0,067887916	0,002881811	0,070769727	0,065006105	Dispatcher
	PROP	0,048497473	0,021804567	0,07030204	0,026692906	Dispatcher
	GUI	0,096723849	0,008726023	0,105449872	0,087997826	Dispatcher
	VOLT	0,061360928	0,003057544	0,064418473	0,058303384	Dispatcher
	GRO	0,063065404	0,002718565	0,065783969	0,060346838	Dispatcher
	SNR	0,082458531	0,007138745	0,089597276	0,075319786	Dispatcher
	DIM	0,062208062	0,00050096	0,062709022	0,061707102	Dispatcher
MAINTENANCE	PRT	0,065323255	0,010004585	0,07532782	0,05531889	Dispatcher
	TECH	0,065787492	0,010004585	0,075792057	0,055782927	Dispatcher
	MTT	0,064208087	0,016974324	0,081182392	0,047233743	Dispatcher
	FIM	0,06739517	0,016960654	0,084355824	0,050434516	Dispatcher
	WARR	0,044133172	0,028021417	0,072154589	0,016111755	Dispatcher
RISK	MSF	0,051956493	0,063428573	0,115385067	-0,01147208	Receiver
	EXCO	0,030846638	0,088928489	0,119775127	-0,058081851	Receiver
	EBS	0,064965766	0,030702594	0,09566836	0,034263172	Dispatcher
	TTF	0,077607592	0,07568114	0,153288732	0,001926452	Dispatcher
	TUN	0,094869157	0,069980871	0,164850029	0,024888286	Dispatcher
	UNM	0,067879773	0,044658894	0,112538667	0,02322088	Dispatcher

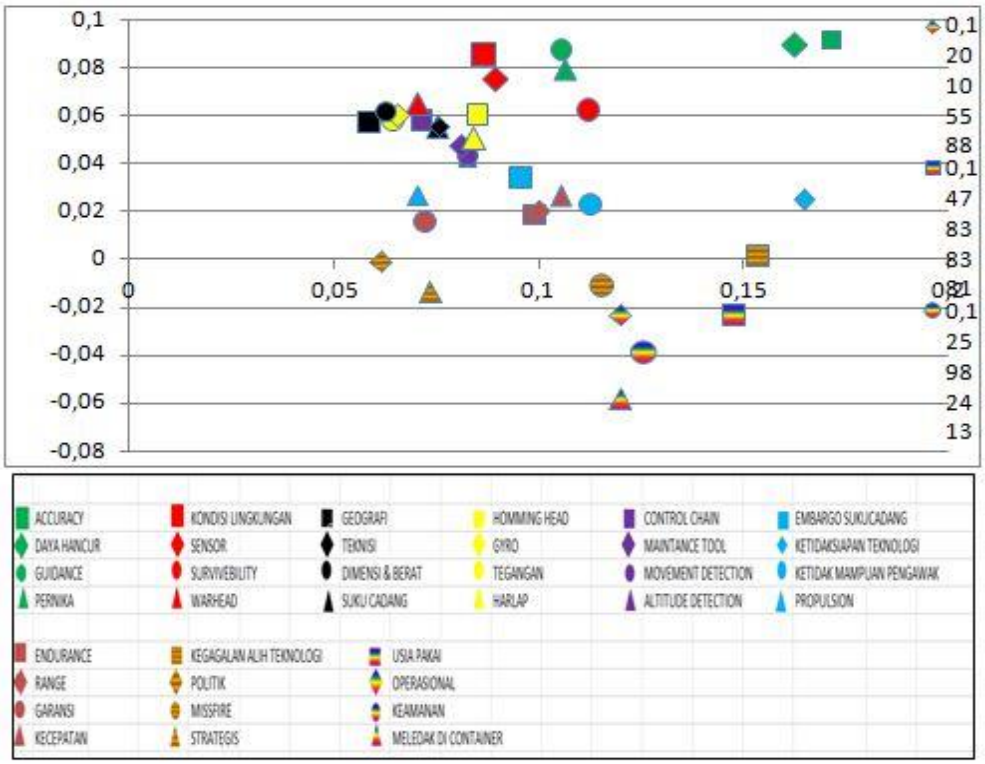

Fig. 2 Impact Diagraph Map

To determine whether there is a relationship between subcriteria one with other subcriteria, it is necessary to determine the value of threshold valuenya first. Threshold value can be found in two ways; that is: Takes the average value of the result table value MMULT and can be determined through expert opinion. The value of treshold value is determined the average value of the result of the mmult table is 0.022840247.

3.2. Data Processing ANP

Geometric Mean (geometric mean) is the midpoint between two or more different decision-makers. After the results of the questionnaire test of each expert is tested consistency, then the results of the filling is feasible to be unified through the geometric mean of each question using Eq. (7). Shown in Tabel 5.

