TUGAS AKHIR – MO141326

ANALISA PENGAMBILAN KEPUTUSAN DALAM PEMILIHAN ALTERNATIF DRE (*DISMANTLEMENT*, *REPAIR AND ENGINEERING*) PADA PEMBONGKARAN ANJUNGAN LEPAS PANTAI

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FINAL PROJECT – MO141326

DECISION MAKING ANALYSIS IN ALTERNATIVE SELECTION OF DISMANTLEMENT, REPAIR AND ENGINEERING (DRE) ON OFFSHORE PLATFORM DECOMMISSIONING

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TUGAS AKHIR

Diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Teknik pada Program Studi S-1 Departemen Teknik Kelautan, Fakultas Teknologi Kelautan, Institut Teknologi Sepuluh Nopember

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SURABAYA, JULI 2017

Tugas Akhir ini dipersembahkan untuk

keluarga tercinta.

"Papa, Mama, Ipan, Rafa

Abang lulus !!!"

"Karena sesungguhnya sesudah kesulitan itu ada kemudahan. Sesungguhnya sesudah kesulitan itu ada kemudahan"

(Q.S. Al-Insyirah : 5-6)

Analisa Pengambilan Keputusan dalam Pemilihan Alternatif DRE (Dismantlement, Repair and Engineering) pada Pembongkaran Anjungan Lepas Pantai

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ABSTRAK

Struktur anjungan minyak dan gas lepas pantai memiliki masa operasi dalam setiap desainnya. Saat masa operasi ini berakhir, maka setiap struktur anjungan akan memasuki fase pascaproduksi, yakni pembongkaran (decommissioning) instalasi struktur anjungan. Terdapat beberapa alternatif DRE (Dismantlement, Repair dan Engineering) pada pembongkaran anjungan minyak dan gas lepas pantai diantaranya *total removal, partial removal* dan *leave in place*. Dalam memilih alternatif DRE pada pembongkaran perlu diperhatikan kriteria yang harus dipertimbangkan sebelum melaksanakan pembongkaran anjungan antara lain lingkungan, biaya, dan alih fungsi serta keamanan dalam pembongkaran anjungan lepas pantai. Oleh karena itu, penting dilakukan analisa pengambilan keputusan yang akan dijadikan sebagai pertimbangan sebelum melaksanakan pembongkaran anjungan. Pada tugas akhir ini dilakukan analisa pengambilan keputusan dengan teknik kuantitatif dan kualitatif untuk pembongkaran anjungan minyak dan gas lepas pantai dengan metode AHP dan SAW. Dari hasil analisis didapatkan keputusan alternatif DRE pada pombongkaran *fixed platform* dengan metode AHP dan SAW adalah total removal dengan masing-masing bobot adalah 0,60 dan 0,93.

Kata Kunci : ***Decommissioning, Total Removal, Partial Removal, Leave in Place, Analytical Hierarchy Process, Simple Additive Weighting***

Decision Making Analysis in Alternative Selection of Dismantlement, Repair and Engineering (DRE) on Offshore Platform Decommissioning

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ABSTRACT

The structure of offshore platform has a lifetime of operation in each of its designs. When this operation end, the structure of the platform will enter the post-production phase, that is decommissioning the installation of the platform structure. There are several dismantlement, repair and engineering (DRE) alternative on decommissioning of offshore platfrom including total removal, partial removal and leave in place. In choosing DRE alternative on decommissioning, it is necessary to consider the criteria that must be considered before carrying out the decommissioning of the platform, such as environment, cost, conversion and sefety. Therefore, it is important to make decision analysis that will be taken into consideration before undertaking the decommissioning of offshore platform. In this bachelor thesis, a decision making analysis with quantitative and qualitative techniques is used to select DRE alternatives on offshore platform decommissioning with AHP and SAW methods. From the analysis result obtained the DRE alternative decision on fixed platform decommissioning with AHP and SAW method is total removal with each weight is 0.60 and 0.93.

Keywords : Decommissioning, Total Removal, Partial Removal, Leave in Place, Analytical Hierarchy Process, Simple Additive Weighting

FOREWORD

Assalammualaikum Wr.W

This bachelor thesis entitled "Decision Making Analysis in Alternative Selection of Dismantlement, Repair and Engineering (DRE) on Offshore Platform Decommissioning" prepared to meet the requirements in completing the undergraduate program (S-1) at Ocean Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember, Surabaya. This bachelor thesis discusses the comparative analysis of decision making on the selection of DRE alternatives on offshore platform decommissioning by comparing the AHP and SAW methods.

The author realizes that this bachelor thesis is far from being perfect. Therefore, any constructive criticism and suggestion will be gladly accepted. Finally, author hope that this bachelor thesis will be beneficial for the readers.

Wassalammualaikum Wr. Wb.

Surabaya, July 2017

Tommy Saputra

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Alhamdulilah, praise be to Allah SWT the Almighty and the most Merciful. All praises are to Allah SWT for all the blesses so that the author can accomplish this bachelor thesis to attain the degree of Sarjana Teknik in Ocean Engineering, ITS. In addition, may peace and salutation be given to Prophet Muhammad SAW who has taken all human being from the darkness to the lightness.

The author would like to express his genuine gratitudes to:

1. I would like to dedicate this work to my beloved parents, Papa Edi Suhaimi and Mama Novita Yuhendra, my brothers Irfan and Rafa, who always believed in me, always were there and will always be whenever I do need them. I owe you everything.

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Hopefully, may Allah SWT always bless those mentioned above and all their sacrifice becomes their merciful deeds to help them gain a success in their future life.

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CHAPTER I
INTRODUCTION

1.1 Background

Oil and gas are human needs that have been exploited for a long time in order to meet the energy source for life activities. Initially oil and gas exploration and exploitation only took place on land. Along with the development of knowledge and technology, the business of oil and gas utilization has entered deep sea waters. To utilize the hydrocarbons contained in the seafloor is required an oil and gas platform which is a structure with technology capable of exploration and exploitation activities with all conditions that exist in offshore. Surely this structure will require high technology and expensive investment cost with high risk and various technical difficulties. However, as oil and gas prices increase, the use of this technology is more economical to be utilized.

Oil and gas platform technology has long been used in the energy industry. This technology was first used in 1891 in Ohio, USA. Indonesia has begun using the first offshore platform technology operated by PN PERTAMINA-IIAPCO in October 1970 which was inaugurated by President Soeharto at Cinta's production field, north coast of Java. Since that time oil and gas platforms are used in various regions of Indonesia including Natuna, East Kalimantan and North East Sumatra also Java Sea. Currently the platforms have reached the end of the service, so in 2017 will soon begin the decommissoning of the platform.

Along with the end of service life of the oil and gas platforms, the platforms will enter the decommissioning phase. Usually structure of the oil and gas platform has service life between 20-25 years. Post operative structures that are no longer used if left alone will cause some problems. This issues include the safety, environment and the marine biota around the platforms. Based on SKK Migas data there are 613 platforms spread across the territory of Indonesia. There are 335 platforms over the age of 20, 151 platforms are 16-20 years, 120 platforms 11-15 years and 7 platforms that are less than 10 years. As many as 76.51% of the platforms have 4 leg and 73.6% are in depths of 50-100 m. While the number of platforms that ready to be dismantled amounted to 13 platforms. The post production platforms have caused some safety issues in Indonesia. The Marine Security Coordinating Board (Bakorkamla) notes that until 2013 there have been 12 ship collision incidents with platforms that are no longer in operation.

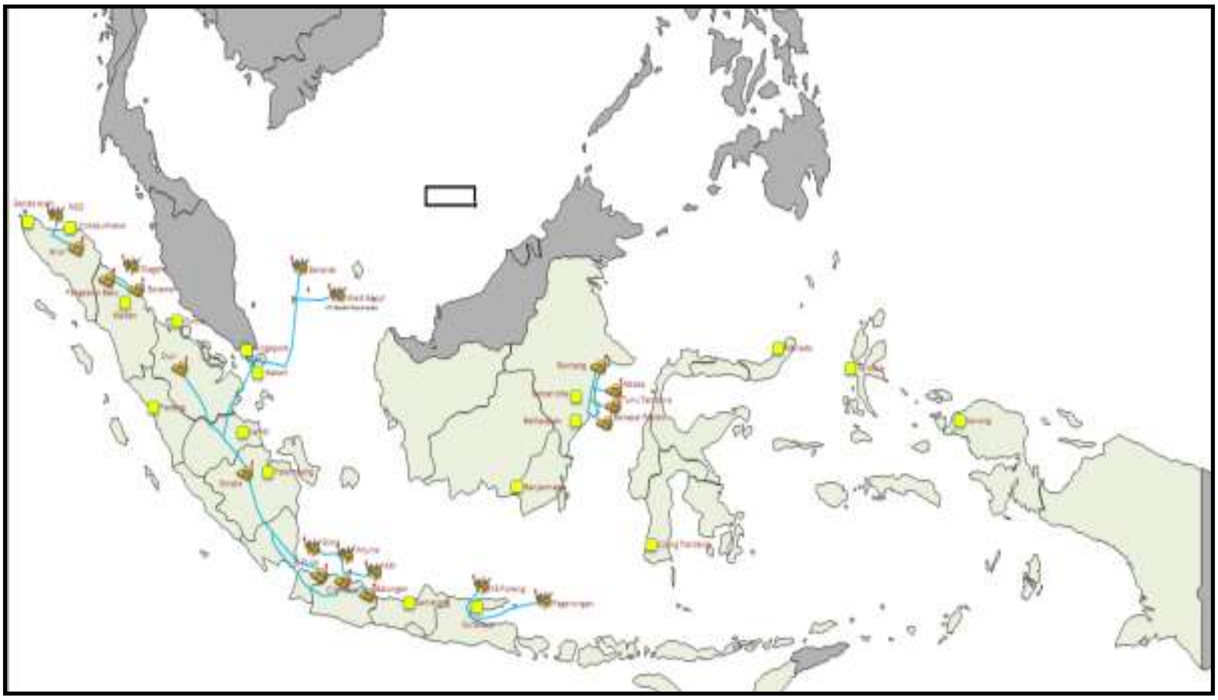

Figure 1.1 Offshore Platform Deployment Map in Indonesia
(Source : SKK Migas, 2016)

In many countries, the issue of dismantling offshore platforms cause problems between communities, environmental activists, as well as the companies that operate the rig. To overcome this, Indonesia has had regulations regulating technical guidelines for the dismantling of offshore oil and gas platforms that is minister regulation of ESDM No. 01/2011.

Decision making analysis in alternative selection of fixed platform's dismantlement, repair and engineering (DRE) used as a tool for decision makers in the selection process of DRE's alternative quickly and appropriately, and able to provide more objective recommendations on DRE of platforms.

There are several alternative of DRE's offshore platform (Henrion et al., 2014) that are complete removal, partial removal and leave in place. In this final project, authors use the method Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) to choose alternative of DRE's platform. The AHP method can be used to selectively rank the available options effectively on complex issues by utilizing information from experts opinion that combine the power of human assumptions and logic. Currently AHP has been applied in various areas of management, marketing, finance and analysis of planning and engineering. The SAW method is often known as the weighted sum method. This method is the most famous and widely used method in the face of Multiple Attribute Decision Making (MADM) situation. MADM is a method to obtain an optimal alternative that consists of several criteria in determining decision-making.

The structure that used as the object of this bachelor thesis is Attaka H platform which is located off the coast of Makassar Strait. The platform owned by Chevron Indonesia Company was installed in October 1972 with depth of 198 ft.

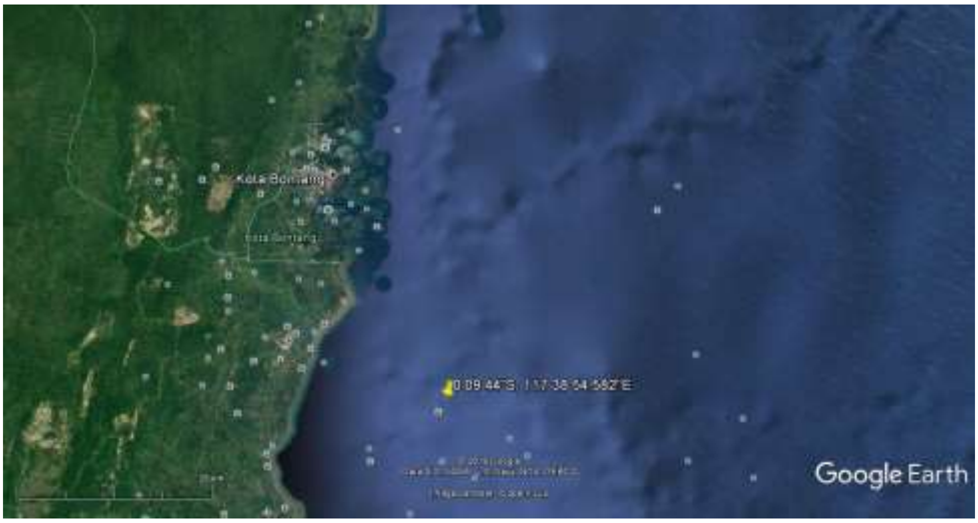

Figure 1.2 Location of Attaka Platform

(Source : Google Earth Pro)

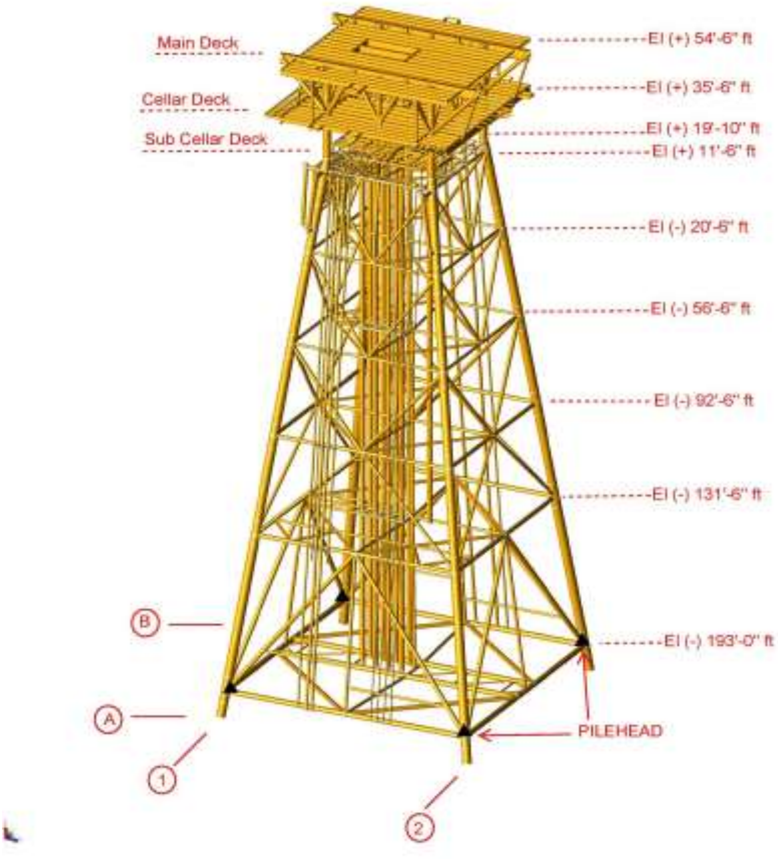

Figure 1.3 Structure Modeling by SACS of Attaka Platform

(Source : PT. Singgar Mulia's Report)

1.2 Problem Formulation

The problems to be studied in this bachelor thesis are:

1. What is the result of the decision in the alternative selection of dismantlement, repair, and engineering (DRE) on decommissioning of fixed platform with Analitycal Hierarchy Process (AHP) method ?
2. What is the result of the decision in the alternative selection of dismantlement, repair, and engineering (DRE) on decommissioning of fixed platform with Simple Additive Weighting (SAW) method ?

1.3 Objectives

Objectives to be achieved by the author are as follows:

1. Determine the decision result in dismantlement, repair, and engineering (DRE) alternative selection on decommissioning of fixed platform with Analitycal Hierarchy Process (AHP) method
2. Determine the decision result in dismantlement, repair, and engineering (DRE) alternative selection on decommissioning of fixed platform with Simple Additive Weighting (SAW) method

1.4 Benefits

The expected benefits of this bachelor thesis are to be used as a consideration for the analysis of decommissioning for relevant stakeholders such as the Ministry of Energy and Mineral Resources, Ministry of Marine Affairs and Fisheries, PT Chevron Indonesia and PT Pertamina as state-owned energy company as well or other parties. Decision making analysis of quantitative and qualitative in this bachelor thesis to determine the decision in determining the DRE of offshore fixed platform installation.

1.5 Assumptions

To clarify the problem of this thesis, it is necessary to have the scope of testing or assumptions as follows:

a. This bachelor thesis only used AHP and SAW method in analyzing decision making.
b. Decommissioning project is assumed to be done without a hitch.
c. Alternative decision of decommissioning only considered from predetermined criteria.
d. Decision making based on oil and gas expert's perspective from operators.
e. The object of study was conducted on Attaka platform owned PT Chevron Indonesia by considering provisions set forth in Permen ESDM No. 11/2011, PP No. 35/2004 article 78 paragraph 1 and PSC (Production Sharing Contract) agreement 1976-1988,

Permen ESDM No. 35/2006, article 17 and 18, and PM Perhubungan No. 129/2016 article 70 also IMO Guidelines 1989 (Removal of Offshore Installations and Structures on the Continental Shelf and in the EEZ).

1.6 Systematics of Writing

Systematics of writing used in this bachelor thesis report consists of five chapters are as follows:

CHAPTER I PREFACE. Explaining several things about the research in the bachelor thesis, which is underlying problem of research on decision analysis of decommissioning platforms so it is important to do, the formulation of the problems that become the problems and needs to be answered, the purpose used to answer the problems raised, benefits gained from the research of bachelor thesis, and scope of problems, also an explanation of the reporting system used in the bachelor thesis.

CHAPTER II LITERATURE REVIEW AND BASIC THEORY. Explaining what is the references of this bachelor thesis and the basics of theory, equations, and code used in this thesis. The theories listed in this chapter include: a general description of the structure of platform, the decommissioning of platforms, the techniques and methods of quantitative and qualitative decision making.

CHAPTER III RESEARCH METHODOLOGY. Explaining the sequence of analysis performed to solve the problem in this bachelor thesis.

CHAPTER IV RESULT AND DISCUSSION. Describing the application of decision making methods that have been done in this thesis and discusses the results that have been obtained.

CHAPTER V CONCLUSION. Explaining the conclusions that have been obtained from the analysis on this thesis and the author's suggestions as a consideration in the purposes of further research.

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CHAPTER II

LITERATURE REVIEW AND BASIC THEORY

2.1 Literature Review

The decision making technique using the Fuzzy Multiple Attribute Decision Making (FMADM) method is a decision selection method by determining the most optimal alternative choice of selected alternatives with predetermined criteria. Simple Additive Weighting (SAW) is one of the commonly used methods in the case of FMADM. This method of research ever conducted by Heri Sulistiyo on "Sistem Pendukung Keputusan Untuk Menentukan Penerima Beasiswa di SMAN 6 Pandeglang". Decision making technique with FMADM method is a quantitative and qualitative decision making technique that can be applied to complex problems in daily life.

Fuzzy technique can be used in many problems, both in industry and in the formal field. The research of Muhammad Eka Putra Galus has done research on "Analisa Penggunaan Metode AHP dan Fuzzy AHP pada Perankingan Siswa" with case study of SMK N 1 Batam.

Reason used Fuzzy (Kusumadewi, 2010 on Nabila Khalida Sukandar, 2014) are:

1. Fuzzy logic concept is easy to understand because Fuzzy logic uses the basic set theory, then the mathematical concepts based on Fuzzy reasoning are fairly easy to understand.
2. Fuzzy logic is very flexible, able to adapt to the changes and uncertainties that accompanied the problem.
3. Fuzzy logic has a tolerance to incorrect data. If given a group of fairly homogeneous data, and then there are some "exclusive" data, then Fuzzy logic has the ability to handle such exclusive data.
4. Fuzzy logic is capable of modeling very complex nonlinear functions.
5. Fuzzy logic can build and apply the experiences of experts directly without having to go through the training process. In this case, often known as Fuzzy Expert System which becomes the most important part.
6. Fuzzy logic can work in conjunction with conventional control techniques. This generally occurs in the field of mechanical engineering as well as electrical engineering.
7. Fuzzy logic is based on natural language. Fuzzy logic uses daily language so it is easy to understand.

The analysis using AHP method was done in the field of engineering and maritime management ever done by K.L Na et al in a journal entitled “An Expert Knowledge Based Decommissioning Alternative Selection System for Fixed Oil and Gas Assets in The South China Sea”.

Analysis of decision making in choosing the method of platform decommissioning has been done by Ocean Engineering student Rizqi August who researched “Analisis Pembongkaran Platform Pertamina ED-WELL Tripod Berbasis Biaya, Waktu dan *Trade-Off* Analisis”. The study used trade-off analysis technique to determine decommissioning method to be selected with cost and time criteria so that the best decision was made using partial removal method.

2.2 Basic Theory

2.2.1 Offshore Structure

An offshore platform is an offshore constructed structure to support the exploration or exploitation of oil and gas. Usually the offshore platform has a drilling rig that serves to analyze the reservoir's geological properties as well as to create a hole that allows the removal of petroleum or natural gas reserves from the reservoir. This offshore structure does not have direct access to land, can be fixed in the seafloor and required to survive in all weather conditions.

Some concepts of offshore structures are (Ainnillah, 2017):

a. Fixed Offshore Structure

   In fixed construction, vertical, horizontal and moment loads can be transformed by the foundation construction to the seafloor. This type is the oldest and most built. One disadvantage is that production and installation costs of steel structures will rise exponentially to depth. An example is the jack up platform.

b. Floating Offshore Structure

   This type has a character moves to follow the wave motion. Often this platform is connected to the seabed using mechanical equipment mooring line or dynamic positioning. For this type of platform, the most important is the mobility and its ability to anticipate the movement due to waves and currents.

c. Compliant Structure

   This type of platform aims to meet the requirements of special functions such as economic factors and technical factors. The general planning principle of the compliant structure is to obtain an optimal solution to the requirements of those functions. An example of this type is Tension Leg Platform.

2.2.2. Decision Making Method

Any decisions taken in a defined environment contain two elements, namely act and outcome. Actions are often called variable (free) decisions, while the results are called variable (not free) consequences. The decision maker chooses the action so that the result is the best. If the alternatives of action are available, then it becomes a matter of selection problem between those choices of actions that produce the best results (Rosyid, 2009).

The decision making process according to Simon's model [2] can be divided into four phases are (Dwi Citra Hartini et al, 2015):

a. Intelligence Phase

   Decision makers perform the identification process on all scope of issues to be solved. At this stage the decision maker must understand the reality and define the problem by testing the data obtained.

b. Design Phase

   Modeled a defined problem by deciphering a decision element first, an alternative decision variable, evaluation criteria selected. The model is then validated based on the criteria set for evaluating the alternative decision to be selected. Determination of solutions is the process of designing and developing alternative decisions, determining the number of actions taken, and assigning the weight given to each alternative.

c. Choice Phase

   The stage of selection of the solution produced by the model. When the solution is acceptable in this last phase, then proceed with the implementation of decision solutions in real world.

d. Implementation of Solution

   Essentially the implementation of a proposed solution to a problem is the initiation of new things or the introduction of change that must be managed. User expectations should be managed as part of change management.

2.2.2.1. Simple Additive Weighting (SAW) Method

Fuzzy Multiple Attribute Decision Making (FMADM) is a method used to find the optimal alternative of a number of alternatives with certain criteria. Heri Sulistiyo states that the core of FMADM is to determine the weight for each attribute, then proceed with a ranking process that will select the alternatives already given. Basically, there are 3 approaches to finding attribute weights, which are subjective, objective and subjective approaches between subjective and objective. In solving the problem of FMADM, one of method that can be used is Simple Additive Weighting (SAW) method. This method is commonly known as the weighted summing method.

In this research, SAW method is chosen because this method determines the weight of each attribute, then done by ranking to find the best DRE alternative on decommissioning from several alternatives, so it is expected that the assessment will be more accurate because it is based on the weight of the criteria that have been determined.

The basic concept of the SAW method is to find a weighted sum of performance ratings on each alternative on all attributes. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings.

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\, x_{ij}} & if\ j\ benefit\ attribute \\ \dfrac{\underset{i}{Min}\, x_{ij}}{x_{ij}} & if\ j\ cost\ attribute \end{cases} \qquad (2.1)$$

where:

r_{ij}	= weighted normalized performance rating
x_{ij}	= attribute weight of each criteria
$\underset{i}{Max}\, x_{ij}$	= the biggest weight of each criteria
$\underset{i}{Min}\, x_{ij}$	= the smallest weight of each criteria
benefit	= if the biggest weights are the best
cost	= if the smallest weights are the best

r_{ij} is the normalized performance rating of the Ai alternatives in the C_j; i=1,2...,m attribute and j=1,2,...,n. Weight preference for each alternative (A_i) given by:

$$Ai = \sum_{j=1}^{n} w_j r_{ij} \qquad (2.2)$$

where:

Ai = the rank for each alternative

Wj = the weight of each criteria

r_{ij} = the weighted normalized performance rating

The largest weight of Vi indicates that Ai's alternatives are preferred.

2.2.2.2. Analitycal Hierarchy Process (AHP) Method

AHP is a method developed by mathematicians from the University of Pittsburgh, Prof. Thomas L. Saaty. AHP is a method for making alternative decision sequences and choosing the best alternative at the time of decision making with several criteria in decision making. The most important thing of this method is the functional hierarchy with the main input of human perception. This decision making method is effective to simplify and accelerate complex decision-making processes by solving the problem into sections, organizing sections or variables in a hierarchical order, assigning numerical weights to subjective considerations of the importance of each variable and synthesizing these considerations for defining variables Which has the highest priority and acts to influence the outcome of the situation.

2.2.2.2.1. Basic Principles of AHP

In solving the problem with AHP there are several principles that must be understood (Sudaryono, 2010), including:

1 Create a hierarchy

Complex systems can be understood by breaking them into supporting elements, arranging elements hierarchically and combining them.

2 Weighing criteria and alternative

Criteria and alternative are done by pairwise comparisons. According to Saaty (1988), for variety of issues of scale 1 to 9 is the best scale for expressing opinions. The weight and definition of qualitative opinion from the comparison scale of Saaty can be measured by analytical tables such as table 2.1.

Table 2.1 Weighted Scale of Pairwise Comparison

Intensity of Interest	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very strong Imporatnce
9	Extreme Importance
2,4,6,8	Weight between two adjacent weights

This research uses validity test by conducting expert judgment in the form of questionnaire. The expert in this case is someone who is an expert in a certain field / someone who knows about the issues to be studied.

3 Set priorities

For each criteria and alternative, a pairwise comparison is required. The weight of the relative comparison of all criteria can be adjusted to the predetermined judgment to generate weight and priority. Weights and priorities are calculated by manipulating the matrix or by solving the mathematical equations

4 Logical Consistency

Consistency has two meanings. First, similar objects can be grouped according to uniformity and relevance. Second, it concerns the degree of relationship between objects based on certain criteria.