Tabel. 5 Geometric Mean Matrices Comparison Pair on Criteria

Geomean	General	Technical	Tactic	Maintenance	Risk
General	0	0	0	3	5
Technical	4	0	0	3	6
Tactic	5	4	0	3	4
Maintenance	0	0	0	0	3
Risk	0	0	0	0	0

The results of processing using Superdecision software it is known that five subcriteria that have the

biggest weight are Accuracy (0.146213), then Power Destroyed (0.103095), Politis (0.064534), Pernika (0.047829) and Survivebility (0.047687).

After knowing the weight of each subcriteria, then the weight of each criterion can also be known. The way to know the weight of the criteria is to add weight of the subcriteria to each criterion. about the criteria weight, the result that the criteria that have the highest weight is the Tactical criterion (0.408843). The next rank is Technical (0.194588), General (0.18956), Treatment (0.093741), and Risk (0.079613).shown in Table 6.

Tabel. 6 Weighting Criteria

NO	Criteria	Weight
1.	General	0,18956
2.	Technical	0,194588
3.	Maintenance	0,093741
4.	Tactic*	0,408843
5.	Risk	0,079613

that exist. The final calculation result is the ranking value of each alternative priority of Surface Surface Selection to Surface at Indonesian warship Sampari Class. From the results of questionnaires ANP, obtained data processing Fig. 3 and Fig. 4.

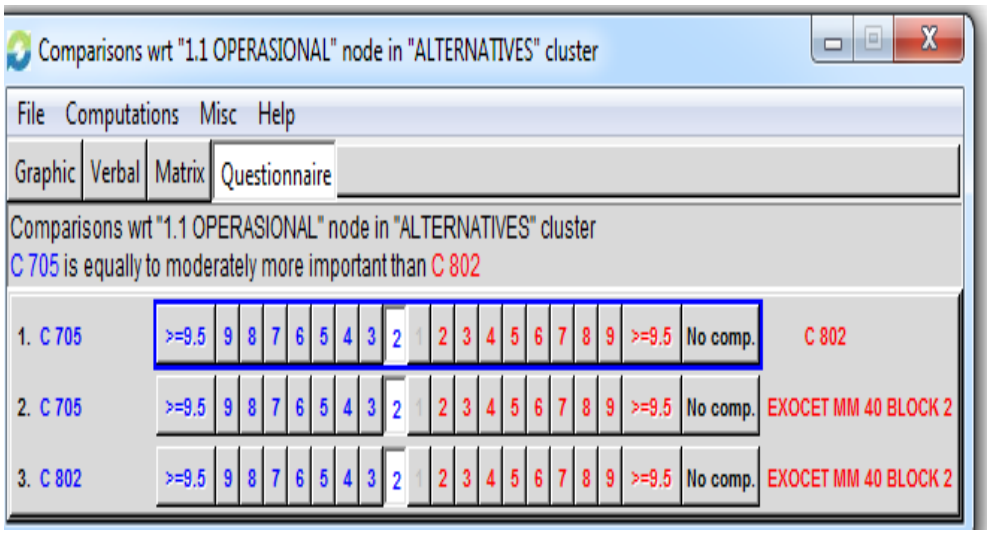

Fig. 3 Comparison of Paired Operational Nodes in Cluster Alternatives on Super Decision

Figure 3 describes the result of processing using Super Decision software that comparison of sub-criteria "operational" to each alternative that is cluster C 705 is equally to moderately more important than C 802.

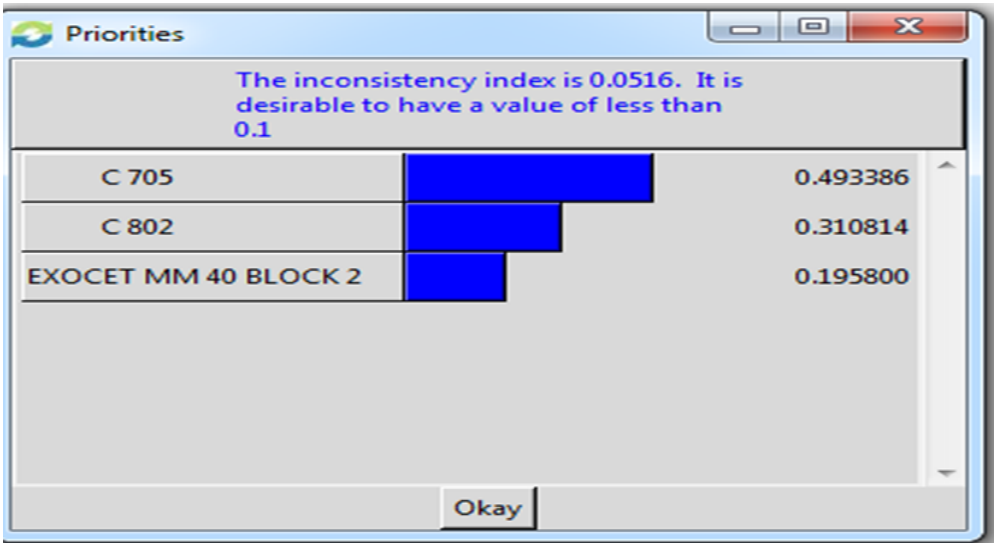

Fig. 4 Index Inconsistency Figure 4.15 is 0.0516

The end result of the synthesis process of all data then obtained the value of alternative weight or alternative priority value of missile selection and ranking of the alternatives shown in Fig. 5.

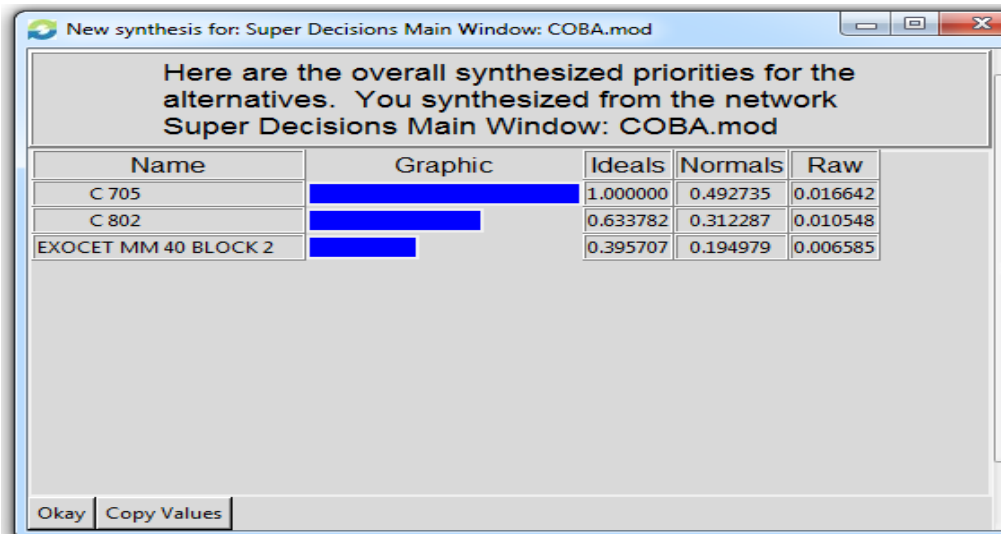

Fig. 5 Alternative Priority Value Of Missile Selection

3.3. Sensitivity Analysis

Sensitivity analysis is conducted to find out the extent of stability of the priority of the alternatives. The vertical line indicates the weight value of each indicator to be tested for sensitivity, while the horizontal line is the indicator hose for the change of weight value in each alternative. In this study Sensitivity analysis is done by changing the value of weight on the alternatives and nodes tested can be seen in Fig. 6 and Fig. 7.