Basically the procedure in the AHP method (Sudaryono, 2010), includes:

1. Identify the problem and determine the desired solution, then compile the hierarchy of problems encountered
2. Determining the priority of the elements

The first step in determining the priority of the elements is to make a pair comparison, ie comparing the elements in pairs according to given criteria. A pairwise comparison matrix is filled with numbers to represent the relative importance of an element against the other elements.

3. Measuring consistency

In making decisions, it is important to know how well consistency is done because we do not want decisions based on consideration with low consistency. Things done in this step:

- Multiply each weight in the first column with the relative priority of the first element, the weight in the second column with the relative priority of the second element and so on.
- Add each line
- The result of the sum of rows divided by the relevant relative priority element
- Sum it up with the number of elements that exist, the result is called χ max

4. Calculating the consistency index (CI) with the formula:

$$CI = \frac{\lambda\ Max - n}{n} \qquad (2.3)$$

where,

n = the number of elements

5. Calculating the consistency ratio (CR) with the formula:

$$CR = \frac{CI}{RI} \qquad (2.4)$$

6. Check the consistency of the hierarchy. If the weight is more than 10%, then the weighting of judgment data must be corrected. However, if the consistency ratio is less

than or equal to 10%, then the calculation result can be stated correctly. List of random consistency indexes such as table 2.2.

Table 2.2 List of Random Consistency Index

Matrix Size	Random Index (RI)
1,2	0
3	0,58
4	0,9
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49
11	1,51
12	1,48
13	1,56
14	1,56
15	1,59

7. Priority setting in each hierarchy
8. Priority synthesis
9. Decision making

2.2.3. Decommissioning of Offshore Platform

Decommissioning is a process whereby the oil and gas operators and offshore pipelines that planned, obtained approval for and carry out the dismantling, disposal or reuse of such installations when they are no longer required for the present purpose (Offshore Technology Report, BOMEL Ltd, 2001).

In determining the DRE’s alternative of offshore platform decommissioning, it is necessary to consider several factors, namely the age of the structure of the platform, the location and depth of the platform, the type of platform, the environmental conditions, the strength of the soil and the policies associated with dismantling the platform.

2.2.3.1. Decommissioning Processes and Steps of Offshore Platform

In carrying out the decommissioning of offshore platforms, there are several processes to be implemented, including:

a. Project management
b. Engineering and planning
c. Fulfillment of licenses and rules
d. Preparation of platform and blockage wells
e. Rules of conductor
f. Mobilization and demobilization of barge
g. Release of platform
h. Pipeline dan cable dismantling
i. Material disposal and site cleaning

The general process of decommissioning is as follows (Murdjito, 2015):

1. Installation of lifting aids and ready to cut
2. 50 % pre tension on slings and cutting
3. Lifting and moving
4. Laying down the top side to designated on barge
5. Rigging the lifting aids on the jacket
6. Cutting the jacket & conductor at sea bed
7. Lifting the jacket
8. Laying down the jacket to designated on barge
9. Split the jacket (2 part)
10. Sea fastening
11. Sea transportation

Figure 2.1 Decommissioning Process

Figure 2.2 Decommissioning Process

2.2.3.2. Decommissioning Alternatives of Offshore Platform

Generally there are 3 DRE alternatives on decommissioning of offshore platforms. Alternative selection is taken after various considerations and impacts on the environment caused by the selection of alternatives used that can be applied on decommissioning of a platform (August W.R, 2017), namely:

a. Complete Removal Decommissioning

This alternative is an alternative to the discharge of a whole platform, all components of the platform being dismantled and transported using Heavy Lift Vessel (HLV) and barge to the land. In this process platform is cut into 2 parts, top side and jacket. The top side can be used again while the jacket will be cut into scrap. In the work done by cutting the connection between jacket and topside, then jacket will cut 5 ft from above seabed using ROV.

b. Partial Removal Decommissioning

This alternative is an alternative to dismantling the platform by removing a portion of the platform and leaving the rest where the platform operates. This method is done by separating the topside and jacket, topside will be taken to the mainland while the jacket will be left in place. In partial removal, the abandoned jacket has several options, ie jackets cut according to regulation and used as coral reef habitats, reused as jackets for renewable energy generation (wind, current and wave).

c. Leave In Place Decommissioning

This alternative is also called abandonment that is an alternative to demolition where the platform is left in place and abandoned after the previous release of riser procedure. This method is commonly used for platforms located at a depth of more than 400 ft and is not on the shipping line.

2.2.3.3. Policies of Offshore Platform Decommissioning

2.2.3.3.1. National Policies

- Ministry of Energy and Mineral Resources regulation No. 11/2011 (Technical Guidelines for Offshore Oil and Gas Installation)

  Article 1 Paragraph 3

  Decommissioning is the work of partial or complete cutting of the installation and removal / transport of the decommissioning results to a designated location.

  Article 2

  Decommissioning of offshore installation is done in case the offshore installation is no longer used or will be reused for oil and gas exploration and / or exploitation activities elsewhere.

  Article 3

  The regulation of technical guidelines for the dismantling of offshore installations aims to ensure the safety of oil and gas and the implementation of environmental management, to maintain the condition of offshore installations as state property and shipping safety, and to optimize the use of state property.

  Article 5

  Implementation of offshore installation disposal as referred to in Article 4 shall be conducted by the Contractor in accordance with the laws and regulations.

  Article 12

  (1) The obligations of contractors, among others:
  a) cut the conductors for 5 (five) meters below the mud line (mud line) or parallel to the seabed in terms of the distance between the sludge (mud line) and the seabed is less than five (5) meters;
  b) cut the conductor cut segments along a maximum of twelve (12) meters;
  c) dismantle the installation on the surface (top side facility) by cutting the welded joints between piles with deck feet;
  d) cut the pile and the holder for 5 (five) meters below the mud line (mud line) or parallel to the seabed in terms of the distance between the sludge (mud line) and the seabed is less than five (5) meters;
  e) bypass the conduit above the riser bend point and at a distance of three (3) meters from the base of the foot installation;
  f) clog the abandoned pipelines and buried deep ends one (1) meter or protected by a safety material;
  g) cut the pipeline that will be moved, into small sections along the 9 (nine) meters up to twelve (12) meters.
- Government regulation No. 35/2004 article 78 paragraph 1 and PSC (Production Sharing Contract) agreement 1976-1988.

  The existence of the post-operation platform becomes the responsibility of the government to dismantle or use it for other functions.

- Ministry of Transportation regulation No. 129/2016

  Article 70

  (1) Building permits and / or installations in the waters shall be granted to the owner in accordance with the period of utilization
  (2) Building permits and / or installations in waters that have expired the term of utilization and will be reused, may be renewed upon approval of the Director General
- Ministry of Energy and Mineral Resources regulation No. 35/2006, article 17 and 18

  Minister of Energy and Mineral Resources may propose the removal of operating goods (including offshore oil platforms) to be utilized, transferred or destroyed with the approval of the Minister of Finance. In order to utilize oil and gas platforms, other functions must be carried out in full research, whether related to technical issues, standard rules, environments, and applicable legislation.

2.2.3.3.2. International Policies

- IMO Guidelines 1989 (Removal of Offshore Installations and Structures on the Continental Shelf and in the EEZ)

  The main points in the IMO Guidelines are:

  a) The general principle is that all disused installation "are required to be removed";
  b) Installation in water depths of less than 75 metres, or 100 metres after 1 January 1998, and weighing less than 4000 tonnes should be removed unless:
     - not technically feasible
     - involving extreme cost; or
     - constituting unacceptable risk to personnel or the marine environment;
  c) An unobstructed water column of 55 metres must be left in the event of a partial removal;
  d) All installation after 1 January 1998 are to be designed and built so that their entire removal is feasible.

  Existing installation in water depths of greater than 75 metres (or 100 metres if installed after 1 January 1998) or weighing more than 4000 tonnes can be wholly or partially left in place, provided it is shown that they do not cause unjustifiable interference with other users of sea. However, there is no exception to complete removal where the installation os structure is located in approaches to ports, or in straits used for international navigation, in customary deep draught lanes and IMO adopted routing systems.

2.2.3.4. Utilization Alternatives of Offshore Platform Decommissioning

Utilization of offshore oil and gas platforms is possible with an accurate feasibility study and consideration of economic, structural and environmental factors. Currently, in some countries, several alternatives have been made to reuse the post production offshore oil and gas platform structure. Utilization of offshore oil platforms include:

a. Artificial Coral & Aquaculture

The program of utilization of post-production offshore oil and gas platforms for marine habitat is also known as "rig to reef". There are several references to the implementation of the rig to reef program in Indonesia (Murdjito, 2015), including:

- United States of America

  This program has been done for a long time in America, especially in the Gulf of Mexico and Louisiana. This oil production platform is also called the largest complex of artificial reefs in the world. Since 2000, 151 platforms have been converted to permanent coral reefs. There are 90 platforms transported to the new location and 61 platform left in place.

- Brunei

  Brunei has had a rig to reef program policy since 1998. The Shell Brunei Petroleum offshore operator has transported a number of old platforms and jackets to two areas designed for artificial reef locations far from the shipping line.

b. The location of sports and water tours

Utilization of post production oil and gas platform structure for reuse has been successfully done in East Coast of Sabah, Malaysia. Currently underwater adventure tour around Sipadan island, has been known by divers around the world.

c. Military post

Malaysia will implement the utilization of a modified post-production platform for its defense post in Bintulu. It is planned that the platform will be used for helicopter landing base, handling drones, and stations for Malaysian special task force.

d. Renewable energy

In theory the platforms that is no longer operating can still be utilized to produce renewable energy coming from wind, current, and geothermal (Murdjito, 2015).

e. Monitoring station and marine research

f. Rescue Base

This utilization has been made in the UK where the private sector utilizes the post production platform as a rescue base for active platforms operating around it.

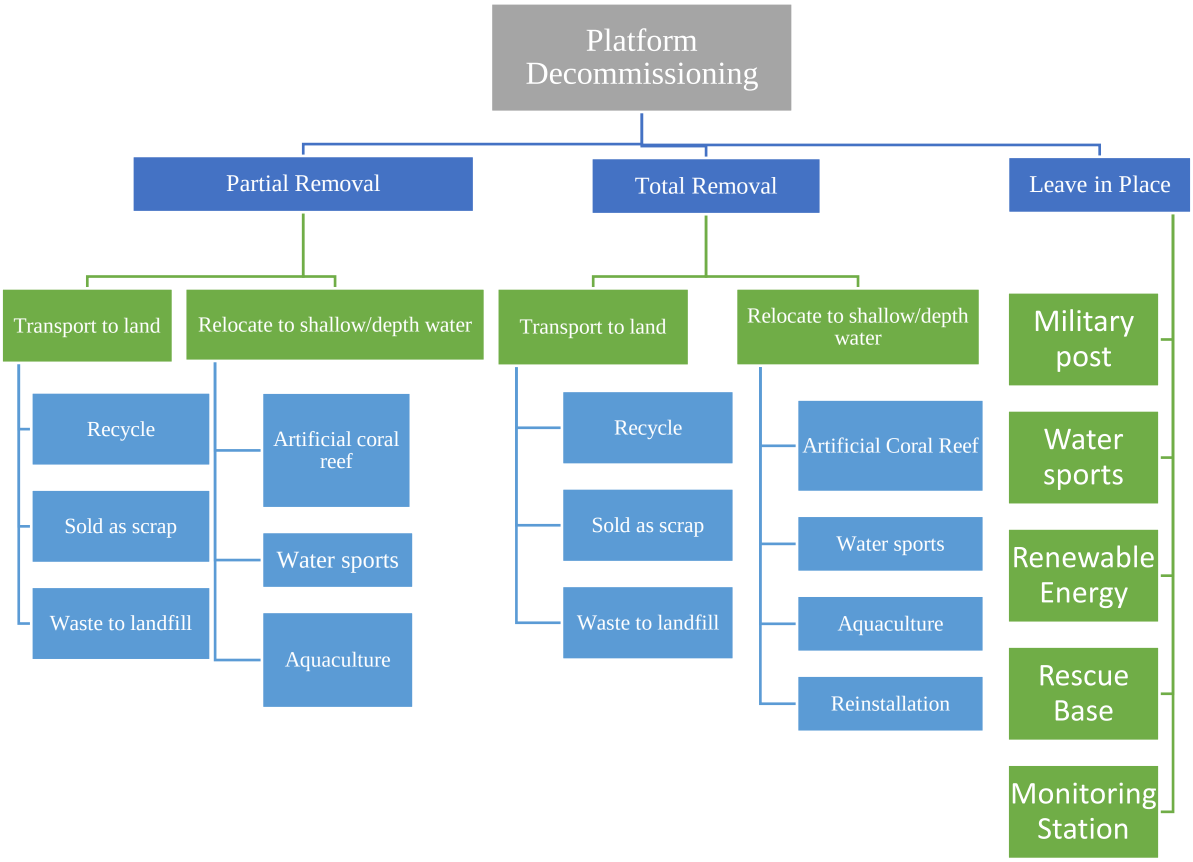

Figure 2.3 Alternative Options on Decommissioning for Operator

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CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Flowchart

The explanation of this bachelor thesis can be seen in Figure 3.1:

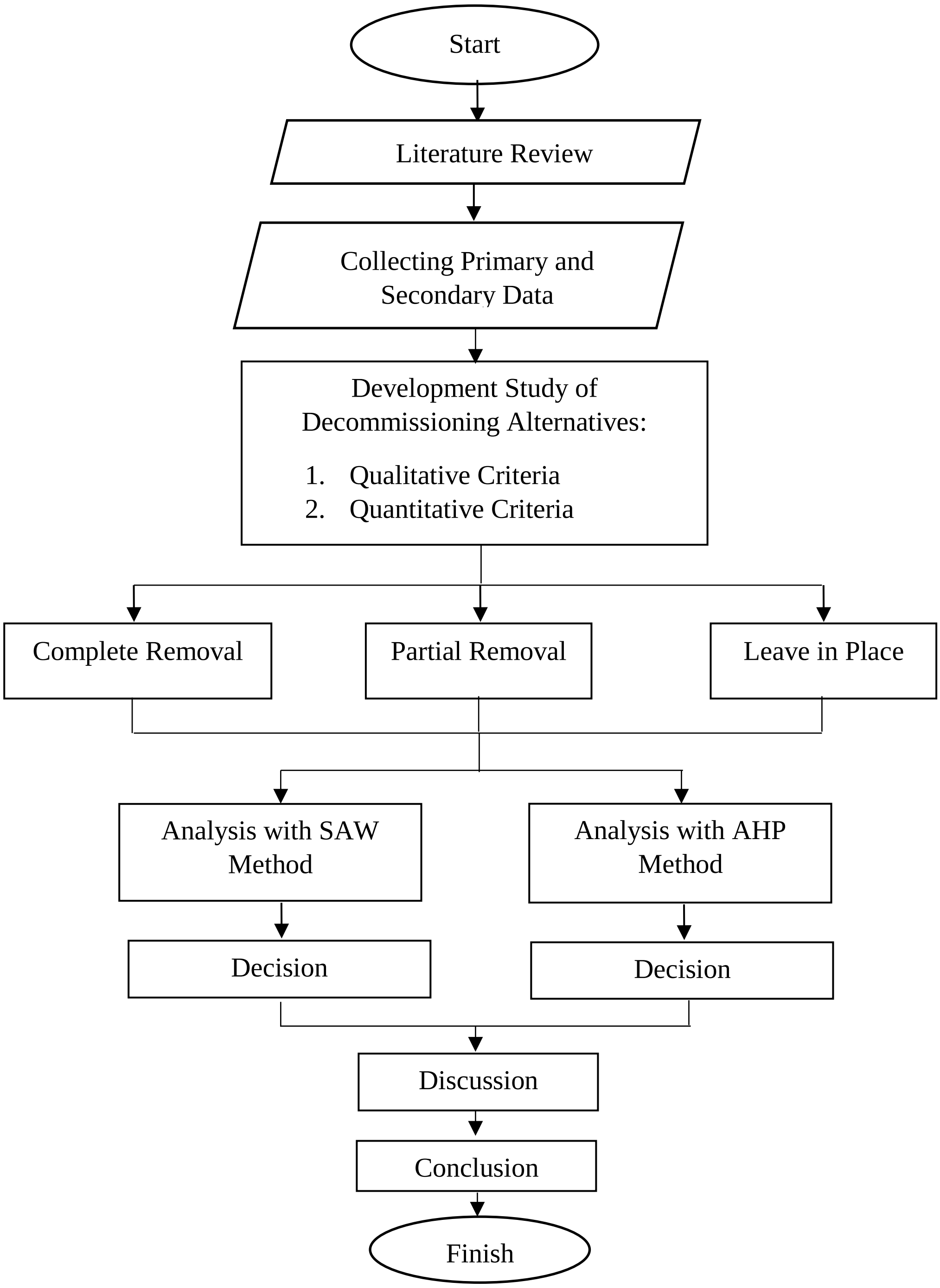

Figure 3.1 Research Flowchart of Bachelor Thesis

Furthermore, for each method described by the advanced flowchart, Figure 3.1a describes the analysis with the AHP method and Figure 3.1b describes the analysis by the SAW method.

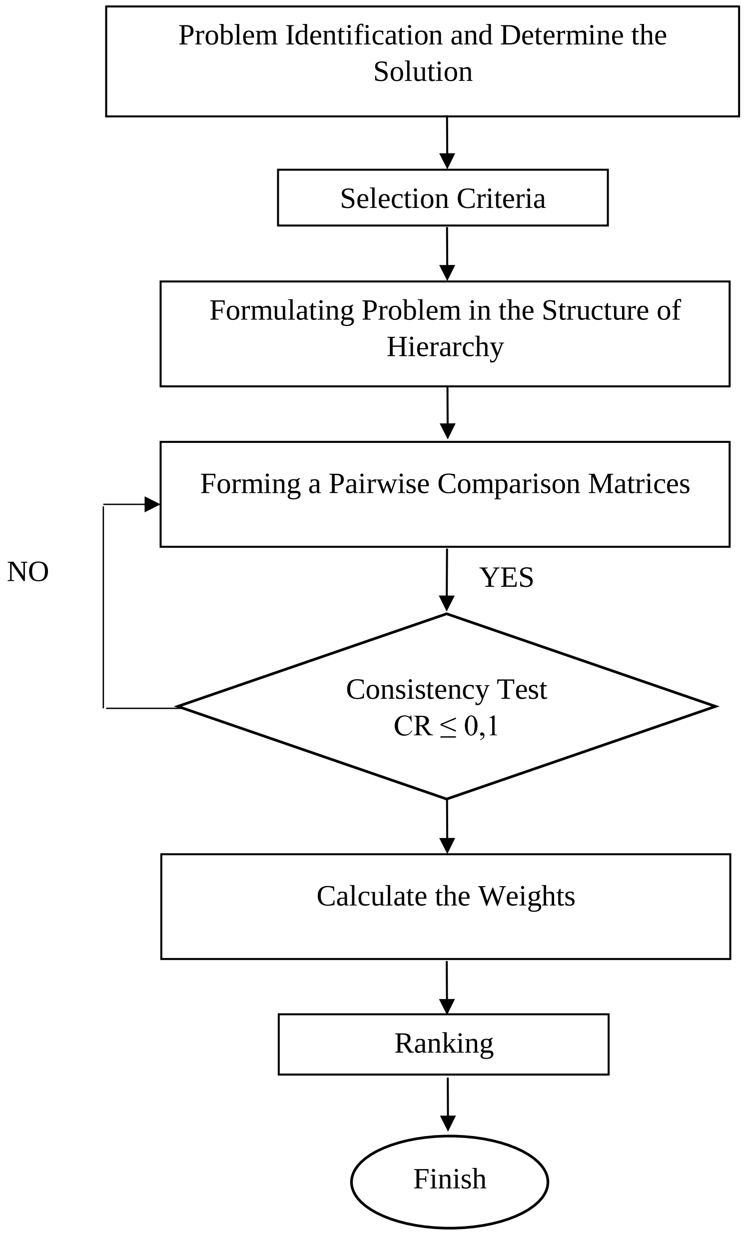

Figure 3.1a Research Flowchart of Bachelor Thesis (Advanced)

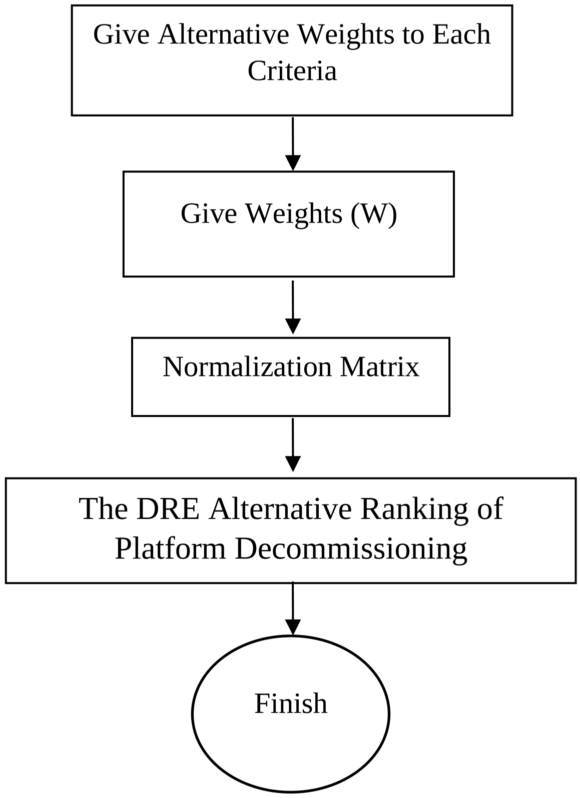

Figure 3.1b Research Flowchart of Bachelor Thesis (Advanced)

3.2 Research Steps

Based on the research flowchart, the research procedures and research steps in achieving the purpose of this bachelor thesis is described as follows:

1. Literature Review

   The study of literature as reference materials and the sources of theories required in the completion of this thesis are obtained from various sources, among others the collection of books, magazines, journals in ITS library and FTK reading room and internet access also module/note during lectures at Ocean Engineering Department, ITS.

2. Collecting Data

   The data required are primary data taken from questionnaires to oil and gas experts in Indonesia and secondary data in the form of platform structure and environmental data.

3. Development Study of Alternatives

   Explain the alternatives of DRE undertaken in the decommissioning as well as the advantages and disadvantages of each alternative.

4. Method Analysis

Explain the application of quantitative and qualitative decision making techniques used in this bachelor thesis by using AHP and SAW methods.

5. Decision Making

   From the application of decision making techniques obtained the best decision based on predetermined criteria of each method.

6. Result and Conclusion

   The results and conclusions of this research are the best decision alternative to determine DRE of decommissioning using AHP and SAW method.

3.3 Method of Collecting Data

a. Primary Data

Represents the data obtained directly from the object under study. In this thesis the primary data collection method was obtained by using questionnaires with AHP and SAW methods. The questionnaire contains a list of written questions that have been prepared previously based on literature studies and submitted to respondents who come from a specified professional oil and gas operators. The design of the questionnaire in this research is in the appendices.

b. Secondary Data

Represents data obtained from other parties. In this thesis, secondary data is a collection of structural and environmental data obtained from DRE project report by Ir. Murdjito, M.Sc. The data is shown in Table 3.1.

Table 3.1 Data of Attaka H Platform

Platform Name	**Attaka H**
Location	Makassar Strait, East Kalimantan 0º 09’ 44,901’’ S 117 º 38’ 54,482’’ E
Operator	Chevron Indonesia Company
Installation Time	Oktober 1972
Dimensional Work Area	40” x 40” (Unmanned)
Number of Leg	4
Jacket Support	Main Deck, Cellar Deck, Sub Cellar Deck, Boat Landing (1), Barge Bumper (2), Riser (11), Conductor (8)
Depth	198 ft (60,4 m)
Wave Height	16,3 ft (100 th)
Wave Period	8,1 s (100 th)
Average of Surface Temperature	30 º C
Ph	7,51
Total Weight	5,495.335 kips
Number of Deck	3
Number of Well	8
Number of Pile	4

Figure 3.2 Attaka Platform

(Source: DRE Project Report)

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CHAPTER IV

RESULT AND DISCUSSION

The analysis conducted in this bachelor thesis is the selection of DRE alternatives on the decommissioning of offshore oil and gas platforms using Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods.

4.1 Analytical Hierarchy Process (AHP) Method

The steps of the AHP method that is done in the DRE alternative selection of platform decommissioning are as follows:

a. Arrange the Hierarchy

Arrangement of hierarchical structure of problems with the first level is the purpose of the problem of determining DRE alternative of decommissioning Attaka H Platform owned by Chevron Indonesia Company in Makassar Strait, the second level is criteria considered; environment (C1), cost (C2),conversion (C3), security and safety (C4), and the last level is the DRE alternative; total removal (A1), partial removal (A2), and leave in place (A3). The hierarchical structure of this problem can be seen in the Figure 4.1 at appendix A.

b. Weighting for Pairwise Comparison

If the hierarchy has been properly composed, then weighted on each hierarchy based on its relative importance level. In this thesis, the comparison is done at level 2 (between criteria), level 3 (between subcriteria) and level 4 (between alternatives). Weighting at level 4 (between alternatives), is intended to compare the weight of choice based on each criterioa. The result of weighting is the weight which is the character of each alternative. While weighting at level 2 (criteria), intended to compare the weight of each criteria in order to achieve the goal so obtained weighting from the importance of each criteria to achieve the established goal of determining the DRE alternative of Attaka platform decommissioning. The weighting procedure of pairwise comparisons in AHP refers to the weighting developed by Thomas L Saaty as in the Table 2.1.

In weighting the importance of pairwise comparison applies the law of the reciprocal axioms, meaning that if an element A is weighted 5 times more important than element B, then element B is more important 1/5 than element A. If A and B are equally important then each weighs 1 .

Data collection at this thesis is done by using questioner, for multiple comparison done by using matrix differentiation questioner.

c. Consistency Test

Each pairwise comparison element will be tested for consistency in weighting in order to do the next step. Each stage can be continued if the weighting done is consistent. Respondent assessments as follows:

Table 4.1a Comparison Pairwise between Decision Maker

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Expert 1	Expert 2	Expert 3		
Expert 1	1	0.2	3	0.84	0.18
Expert 2	5.00	1	7	3.27	0.72
Expert 3	0.33	0.14	1	0.36	0.08
Total	6.33	1.34	11.00	4.54	1
Priority Row	1.17	0.96	0.87		
Lamda Max	3.00				
CI	0.00				
CR	0.18%				

Table 4.1b Normalized Matrix

Factor A Element	Factor B Element			Weight
	Expert 1	Expert 2	Expert 3	
Expert 1	0.16	0.15	0.27	0.19
Expert 2	0.79	0.74	0.64	0.72
Expert 3	0.05	0.11	0.09	0.08
Total	1	1	1	1

1) Respondent 1

Table 4.1.1 Comparison Pairwise between Criteria

Factor A Element	Factor B Element				Root of Product	Priority Vector
	Environment	Cost	Conversion	Safety		
Environment	1	0.20	3	0.20	0.59	0.1
Cost	5	1	7	0.33	1.85	0.3
Conversion	0.33	0.14	1	0.20	0.31	0.1
Safety	5	3	5	1	2.94	0.5
Total	11.33	4.34	16.00	1.73	6.08	1
Priority Row	1.10	1.32	0.82	0.84		
Lamda Max	4.08					
CI	0.03					
CR	2.94%					

Table 4.1.2 Normalized Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.09	0.05	0.19	0.12	0.109
Cost	0.44	0.23	0.44	0.19	0.325
Conversion	0.03	0.03	0.06	0.12	0.060
Safety	0.44	0.69	0.31	0.58	0.505
Total	1	1	1	1	1

Based on the Table 4.1.1 obtained weighting data based on the first expert thought in determining the priority. In this case the expert selects from 4 criteria. From the above data obtained CR is 2.94%, because CR <10% then the decision is consistent.