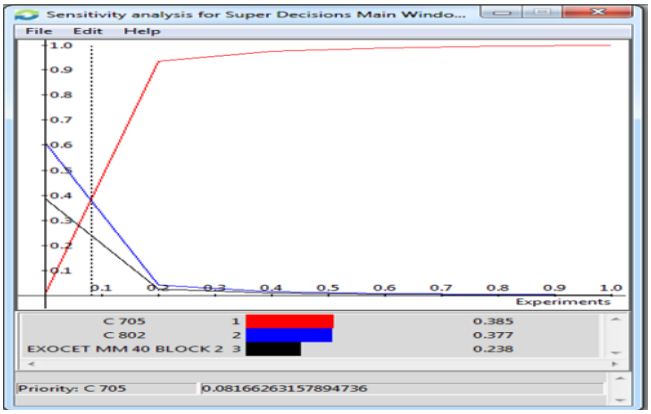

Fig. 6 Alternative Sensitivity Analysis of Missile C 705

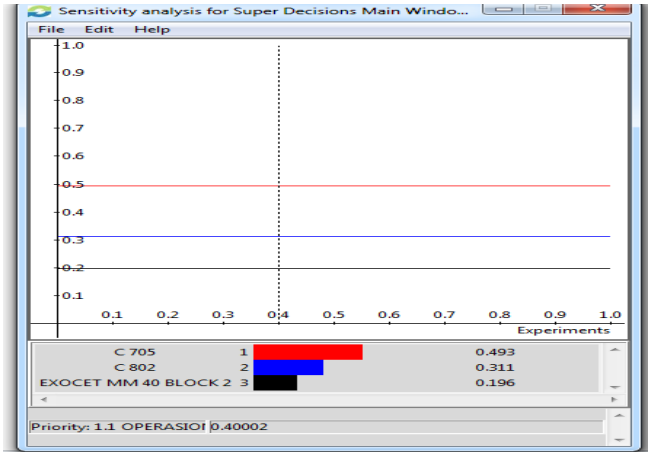

Fig. 7 Sensitivity Analysis of Operational Node Work

4. CONCLUSION

The results of data collection and processing, as well as analysis and interpretation of the results of data processing has been done that sub criteria main / critical that get the highest priority weight in the selection of surface surface to surface alternative is the Accuracy subcriteria with the priority weight value of 0.146213. In the selection of Surface to Surface Missile / SSM (Surface to Surface Missile / SSM) priority on a very complex Indonesian warship Class Sampari, the DEMATEL method is very helpful in describing the relationship between criteria and subcriteria clearly. However, because in DEMATEL method has not produced an alternative priority hence needed a method to find alternative priority that is ANP method, so that more accurate alternative priority is obtained. In addition, in this research it is found that the addition of Expert number does not affect the significant difference either consistency or rank value alternatives to be selected. Surface to Surface Missile (SSM) alternatives to the Selected Selected Indonesian warship are the ones who get the greatest value from the calculation using Super Decision Software ie C 705 missile with priority weight value of 0, 493386 and then sequentially the second alternative priority in the selection of surface-to-surface missiles then is the C-802 missile with a priority weight value of 0.310814 and as the last priority of the three alternatives is the Exocet MM 40 Block 2 missile with a priority weight value of 0, 195800.

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THE FRAMEWORK COBIT 5 FOR ANALYSIS MEASUREMENT OF PERFORMANCE NFORMATION ACADEMIC SYSTEM

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ABSTRACT

Information technology (IT) also has an important role in performing the function of college or university, so it can be trusted to improve the effiency and effectiveness of the academic process so that the academic services can be maximized as well as supporting the innovation of university business process to develop. The Naval Academy (AAL) is one of the educational institutions in the Indonesian National Defense Force and has the task of creating professional Navy officers, possessing current technological mastery and heading to the World Class Navy. With reference to the desired results above, AAL uses information technology in conducting teaching and learning activities. Academic Information System or SIAKAD is an information system that is built and developed with modules contain of the educational calendar and course materials. The use of Academic Information System is perceived not yet optimal among the factors of information content, ease of access and availability of systems that have not been in accordance with the wishes of its users. From the above problems, the authorconducted a research on "measurement of performance of academic information system governance in the Indonesian Naval Academy ". With the resulting maturity level, it is known that the current level of maturity (as-is) for the average APO (Align, Plan, and Organize) domain (3 – Defined Process) means that the process is at a fixed stage, stage of implementation of standardized processes, meaning that there is a standard IT process that applies everywhere in the scope of the organization means that the Academic Information system in terms of strategic order is already at a stable stage. While the Domain DSS (Deliver, Service, Support), the average level of maturity reach (Defined Process) which means also at a fixed stage means the agency has been running the task of the IT process and has achieved its goals in well managed through the stages of planning, evaluation and better tailored adjustments.

KEYWORDS : COBIT 5, IT Governance, Maturity Level.

1. INTRODUCTION

The development of information technology today has been adopted by many organizations from various fields, not least in the education world (Annwareen., 2008). Information technology (IT) also has an important role in performing the function of college or university, so it can be trusted to improve the effiency and effectiveness of the academic process so that the academic services will be maximized, and support the innovation of university business process to develop. To be able to maintain maximum IT utilization can occur when evaluated the extent to which information technology services are utilized, but the evaluation and control of the use of IT sometimes less attention by universities so that the availability of IT services to

be less than the maximum and not appropriate (García, 2013). The function of information technology to be able to provide strategic opportunities for universities, required a good information technology governance. Evaluation has objectives in assessing, monitoring, and ensuring that academic service resources can operate effectively in line with the objectives of the university's strategic plan.

The Naval Academy (AAL) is one of the educational institutions in the Indonesian Defense Force and has the job of creating professional Navy officers, possessing current technological mastery and heading to the World Class Navy. With reference to the desired results above then AAL uses information technology in conducting teaching and learning activities. By using IT, students and lecturers will be able to provide the delivery of learning materials without limitation of time and space as well as place for teaching and learning activities. There are 3 information systems in Indonesian Naval Academy (AAL) that support teaching and learning activity, those are Siakad (Academic Information System), Smart Class and CBT (Computer Based Training) (Romuald Cwilewicz, 2003).

Academic Information System or SIAKAD is an information system that is built and developed with modules contain of education calendar and lecture materials that can be taken by learners and used at any time.Some factors which are perceived not yet optimal in the use of Academic Information System are information content, ease of access and the availability of systems that have not been in accordance with the wishes of its users.

From the mentioned problems it is necessary to have a governance that can solve current problems. Solving these problems are expected in order to improve the quality and performance of the Academic Information System system. Based on the background, the author intends to conduct a research entitled "Measurement of performance of academic information system governancein the Indonesian Naval Academy".

2. LITERATURE REVIEW

2.1. Basic Concepts of Information Systems

Information system is a system within an organization that brings daily transaction processing needs, support information, managerial and strategic activities of an organization and provide certain outside parties with reports required reports (Grembergen, 2008).