Figure 4.2a Determining The Priority of Criteria

Table 4.1.3 Weighting of Environtmental Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Biomass Production	Coral Habitat	Biodiversity Increasing		
Biomass Production	1	5	5	2.92	0.64
Coral Habitat	0.20	1	5	1.00	0.22
Biodiversity Increasing	0.20	0.20	1	0.34	0.07
Total	1.40	6.20	11.00	4.57	1
Priority Row	0.90	1.36	0.82		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.4 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Biomass Production	Coral Habitat	Biodiversity Enhancement	
Biomass Production	0.71	0.81	0.45	0.66
Coral Habitat	0.14	0.16	0.45	0.25
Biodiversity Enhancement	0.14	0.03	0.09	0.09
Total	1	1	1	1

Table 4.1.5 Weighting of Cost Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Pre Decommissioning	Operasional	Recovery Area		
Pre Decommissioning	1	0.20	0.20	0.34	0.07
Operasional	5	1	5	2.92	0.64
Recovery Area	5	0.20	1	1.00	0.22
Total	11.00	1.40	6.20	4.57	1
Priority Row	0.82	0.90	1.36		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.6 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Pre Decommissioning	Operasional	Recovery Area	
Pre Decommissioning	0.09	0.14	0.03	0.09
Operasional	0.45	0.71	0.81	0.66
Recovery Area	0.45	0.14	0.16	0.25
Total	1	1	1	1

Table 4.1.7 Weighting of Conversion Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Aquaculture	Tourism Potential	Renewable Energy		
Aquaculture	1	5	0.20	1	0.22
Tourism Potential	0.20	1	0.20	0.34	0.07
Renewable Energy	5	5	1	2.92	0.64
Total	6.20	11.00	1.40	4.57	
Priority Row	1.36	0.82	0.90		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.8 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Aquaculture	Tourism Potential	Renewable Energy	
Aquaculture	0.16	0.45	0.14	0.25
Tourism Potential	0.03	0.09	0.14	0.09
Energi Alternatif	0.81	0.45	0.71	0.66
Total	1	1	1	1

Table 4.1.9 Weighting of Safety Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Shipping Access	Fishing Activities	Risk of Work Safety		
Shipping Access	1	5	0.20	1	0.22
Fishing Activities	0.20	1	0.20	0.34	0.07
Risk of Work Safety	5	5	1	2.92	0.64
Total	6.2	11	1.4	4.57	
Priority Row	1.36	0.82	0.90		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.10 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Shipping Access	Fishing Activities	Risk of Work Safety	
Shipping Access	0.16	0.45	0.14	0.25
Fishing Activities	0.03	0.09	0.14	0.09
Risk of Work Safety	0.81	0.45	0.71	0.66
Total	1	1	1	1

Table 4.1.11 Weighting of Biomass Production Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	5	1	0.22
Partial Removal	5	1	5	2.92	0.64
Leave in Place	0.20	0.20	1	0.34	0.07
Total	6.20	1.40	11.00	4.57	
Priority Row	1.36	0.90	0.82		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.12 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.16	0.14	0.45	0.25
Partial Removal	0.81	0.71	0.45	0.66
Leave in Place	0.03	0.14	0.09	0.09
Total	1	1	1	1

Table 4.1.13 Weighting of Coral Habitat Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	5	2.92	0.64
Leave in Place	5	0.20	1	1	0.22
Total	11	1.40	6.20	4.57	
Priority Row	0.82	0.90	1.36		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.14 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.14	0.03	0.09
Partial Removal	0.45	0.71	0.81	0.66
Leave in Place	0.45	0.14	0.16	0.25
Total	1	1	1	1

Table 4.1.15 Weighting of Biodiversity Enhancement Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	5	2.92	0.64
Leave in Place	5	0.20	1	1	0.22
Total	11.0	1.4	6.2	4.57	
Priority Row	0.82	0.90	1.36		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.16 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.14	0.03	0.09
Partial Removal	0.45	0.71	0.81	0.66
Leave in Place	0.45	0.14	0.16	0.25
Total	1	1	1	1

Table 4.1.17 Weighting of Predecommissioning Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	5	2.92	0.64
Leave in Place	5	0.20	1	1	0.22
Total	11.0	1.4	6.2	4.57	
Priority Row	0.82	0.90	1.36		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.18 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.14	0.03	0.09
Partial Removal	0.45	0.71	0.81	0.66
Leave in Place	0.45	0.14	0.16	0.25
Total	1	1	1	1

Table 4.1.19 Weighting of Operational Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	0.20	1	0.22
Leave in Place	5	5	1	2.92	0.64
Total	11.0	6.2	1.4	4.57	
Priority Row	0.8	1.4	0.9		
Lamda Max	3.1				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.20 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.03	0.14	0.09
Partial Removal	0.45	0.16	0.14	0.25
Leave in Place	0.45	0.81	0.71	0.66
Total	1	1	1	1

Table 4.1.21 Weighting of Recovery Area Cost with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	0.20	1	0.22
Leave in Place	5	5	1	2.92	0.64
Total	11.0	6.2	1.4	4.57	
Priority Row	0.82	1.36	0.90		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.22 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.03	0.14	0.09
Partial Removal	0.45	0.16	0.14	0.25
Leave in Place	0.45	0.81	0.71	0.66
Total	1	1	1	1

Table 4.1.23 Weighting of Aquaculture Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	0.20	1	0.22
Leave in Place	5	5	1	2.92	0.64
Total	11.0	6.2	1.4	4.57	
Priority Row	0.82	1.36	0.90		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.24 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.03	0.14	0.09
Partial Removal	0.45	0.16	0.14	0.25
Leave in Place	0.45	0.81	0.71	0.66
Total	1	1	1	1

Table 4.1.25 Weighting of Tourism Potential Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.07
Partial Removal	5	1	5	2.92	0.64
Leave in Place	5	0.20	1	1	0.22
Total	11.0	1.4	6.2	4.57	
Priority Row	0.8	0.9	1.4		
Lamda Max	3.1				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.1.26 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.14	0.03	0.09
Partial Removal	0.45	0.71	0.81	0.66
Leave in Place	0.45	0.14	0.16	0.25
Total	1	1	1	1

Table 4.1.27 Weighting of Renewable Energy Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	0.20	0.34	0.08
Partial Removal	5	1	3.00	2.466212074	0.60
Leave in Place	5	0.33	1	1.19	0.29
Total	11.0	1.5	4.2	4.14	
Priority Row	0.9	0.9	1.2		
Lamda Max	3.0				
CI	0.01				
CR	2.29%				

Based on data CR is 2.29%, because CR < 10% then the decision is consistent.

Table 4.1.28 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.09	0.13	0.05	0.09
Partial Removal	0.45	0.65	0.71	0.61
Leave in Place	0.45	0.22	0.24	0.30
Total	1	1	1	1

Table 4.1.29 Weighting of Shipping Access Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	9	3.56	0.69
Partial Removal	0.20	1	7	1.12	0.22
Leave in Place	0.11	0.14	1	0.25	0.05
Total	1.3	6.1	17.0	5.15	
Priority Row	0.90	1.33	0.83		
Lamda Max	3.07				
CI	0.03				
CR	5.78%				

Based on data CR is 5.78%, because CR < 10% then the decision is consistent.

Table 4.1.30 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.763	0.814	0.529	0.702
Partial Removal	0.153	0.163	0.412	0.242
Leave in Place	0.085	0.023	0.059	0.056
Total	1	1	1	1

Table 4.1.31 Weighting of Work Safety Risks with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	7	9	3.98	0.74
Partial Removal	0.14	1	5	0.89	0.17
Leave in Place	0.11	0.20	1	0.28	0.05
Total	1.3	8.2	15.0	5.36	
Priority Row	0.9	1.4	0.8		
Lamda Max	3.1				
CI	0.0				
CR	7.20%				

Based on data CR is 7.2%, because CR < 10% then the decision is consistent.

Table 4.1.32 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.797	0.854	0.600	0.750
Partial Removal	0.114	0.122	0.333	0.190
Leave in Place	0.089	0.024	0.067	0.060
Total	1	1	1	1

Table 4.1.33 Weighting of Fishing Activities Safety with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	7	9	3.98	0.74
Partial Removal	0.14	1	5	0.89	0.17
Leave in Place	0.11	0.20	1	0.28	0.05
Total	1.3	8.2	15.0	5.36	
Priority Row	0.93	1.37	0.79		
Lamda Max	3.08				
CI	0.04				
CR	7.20%				

Based on data CR is 7.2%, because CR < 10% then the decision is consistent.

Table 4.1.34 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.80	0.85	0.60	0.75
Partial Removal	0.11	0.12	0.33	0.19
Leave in Place	0.09	0.02	0.07	0.06
Total	1	1	1	1

Table 4.1.35 All Weight Evaluation

Alternatives / Crtiteria	Environment			Cost			Conversion			Safety			All Weight Evaluation
	0.11			0.33			0.06			0.51			
	PLB	HTK	PB	PD	OP	RA	AK	PP	EA	AP	RKP	APR	
	0.66	0.25	0.09	0.09	0.66	0.25	0.25	0.09	0.66	0.25	0.09	0.66	
Total Removal	0.25	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.70	0.75	0.75	0.429
Partial Removal	0.66	0.66	0.66	0.66	0.25	0.25	0.25	0.66	0.61	0.24	0.19	0.19	0.300
Leave in Place	0.09	0.25	0.25	0.25	0.66	0.66	0.66	0.25	0.30	0.06	0.06	0.06	0.271

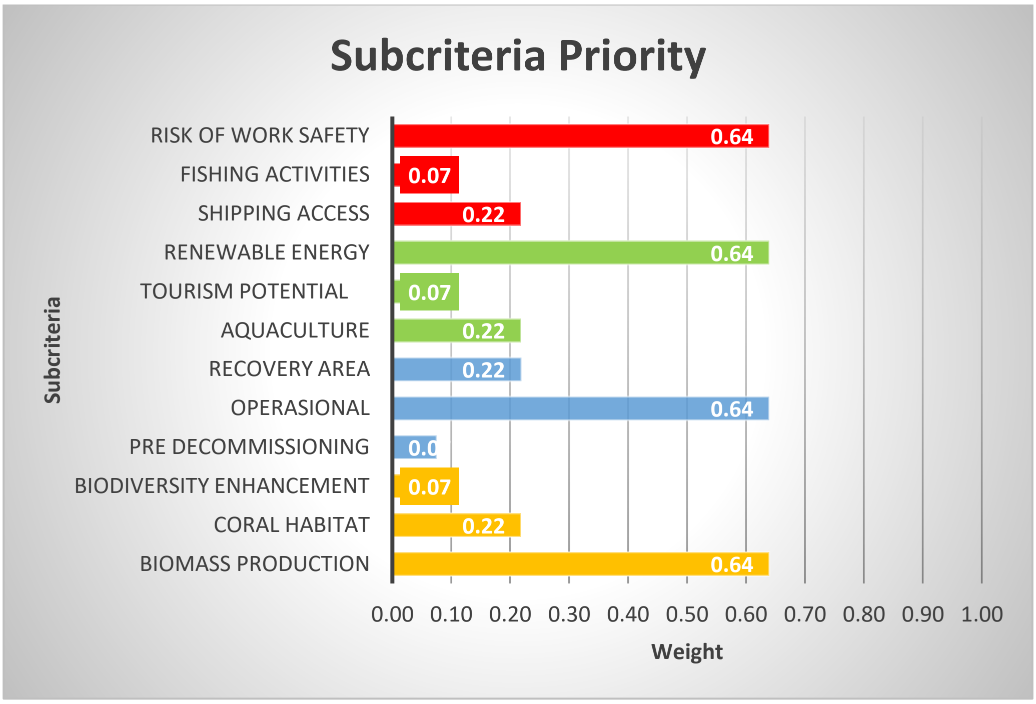

Figure 4.2b Determining The Priority of Each Subcriteria

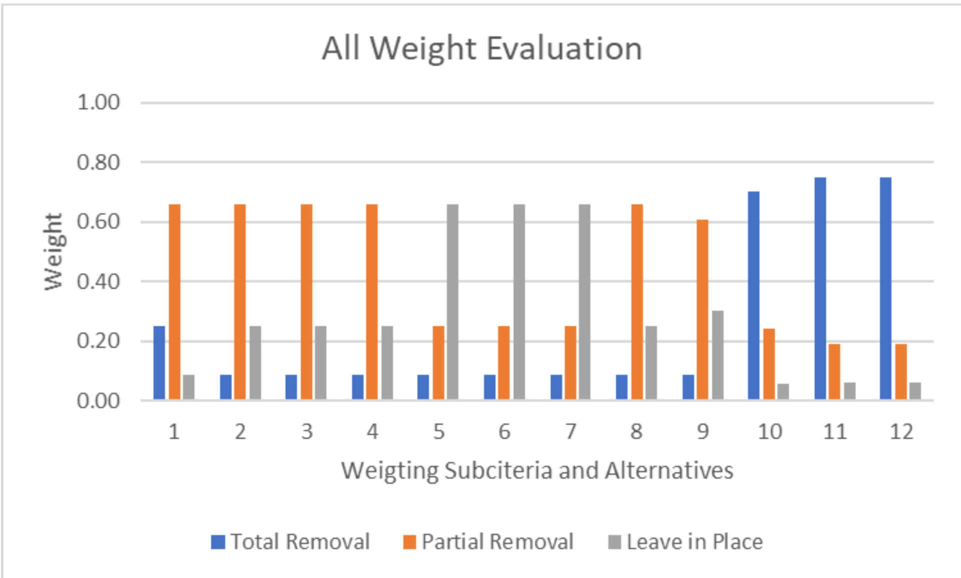

Figure 4.2c All Weight Evaluation

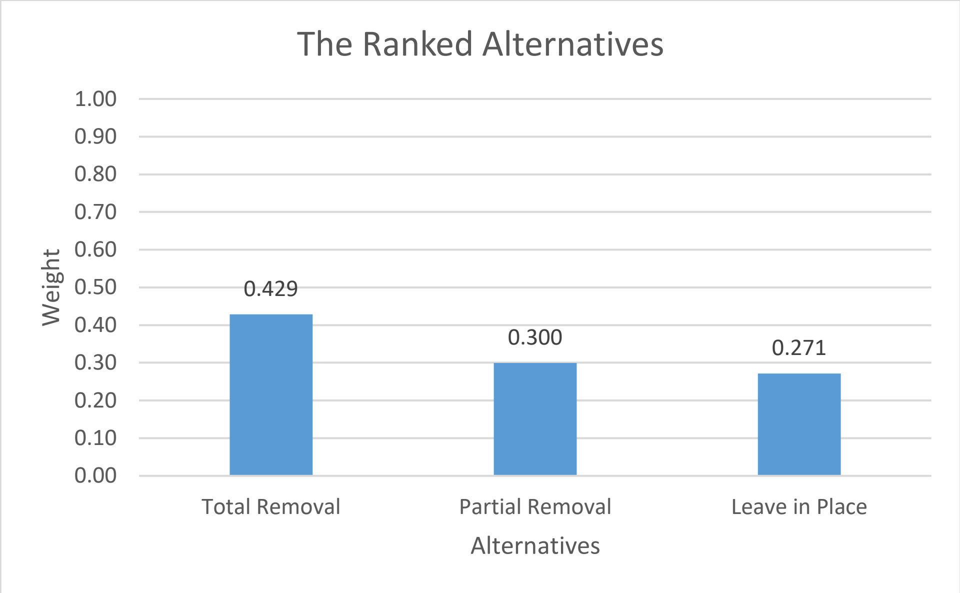

Figure 4.2d The Ranked Alternatives

Table 4.1.35 is the result of computation by inputting the eigen vector and summing up all the eigen vectors associated with each alternative. Based on the above data obtained the weight of all weight evaluation of DRE alternatives. The highest weight of all weight evaluation is best decision of DRE alternative. So it can be known from respondent 1 that the best decision of DRE alternative is total removal with the weight is 0.429.

2) Respondent 2

Table 4.2.1 Comparison Pairwise between Criteria

Factor A Element	Factor B Element				Root of Product	Priority Vector
	Environment	Cost	Conversion	Safety		
Environment	1	5.0	3.0	1	1.97	0.408
Cost	0.2	1	1	0.3	0.51	0.105
Conversion	0.3	1	1	0.3	0.58	0.120
Safety	1	3.0	3.0	1	1.73	0.359
Total	2.53	10	8	2.67	4.82	1
Priority Row	1.03	1.05	0.96	0.96		
Lamda Max	4.00					
CI	0.00					
CR	0.14%					

Based on the Table 4.2.1 obtained weighting data based on the second expert thought in determining the priority. In this case the expert selects from 4 criteria. From the above data obtained CR is 0.14%, because CR <10% then the decision is consistent.

Table 4.2.2 Normalized Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.394736842	0.5	0.375	0.375	0.411
Cost	0.078947368	0.1	0.125	0.125	0.107
Conversion	0.131578947	0.1	0.125	0.125	0.120
Safety	0.394736842	0.3	0.375	0.375	0.361
Total	1	1	1	1	1

Figure 4.3a Determining The Priority of Criteria

Table 4.2.3 Weighting of Environtmental Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Biomass Production	Coral Habitat	Biodiversity Enhancement		
Biomass Production	1	0.2	0.2	0.34	0.09
Coral Habitat	5.0	1	1	1.71	0.45
Biodiversity Enhancement	5.0	1	1	1.71	0.45
Total	11.00	2.20	2.20	3.76	1
Priority Row	1.00	1.00	1.00		
Lamda Max	3.00				
CI	0.00				
CR	0.0%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.4 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Biomass Production	Coral Habitat	Biodiversity Enhancement	
Biomass Production	0.09	0.09	0.09	0.0909
Coral Habitat	0.45	0.45	0.45	0.4545
Biodiversity Enhancement	0.45	0.45	0.45	0.4545
Total	1	1	1	1.0

Table 4.2.5 Weighting of Cost Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Pre Decommissioning	Operational	Recovery Area		
Pre Decommissioning	1	0.33	3.00	1.00	0.26
Operational	3	1	5	2.47	0.63
Recovery Area	0.3	0.20	1	0.41	0.10
Total	4.33	1.53	9.00	3.91	1
Priority Row	1.11	0.97	0.93		
Lamda Max	3.01				
CI	0.00				
CR	0.72%				

Based on data CR is 0.72%, because CR < 10% then the decision is consistent.

Table 4.2.6 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Pre Decommissioning	Operational	Recovery Area	
Pre Decommissioning	0.23	0.22	0.33	0.26
Operational	0.69	0.65	0.56	0.63
Recovery Area	0.08	0.13	0.11	0.11
Total	1	1	1	1

4.2.7 Weighting of Conversion Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Aquaculture	Tourism Potential	Area Renewable Energi		
Aquaculture	1	3	3	2	0.6
Tourism Potential	0.33	1	1	0.693	0.2
Renewable Energi	0.33	1	1	0.693	0.2
Total	1.67	5	5	3.47	
Priority Row	1	1	1		
Lamda Max	3				
CI	0				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.8 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Aquaculture	Tourism Potential	Area Renewable Energi	
Aquaculture	0.60	0.60	0.60	0.60
Tourism Potential	0.20	0.20	0.20	0.20
Renewable Energi	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.9 Weighting of Safety Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Shipping Access	Fishing Activities	Risk of Work Safety		
Shipping Access	1	5	1	1.71	0.45
Fishing Activities	0.20	1	0.20	0.34	0.09
Risk of Work Safety	1	5	1	1.71	0.45
Total	2.2	11	2.2	3.76	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.10 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Shipping Access	Fishing Activities	Risk of Work Safety	
Shipping Access	0.45	0.45	0.45	0.45
Fishing Activities	0.09	0.09	0.09	0.09
Risk of Work Safety	0.45	0.45	0.45	0.45
Total	1	1	1	1

Table 4.2.11 Weighting of Biomass Production Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.68
Partial Removal	0.2	1	3	0.84	0.20
Leave in Place	0.2	0.3	1	0.41	0.09
Total	1.40	6.33	9	4.31	
Priority Row	0.95	1.24	0.85		
Lamda Max	3.04				
CI	0.02				
CR	3.38%				

Based on data CR is 3.38%, because CR < 10% then the decision is consistent.

Table 4.2.12 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.79	0.56	0.69
Partial Removal	0.14	0.16	0.33	0.21
Leave in Place	0.14	0.05	0.11	0.10
Total	1	1	1	1

Table 4.2.13 Weighting of Coral Habitat Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.60
Partial Removal	0.3	1	1	0.69	0.20
Leave in Place	0.3	1	1	0.69	0.20
Total	1.67	5	5	3.47	
Priority Row	1.00	1.00	1.00		
Lamda Max	3.00				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.14 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.60	0.60	0.60
Partial Removal	0.20	0.20	0.20	0.20
Leave in Place	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.15 Weighting of Biodiversity Enhancement Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.6
Partial Removal	0.33	1	1	0.69	0.2
Leave in Place	0.33	1	1	0.69	0.2
Total	1.67	5	5	3.47	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.16 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.60	0.60	0.60
Partial Removal	0.20	0.20	0.20	0.20
Leave in Place	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.17 Weighting of Predecommissioning Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.2	1	1	0.58	0.14
Leave in Place	0.2	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.18 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.71	0.71	0.714
Partial Removal	0.14	0.14	0.14	0.143
Leave in Place	0.14	0.14	0.14	0.143
Total	1	1	1	1

Table 4.2.19 Weighting of Operational Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.2	1	1	0.58	0.14
Leave in Place	0.2	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1.0	1.0	1.0		
Lamda Max	3.0				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.20 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.71	0.71	0.71
Partial Removal	0.14	0.14	0.14	0.14
Leave in Place	0.14	0.14	0.14	0.14
Total	1	1	1	1

Table 4.2.21 Weighting of Recovery Area Cost with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.2	1	1	0.58	0.14
Leave in Place	0.2	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.22 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.71	0.71	0.71
Partial Removal	0.14	0.14	0.14	0.14
Leave in Place	0.14	0.14	0.14	0.14
Total	1	1	1	1

Table 4.2.23 Weighting of Aquaculture Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.6
Partial Removal	0.3	1	1	0.69	0.2
Leave in Place	0.3	1	1	0.69	0.2
Total	1.7	5	5	3.47	
Priority Row	1	1	1		
Lamda Max	3				
CI	0				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.24 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.60	0.60	0.60
Partial Removal	0.20	0.20	0.20	0.20
Leave in Place	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.25 Weighting of Tourism Potential Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.6
Partial Removal	0.3	1	1	0.69	0.2
Leave in Place	0.3	1	1	0.69	0.2
Total	1.7	5	5	3.47	
Priority Row	1.0	1.0	1.0		
Lamda Max	3.0				
CI	0				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.26 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.60	0.60	0.60
Partial Removal	0.20	0.20	0.20	0.20
Leave in Place	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.27 Weighting of Renewable Energy Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.6
Partial Removal	0.3	1	1	0.69	0.2
Leave in Place	0.3	1	1	0.69	0.2
Total	1.7	5	5	3.47	
Priority Row	1.0	1.0	1.0		
Lamda Max	3.0				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.28 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.60	0.60	0.60
Partial Removal	0.20	0.20	0.20	0.20
Leave in Place	0.20	0.20	0.20	0.20
Total	1	1	1	1

Table 4.2.29 Weighting of Shipping Access Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.20	1	1	0.58	0.14
Leave in Place	0.20	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.30 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.714	0.714	0.714	0.714
Partial Removal	0.143	0.143	0.143	0.143
Leave in Place	0.143	0.143	0.143	0.143
Total	1	1	1	1

Table 4.2.31 Weighting of Work Safety Risks with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.20	1	1	0.58	0.14
Leave in Place	0.20	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1.0	1.0	1.0		
Lamda Max	3.0				
CI	0.0				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.32 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.714	0.714	0.714	0.714
Partial Removal	0.143	0.143	0.143	0.143
Leave in Place	0.143	0.143	0.143	0.143
Total	1	1	1	1

Table 4.2.33 Weighting of Fishing Activities Safety with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	5	2.92	0.71
Partial Removal	0.20	1	1	0.58	0.14
Leave in Place	0.20	1	1	0.58	0.14
Total	1.4	7	7	4.09	
Priority Row	1	1	1		
Lamda Max	3				
CI	0.00				
CR	0.00%				

Based on data CR is 0%, because CR < 10% then the decision is consistent.