2.2. IT Governance

Information Technology governance is a policy framework, procedures and set of processes that aim to direct and control the company in order to achieve company goals by providing additional business value, through balancing the benefits and risks of IT and the processes in it (Ramlaoui, 2014). information technology governanceis defined as an integral part of organizational governance that consists of leadership, organizational structures and processes that ensure that organizational information technology continues as well as enhances organizational goals and strategies (IT Governance Institute, 2007). Information technology governance undertakes the specification of decision rights and accountability frameworks to guide the desired behavior in the use of information technology. Information technology governance is not just a specific decision-making but rather the determination of who systematically makes and contributes to the decision (Ron Webber, 1999).

In its implementation, IT governance can be interpreted as a process of control and performance

improvement which is done continuously to the application of IT in the company (S.Elhasnaoui, 2013). The IT governance process begins with goal setting for enterprise IT. Goals will give direction. The carried-outIT activities must be based on those objectives. Finally, performance is measured and compared, the achieved results are compared to the previous results achievement and adjustments are made in relation to the intended purpose (Gerke, 2009).

2.3. COBIT Framework

COBIT is an IT governance standard developed by the IT Governance Institute (ITGI), an organization formed by ISACA that studies the US-based IT governance model (ISACA, 2012). COBIT is an IT governance framework and a set of tools that support and enable managers to bridge the gaps between controllable requirements, technical issues and business risks (ITGI, 2003). COBIT 5 is a strategic development that provides ISACA's next generation guidance on governance and management for organizational IT assets (ISACA, 2012).

One of the principles in COBIT 5 is the division between governance and management processes (Fröhlich, 2010). In line with this principle, each organization is expected to implement a number of governance processes and a number of management processes to achieve overall IT governance and management (ISACA, 2012). COBIT 5 is developed to address important needs, including (Nugroho, 2014):

a. Assist stakeholders in determining what to expect from relevant information and technologies.

b. Overcoming the increasingly pervasive information technology into the company. Information technology is increasingly becoming an important part of business.

c. Support the integration of business and information technology as a whole, and support all aspects that lead to effective corporate information technology governance and management.

2.4. COBIT 5 Process Dimensions

The COBIT 5 process model divides corporate governance and IT management processes into two process domains (ISACA, 2012):

a. Governance

The domain area contains 5 governance processes in the form of domain processes Evaluate, Direct, Monitor. Where there is a definition for each process.

b. Management

The domain area contains 4 domains, aligned with the responsibility areas of Plan, Build, Run, and Monitor (PBRM), providing end-to-end IT coverage. The domain is the structure of the COBIT domain and process 5:

1) Align, Plan, and Organize (APO)

Domains that discuss plans, strategies, and focus on achieving business objects. The realization of a vision strategy is needed to be planned, communicated, and managed to generate perspectives.

2) Build, Acquire, and Implement (BAI)

Provide solutions and services to use. To realize the information technology strategy, the required technology solution, has been built or obtained, or already implemented must be in accordance with the business object.

3) Deliver, Service, and Support (DSS)

Domains that address the delivery and support of required services, including operational support facilities for user support and security management.

4) Monitor, Evaluate, and Assess (MEA)

Observe all processes to ensure follow the directions provided. All information technology processes are needed to be assessed at all times to maintain quality and compliance with control needs. Domains include performance of management, internal control monitoring, related to governance (Sadikin, 2014).

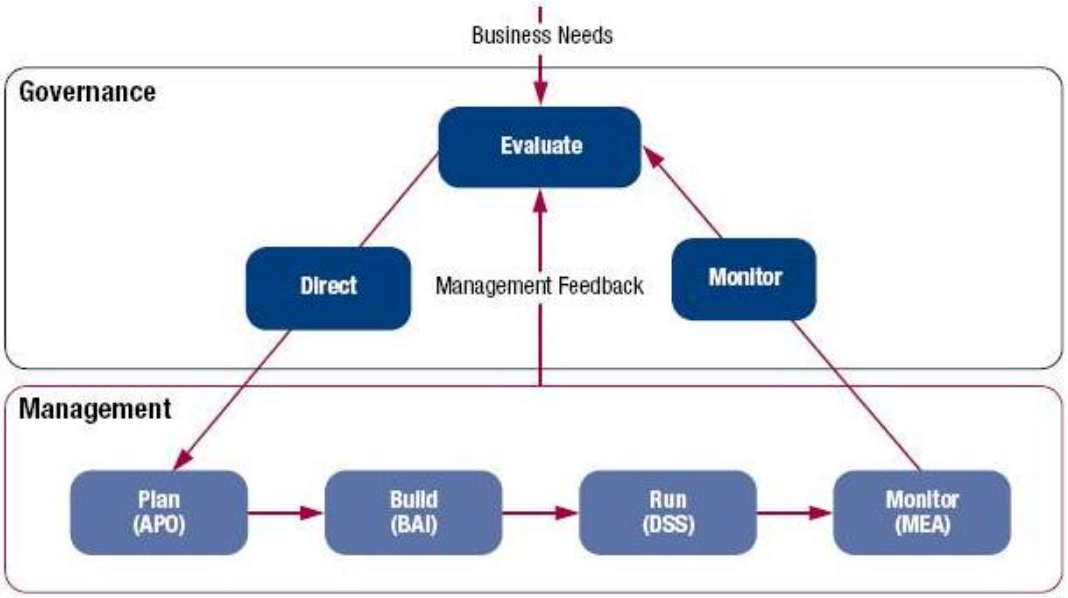

Fig. 1 COBIT 5 Governance and Management key area (ISACA., 2013)

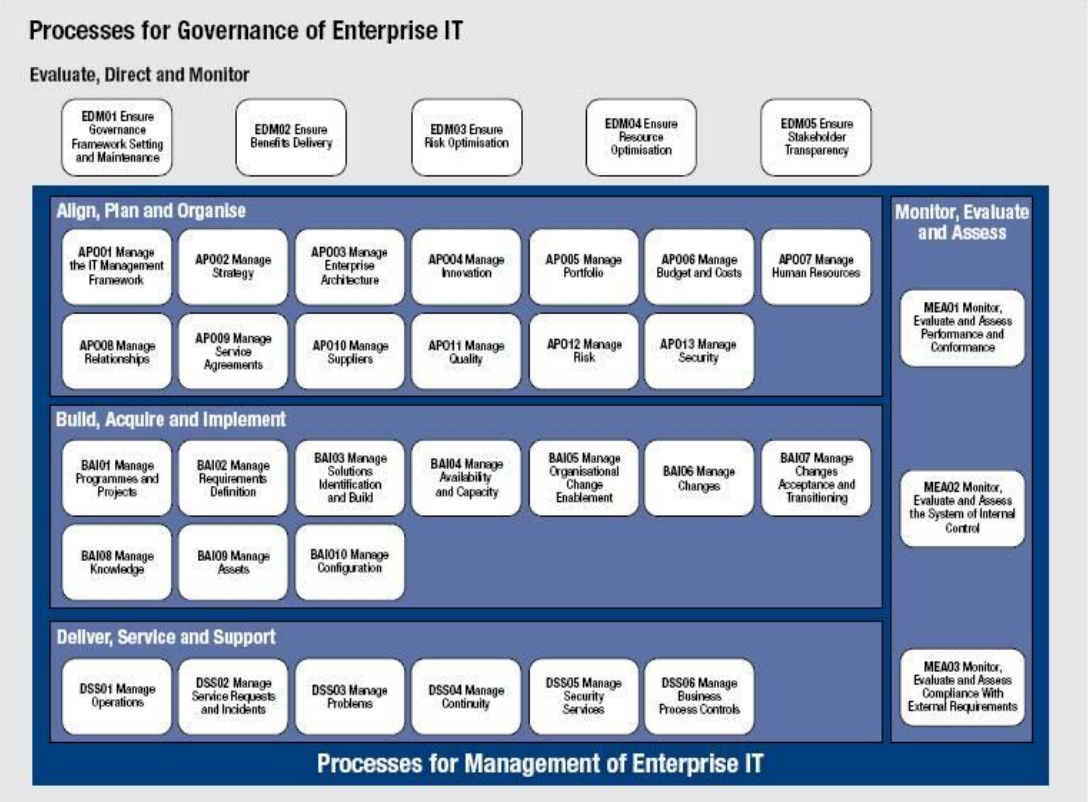

Fig. 2 Domain Process COBIT 5
(ISACA, 2012)

2.5. Maturity Model

The maturity model is used as a tool for benchmarking and self-assessment by IT management more efficiently (Rosmiati, 2016). Benchmarking process can be done gradually to control objectives, starting from processes and high-level control objectives on COBIT so that 3 (three) items can be obtained :

a. Relative size to current organizational conditions

b. Directions to decide directions and goals efficiently

c. Tool to measure progress towards achievement

The measurement scale is given in stages for each IT process represented by a value from 0 to 5 (Tanuwijaya, 2010). The scale is related to the description of the qualitative maturity model that ranges from "Non-existent" to "Optimized" as shown in Figure 2.

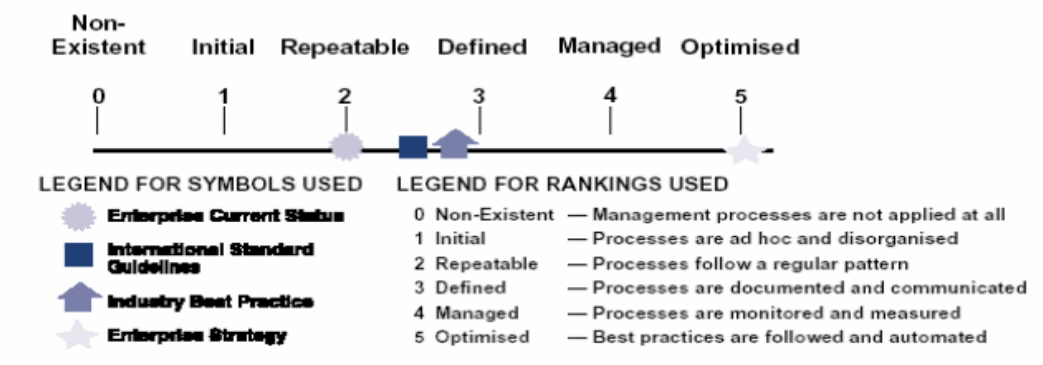

Fig. 3 COBIT Maturity Rate
(IT Governance Institute, 2007)