Table 4.2.34 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.71	0.71	0.71
Partial Removal	0.14	0.14	0.14	0.14
Leave in Place	0.14	0.14	0.14	0.14
Total	1	1	1	1

Table 4.2.35 All Weight Evaluation

Alternatives / Criteria	Environment			Cost			Conversion			Safety			All Weight Evaluation
	0.41			0.11			0.12			0.36			
	PLB	HTK	PB	PD	OP	RA	AK	PP	EA	AP	RKP	APR	
	0.1	0.45	0.45	0.26	0.63	0.11	0.60	0.20	0.20	0.45	0.1	0.45	
Total Removal	0.69	0.60	0.60	0.71	0.71	0.71	0.60	0.60	0.60	0.71	0.71	0.71	0.657
Partial Removal	0.21	0.20	0.20	0.14	0.14	0.14	0.20	0.20	0.20	0.14	0.14	0.14	0.174
Leave in Place	0.10	0.20	0.20	0.14	0.14	0.14	0.20	0.20	0.20	0.14	0.14	0.14	0.170

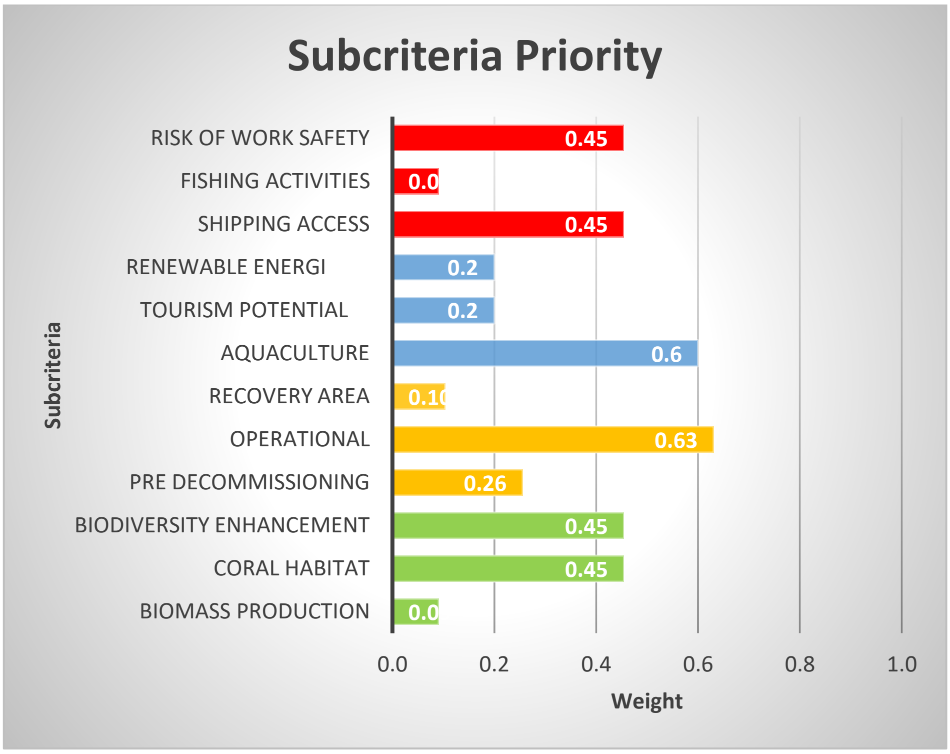

Figure 4.3b Determining The Priority of Each Subcriteria

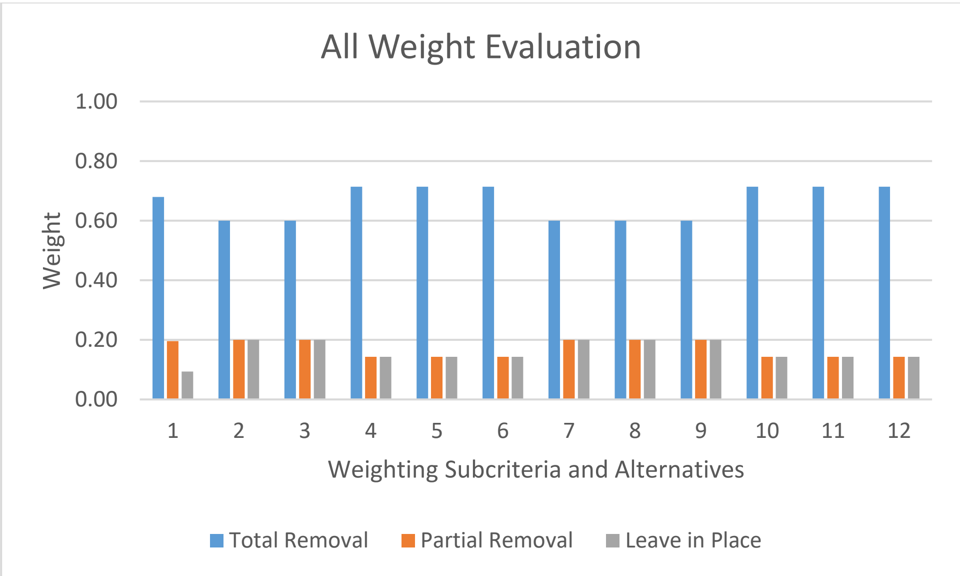

Figure 4.3c All Weight Evaluation

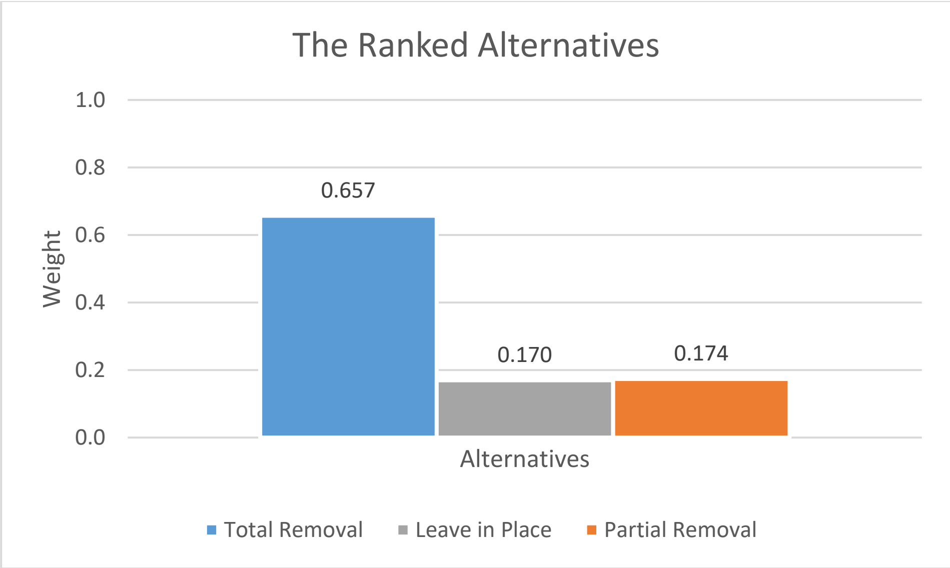

Figure 4.3d The Ranked Alternatives

Table 4.2.35 is the result of computation by inputting the eigen vector and summing up all the eigen vectors associated with each alternative. Based on the above data obtained the weight of all weight evaluation of DRE alternatives. The highest weight of all weight evaluation is best decision of DRE alternative. So it can be known from respondent 2 that the best decision of DRE alternative is total removal with the weight is 0.657.

3) Respondent 3

Table 4.3.1 Comparison Pairwise between Criteria

Factor A Element	Factor B Element				Root of Product	Priority Vector
	Environment	Cost	Conversion	Safety		
Environment	1	0.11	1	0.14	0.35	0.1
Cost	9	1	5	0.20	1.73	0.3
Conversion	1.00	0.20	1	0.20	0.45	0.1
Safety	7	5	5	1	3.64	0.5
Total	18.00	6.31	12.00	1.54	6.77	1
Priority Row	0.94	1.61	0.79	0.83		
Lamda Max	4.18					
CI	0.06					
CR	6.62%					

Table 4.3.2 Normalized Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.06	0.02	0.08	0.09	0.062
Cost	0.50	0.16	0.42	0.13	0.301
Conversion	0.06	0.03	0.08	0.13	0.075
Safety	0.39	0.79	0.42	0.65	0.561
Total	1	1	1	1	1

Based on the Table 4.3.1 obtained weighting data based on the first expert thought in determining the priority. In this case the expert selects from 4 criteria. From the above data obtained CR is 6.62%, because CR <10% then the decision is consistent.

Figure 4.4a Determining The Priority of Criteria

Table 4.3.3 Weighting of Environtmental Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Biomassa Production	Coral Habitat	Biodiversity Enhancement		
Biomassa Production	1	0.11	3	0.69	0.13
Coral Habitat	9.00	1	9	4.33	0.79
Biodiversity Enhancement	0.33	0.11	1	0.33	0.06
Total	10.33	1.22	13	5.48	
Priority Row	1.31	0.97	0.79		
Lamda Max	3.07				
CI	0.03				
CR	5.65%				

Based on data CR is 5,65%, because CR < 10% then the decision is consistent.

Table 4.3.4 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Biomassa Production	Coral Habitat	Biodiversity Enhancement	
Biomassa Production	0.10	0.09	0.23	0.14
Coral Habitat	0.87	0.82	0.69	0.79
Biodiversity Enhancement	0.03	0.09	0.08	0.07
Total	1	1	1	1

Table 4.3.5 Weighting of Cost Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Pre Decommissioning	Operational	Recovery Area		
Pre Decommissioning	1	0.20	0.20	0.34	0.07
Operational	7	1	7	3.66	0.74
Recovery Area	3	0.14	1	0.75	0.15
Total	11.00	1.34	8.20	4.95	
Priority Row	0.76	0.99	1.25		
Lamda Max	3.00				
CI	0.00				
CR	0.26%				

Based on data CR is 0,26%, because CR < 10% then the decision is consistent.

Table 4.3.6 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Pre Decommissioning	Operational	Recovery Area	
Pre Decommissioning	0.09	0.15	0.02	0.09
Operational	0.64	0.74	0.85	0.74
Recovery Area	0.27	0.11	0.12	0.17
Total	1	1	1	1

Table 4.3.7 Weighting of Conversion Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Aquaculture	Tourism Potential	Renewable Energy		
Aquaculture	1	0.3	0.14	0	0.07
Tourism Potential	3.00	1	0.14	0.75	0.15
Energi Alternatif	7	7	1	3.66	0.75
Total	11.00	8.33	1.29	4.90	
Priority Row	0.81	1.28	0.96		
Lamda Max	3.05				
CI	0.03				
CR	4.68%				

Based on data CR is 4.68%, because CR < 10% then the decision is consistent.

Table 4.3.8 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Aquaculture	Tourism Potential	Renewable Energy	
Aquaculture	0.09	0.04	0.11	0.08
Tourism Potential	0.27	0.12	0.11	0.17
Energi Alternatif	0.64	0.84	0.78	0.75
Total	1	1	1	1

Table 4.3.9 Weighting of Safety Criteria with Subcriteria

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Shipping Access	Fishing Activities	Risk of Work Safety		
Shipping Access	1	0.20	0.11	0.28	0.05
Fishing Activities	5.00	1	0.11	0.82	0.15
Risk of Work Safety	7	9	1	3.98	0.73
Total	13	10.2	1.22	5.45	
Priority Row	0.67	1.54	0.89		
Lamda Max	3.10				
CI	0.05				
CR	8.65%				

Based on data CR is 8.65%, because CR < 10% then the decision is consistent.

Table 4.3.10 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Shipping Access	Fishing Activities	Risk of Work Safety	
Shipping Access	0.08	0.02	0.09	0.06
Fishing Activities	0.38	0.10	0.09	0.19
Risk of Work Safety	0.54	0.88	0.82	0.75
Total	1	1	1	1

Table 4.3.11 Weighting of Biomass Production Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.33	5	1.19	0.30
Partial Removal	3	1	3	2.08	0.52
Leave in Place	0.20	0.33	1	0.41	0.10
Total	4.20	1.67	9	3.98	
Priority Row	1.25	0.87	0.92		
Lamda Max	3.04				
CI	0.02				
CR	3.44%				

Based on data CR is 3.44%, because CR < 10% then the decision is consistent.

Table 4.3.12 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.24	0.20	0.56	0.33
Partial Removal	0.71	0.60	0.33	0.55
Leave in Place	0.05	0.20	0.11	0.12
Total	1	1	1	1

Table 4.3.13 Weighting of Coral Habitat Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.14	3	0.75	0.16
Partial Removal	7	1	5	3.27	0.70
Leave in Place	0	0.20	1	0.41	0.09
Total	8	1.34	9	4.65	
Priority Row	1.35	0.94	0.78		
Lamda Max	3.08				
CI	0.04				
CR	6.80%				

Based on data CR is 6.8%, because CR < 10% then the decision is consistent.

Table 4.3.14 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.12	0.11	0.33	0.19
Partial Removal	0.84	0.74	0.56	0.71
Leave in Place	0.04	0.15	0.11	0.10
Total	1	1	1	1

Table 4.3.15 Weighting of Biodiversity Enhancement Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3	3	2.08	0.52
Partial Removal	0.3	1	5	1.19	0.30
Leave in Place	0.3	0.20	1	0.41	0.10
Total	1.7	4.2	9	3.98	
Priority Row	0.87	1.25	0.92		
Lamda Max	3.04				
CI	0.02				
CR	3.44%				

Based on data CR is 3.44%, because CR < 10% then the decision is consistent.

Table 4.3.16 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.60	0.71	0.33	0.55
Partial Removal	0.20	0.24	0.56	0.33
Leave in Place	0.20	0.05	0.11	0.12
Total	1	1	1	1

Table 4.3.17 Weighting of Predecommissioning Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.20	3.00	0.84	0.21
Partial Removal	5	1	3	2.47	0.60
Leave in Place	0	0.33	1	0.48	0.12
Total	6.3	1.5	7.0	4.08	
Priority Row	1.31	0.93	0.82		
Lamda Max	3.06				
CI	0.03				
CR	5.17%				

Based on data CR is 5.17%, because CR < 10% then the decision is consistent.

Table 4.3.18 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.16	0.13	0.43	0.24
Partial Removal	0.79	0.65	0.43	0.62
Leave in Place	0.05	0.22	0.14	0.14
Total	1	1	1	1

Table 4.3.19 Weighting of Operational Cost Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	7.00	0.33	1.33	0.31
Partial Removal	0.14	1	0.33	0.36	0.09
Leave in Place	3	3	1	2.08	0.49
Total	4.1	11.0	1.7	4.23	
Priority Row	1.3	0.9	0.8		
Lamda Max	3.1				
CI	0.03				
CR	4.97%				

Based on data CR is 4.97%, because CR < 10% then the decision is consistent.

Table 4.3.20 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.24	0.64	0.20	0.36
Partial Removal	0.03	0.09	0.20	0.11
Leave in Place	0.72	0.27	0.60	0.53
Total	1	1	1	1

Table 4.3.21 Weighting of Recovery Area Cost with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5.00	5.00	2.92	0.64
Partial Removal	0	1	5.00	1	0.22
Leave in Place	0	0	1	0.34	0.07
Total	1.4	6.2	11.0	4.57	
Priority Row	0.90	1.36	0.82		
Lamda Max	3.08				
CI	0.04				
CR	6.49%				

Based on data CR is 6.49%, because CR < 10% then the decision is consistent.