Table. 1 Maturity Index
(Krisanthi, 2014)

NO	MATURYITY INDEX	MATURITY LEVEL
1.	0 – 0,50	0 – Non-Exist
2.	0,51 – 4,50	0 - Initial/ad Hoc
3.	1,51 – 2,51	2 – Repeatable but Inuituve
4.	2,51 – 3,50	3 – Define Process
5.	3,51 – 4,50	4 – Managed and Measureable
6.	4,51 – 5,00	5 - Optimized

3. RESEARCH METHODS

Stages of workmanship Performance Measurement Governance Academic Information System at the Naval Academy using FRAMEWORK COBIT 5 includes the following stages:

The followings are explanation of the research methodology stages of COBIT 5:

a. Research Objects

The study was conducted on SIAKAD users and Sub directorate of information and data processing(Subditinfolahta)staffs of Naval Academy.

b. Library Studies

It is expected to be able to explore all the information related to the research, both the problems studied and the object of the research objectives.

c. Selection of COBIT Domains 5

Selection is done based on the selection of the functioneddomain.

d. Data Collection

The process of collecting data in the form of observation, questionnaires, and interviews. Observation is done by observing directly the activities undertaken. Observations were made at the Naval Academy Subditinfolahta. Questionnaires were conducted with a maturity level questionnaire. The selected respondents were 10 Subditinfolahta staffsat the Naval Academy. Interview conducted to obtain information in the form of question and answer with the respondent as supporting the result of questionnaire. Interviews were used to obtain more complete information on the issues studied that were not in the questionnaire.

e. Data Processing

Data related to the study were collected, with maturity level analysis adopted by COBIT 5 from ISACA. This step is done to

facilitate the translation and interpret the required evidence.

f. Data Analysis

The process of data analysis is done after data processing, data analysis is done analysis of current maturity level (as is), expected maturity level (to be), and gap analysis (gap analysis).

g. Verify Results

The result of the capability analysis is then done in the form of verification process against the facts.

h. Repair Strategy

After the verification process, then process improvement strategy based on data.

i. Recommendations

After doing the improvement strategy process then made recommendations based on the related domain of COBIT 5.

4. RESULT AND DISCUSSION

4.1. Results of Assessment of Maturity Rates of Each Domain

Based on the result of questionnaire of Performance Measurement of Academic Information System at Naval Academy using FRAMEWORK COBIT 5 with 10 respondents from Navy Academic Data and Management Information Division, the result of maturity assessment of each domain as follows:

Table. 2 Maturity Level Calculation Results

NO	DOMAIN	PROCES		Maturity Level
1	APO	APO01	Manage the IT Management Framework	3,20
2		APO02	Manage Strategy	3,37
3		APO04	Manage Inovation	3,13
4		APO07	Manage Human Relation	3,17
5		APO012	Manage Risk	3,45
6		APO13	Manage Security	3,26
7	DSS	DSS01	Manage Operation	3,46
8		DSS03	Manage Problems	3,49
9		DSS04	Manage Continuity	3,22
		The Average Of Maturity Level		3,31

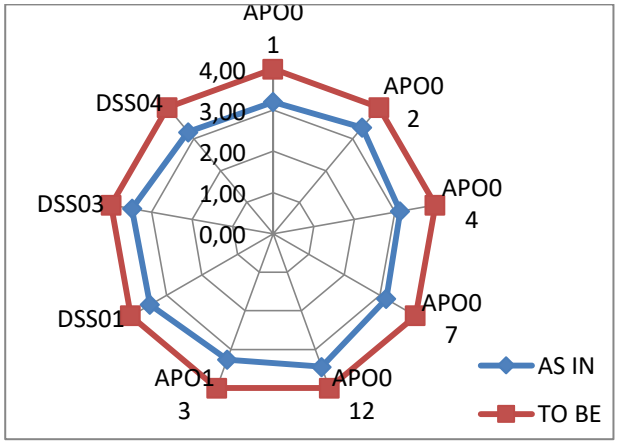

Fig. 3 Graph of Maturity Level Calculation

Based on the results of the Maturity Level calculation, questionnaires and recap of each domain questionnaire, the level of Maturity Level on measurement of performance of academic information system governance in the Indonesian Naval Academy is currently level 3 with the maturity of 3.31 (Defined Process).

In the table and graphic image, the current maturity level shows that the APO04 (Manage Inovation) domain has the lowest current maturity level of 3.13 and is at level 3 of "Defined Process ", Which means managing innovation has been standardized. For the highest current maturity level in the domain DSS03 (Manage Problems) that has a value of 3.49, and is at level 3 is "Defined Process", which means have to identify the problem-solving data access, assets IT has been managed and has been measurable.

4.2. Preparation of Recommendations

From the results of the Measurement of Performance of the Academic Information System governance at the Naval Academy, the following recommendations are given:

Table. 3 APO01 Manage domain The IT Management FrameworkRecommendations

APO01 MANAGE THE IT MANAGEMENT FRAMEWORK			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
Academic information system has no regular maintenance.	3,20	4	To get to level 4 Academic Information System needs a periodic maintenance so that can be monitored and minimize errors that may occur such as damage to the server, and backup data on a regular basis.

Table. 4 domain APO02 Manage StrategyRecommendations

APO02 MANAGE STRATEGY			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
Academic Information System is still running separately from the existing information system in the Naval Academy and has not been widely used by faculty, academic staff and cadets	3,37	4	The need for integration of information systems that have been running in the Naval Academy, and also need to be socialized with the guidebook in using academic information system.

Table. 5 APO04 Manage Innovation domainRecommendations

APO04 MANAGE INOVATION			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
The features contained in the Academic Information System are difficult to use	3,13	4	It needs innovation and evaluation of the features contained in the Academic Information System.

Table. 6 domain APO07 Manage Human RelationsRecommendations

APO07 MANAGE HUMAN RELATION			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
Unmet IT staff needs, and no performance evaluation.	3,17	4	To get to level 4, IT staff needs to be fulfilled and job sharing, as well as performance evaluation to IT staff.

Table. 7 APO12 Manage Risk domainRecommendations

APO12 MANAGE RISK			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
For the handling of incidents occurring against current IT use is not done routinely, but is done at any time in case of a complaint from the user.	3,45	4	IT staff should be effective and periodic responses to inputs and issues requiring design and either from the help desk or incident management process. And for handling incidents that occur against the use of IT should be routine.

Table. 8 APO13 Domain Manage Security recommendations

APO13 MANAGE SECURITY			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
Already using anti-virus but rarely updated, and for user passwords are also never changed.	3,26	4	Installation of antivirus should always be updated in order to maintain system security. To avoid the use of the program by unauthorized users, users' password should always be changed at least once a month

Table. 9 domain DSS03 Manage Operations Recommendations

DSS01 MANAGE OPERATIONS			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
Maintenance or implementation of operational procedures and activities SIAKAD does not have a measurement report at any time.	3,46	4	To go to level 4, a report on the outcome of the procedure is made every month and there is an appropriate allocation of responsibilities and resources.

Table. 10 Domain DSS03 Manage Problem Recommendations

DSS03 MANAGE PROBLEM			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
The problem identification is directly done by the technician and there is no specific support group for identification and root cause analysis.	3,49	4	Create support group of experts to identify and analyze the root of the problem so that problem identification can be done quickly and precisely so that the splitting process can be done immediately.

Table. 10 Domain DSS04 Manage Continuity Recommendations

DSS04 MANAGE CONTINUITY			
CURRENT CONDITION	**VALUE**	**TARGET**	**RECOMMENDATION**
There is already a continuity plan but has no documentof what to do.	3,22	4	Createdocumentation and then monitor and analyze what things should be done.

5. CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

Based on the research conducted on Measurement of Performance of Academic Information System Governance in Indonesian Naval Academy from the result of IT Maturity Level, the conclusion of this research are:

a. From the results of the resulting maturity level is known that the level of maturity (as-is) for the APO (Align, Plan, and Organize) averaged average level (3 - Defined Process) means the process is at a fixed stage, has been in the implementation phase of standardized processes, meaning that there is a standard IT process that applies everywhere in the scope of the organization means that the Academic Information system in terms of strategic order is at a stable stage. While the Domain DSS (Deliver, Service, Support), the average level of maturity reach (Defined Process) which means also at a fixed stage means the agency has been running the task of the IT process and has achieved its goals in well managed through the stages of planning, evaluation and better tailored adjustments.

b. Every subdomain process in both domains is given improvement recommendation which later can affect the current maturity level to go to the level of improvement and to the maturity to be achieved below to improve the process of the

performance of the institution towards the better.

c. Recommendation is based on COBIT level 5 and also refers to the function of Governance that ensures that IT process owned by agency really gives added value for organization, and Management.

5.2. Suggestions

The suggestions that can be submitted after this research is as follows:

a. Current condition of Information Technology and Information Systems in AAL is no alignment between one existing information system with other information systems, so it is expected that there is an alignment of information systems with information technology.

b. Development of Human Resources Competence SI / IT in the form of improving the quality of competence through education planning and training IT human resources both internally and externally of AAL organizations.

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THANK YOU