Table 4.3.22 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.71	0.81	0.45	0.66
Partial Removal	0.14	0.16	0.45	0.25
Leave in Place	0.14	0.03	0.09	0.09
Total	1	1	1	1

Table 4.3.23 Weighting of Aquaculture Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.33	3	1	0.27
Partial Removal	3	1	3	2.08	0.56
Leave in Place	0.3	0	1	0.48	0.13
Total	4.3	1.7	7	3.70	
Priority Row	1.17	0.94	0.91		
Lamda Max	3.02				
CI	0.01				
CR	1.69%				

Based on data CR is 1.69%, because CR < 10% then the decision is consistent.

Table 4.3.24 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.23	0.20	0.43	0.29
Partial Removal	0.69	0.60	0.43	0.57
Leave in Place	0.08	0.20	0.14	0.14
Total	1	1	1	1

Table 4.3.25 Weighting of Tourism Potential Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	3.00	0.14	0.75	0.15
Partial Removal	0	1	0	0.36	0.07
Leave in Place	7	7.00	1	3.66	0.75
Total	8.3	11.0	1.3	4.90	
Priority Row	1.3	0.8	1.0		
Lamda Max	3.1				
CI	0.03				
CR	4.68%				

Based on data CR is 4.68%, because CR < 10% then the decision is consistent.

Table 4.3.26 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.12	0.27	0.11	0.17
Partial Removal	0.04	0.09	0.11	0.08
Leave in Place	0.84	0.64	0.78	0.75
Total	1	1	1	1

Table 4.3.27 Weighting of Renewable Energy Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	7	7	3.66	0.71
Partial Removal	0.14	1	5	0.89	0.17
Leave in Place	0.14	0.20	1	0.31	0.06
Total	1.3	8.2	13	5.16	
Priority Row	0.9	1.4	0.8		
Lamda Max	3.1				
CI	0.05				
CR	9.05%				

Based on data CR is 9.05%, because CR < 10% then the decision is consistent

Table 4.3.28 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.78	0.85	0.54	0.72
Partial Removal	0.11	0.12	0.38	0.21
Leave in Place	0.11	0.02	0.08	0.07
Total	1	1	1	1

Table 4.3.29 Weighting of Shipping Access Subcriteria with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	9	3	3	0.62
Partial Removal	0.11	1	5	0.82	0.17
Leave in Place	0.14	0.20	1	0.31	0.06
Total	1.3	10.2	9	4.86	
Priority Row	0.77	1.72	0.57		
Lamda Max	3.06				
CI	0.03				
CR	5.40%				

Based on data CR is 5.40%, because CR < 10% then the decision is consistent.

Table 4.3.30 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.797	0.882	0.333	0.671
Partial Removal	0.089	0.098	0.556	0.247
Leave in Place	0.114	0.020	0.111	0.082
Total	1	1	1	1

Table 4.3.31 Weighting of Work Safety Risks with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	0.11	9	1	0.18
Partial Removal	9	1	3	3	0.55
Leave in Place	0.11	0.11	1	0.23	0.04
Total	10.1	1.2	13.0	5.44	
Priority Row	1.9	0.7	0.6		
Lamda Max	3.1				
CI	0.0				
CR	7.51%				

Based on data CR is 7.51%, because CR < 10% then the decision is consistent.

Table 4.3.32 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.099	0.091	0.692	0.294
Partial Removal	0.890	0.818	0.231	0.646
Leave in Place	0.011	0.091	0.077	0.060
Total	1	1	1	1

Table 4.3.33 Weighting of Fishing Activities Safety with Alternatives

Factor A Element	Factor B Element			Root of Product	Priority Vector
	Total Removal	Partial Removal	Leave in Place		
Total Removal	1	5	7.00	3.27	0.72
Partial Removal	0.20	1	3.00	0.84	0.19
Leave in Place	0	0	1	0.36	0.08
Total	1.3	6	11.0	4.54	
Priority Row	0.97	1.18	0.88		
Lamda Max	3.02				
CI	0.01				
CR	1.95%				

Based on data CR is 1.95%, because CR < 10% then the decision is consistent.

Table 4.3.34 Normalized Matrix

Factor A Element	Factor B Element			Weight
	Total Removal	Partial Removal	Leave in Place	
Total Removal	0.74	0.79	0.64	0.72
Partial Removal	0.15	0.16	0.27	0.19
Leave in Place	0.11	0.05	0.09	0.08
Total	1	1	1	1

Table 4.3.35 All Weight Evaluation

Alternatives / Criteria	Environment			Cost			Conversion			Safety			All Weight Evaluation
	0.06			0.30			0.08			0.56			
	PLB	HTK	PB	PD	OP	RA	AK	PP	EA	AP	RKP	APR	
	0.14	0.79	0.07	0.09	0.74	0.17	0.08	0.17	0.75	0.06	0.19	0.75	
Total Removal	0.33	0.19	0.55	0.24	0.36	0.66	0.29	0.17	0.72	0.67	0.29	0.72	0.54
Partial Removal	0.55	0.71	0.33	0.62	0.11	0.25	0.57	0.08	0.21	0.25	0.65	0.19	0.27
Leave in Place	0.12	0.10	0.12	0.14	0.53	0.09	0.14	0.75	0.07	0.08	0.06	0.08	0.19

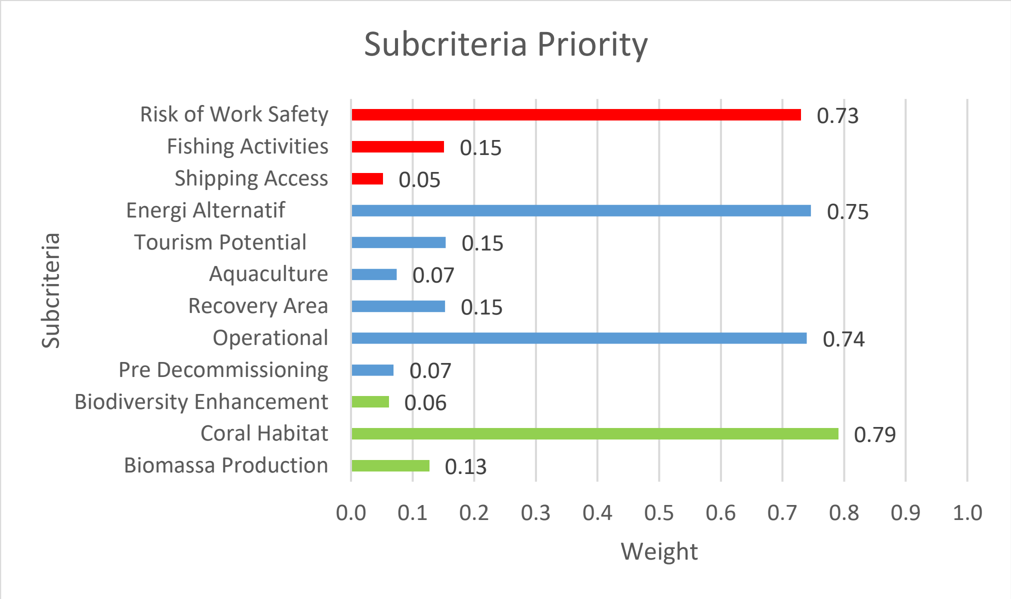

Figure 4.4b Determining The Priority of Each Subcriteria

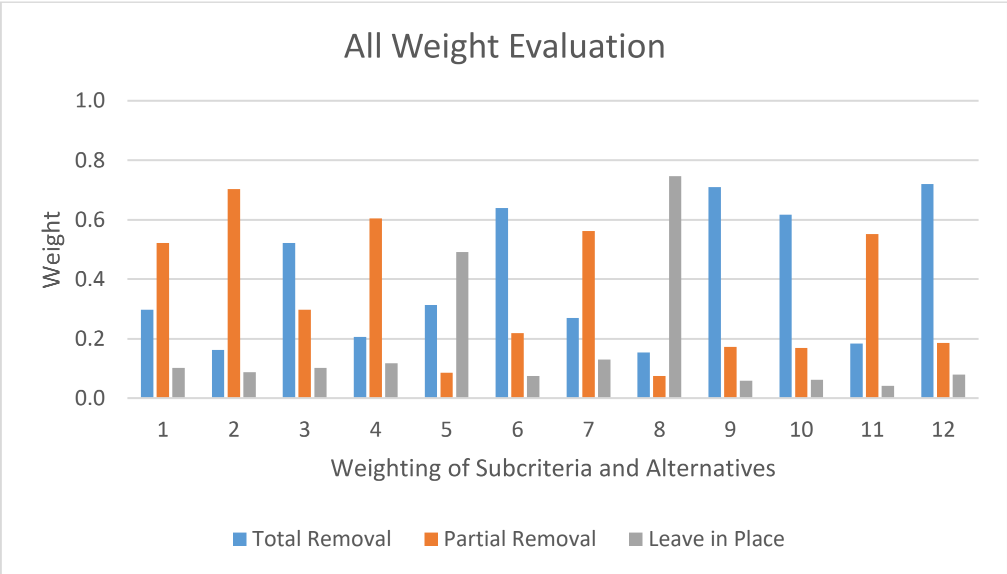

Figure 4.4c All Weight Evaluation

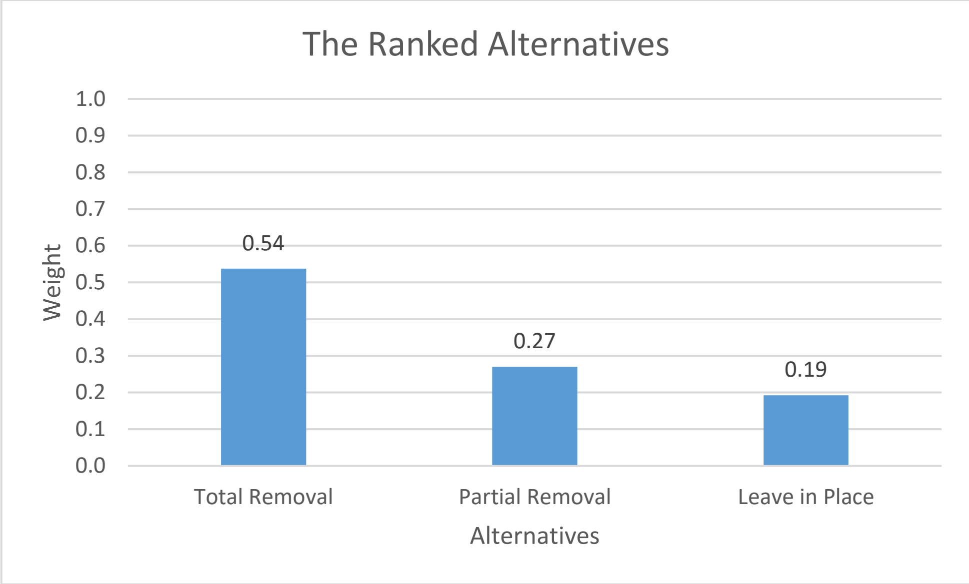

Figure 4.4d The Ranked Alternatives

Table 4.3.35 is the result of computation by inputting the eigen vector and summing up all the eigen vectors associated with each alternative. Based on the above data obtained the weight of all weight evaluation of DRE alternatives. The highest weight of all weight evaluation is best decision of DRE alternative. So it can be known from respondent 3 that the best decision of DRE alternative is total removal with the weight is 0.54.

Table 4.4 The Ranked Alternatives

Alternatif	Responden			Final Weight
	1	2	3	
	0.19	0.72	0.08	
Total Removal	0.43	0.66	0.54	0.60
Partial Removal	0.30	0.17	0.27	0.21
Leave in Place	0.27	0.17	0.19	0.19

Based on table 4.4 obtained the best DRE alternative on platform decommissioning with calculating the average of all weight evaluation from experts. The best alternative based on AHP method is total removal because it has the highest all weight evaluation.

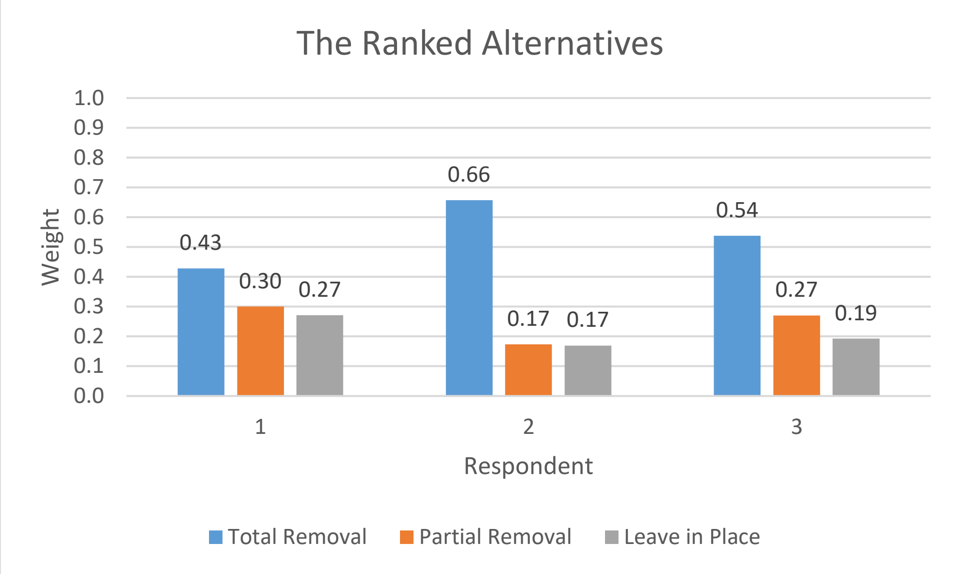

Figure 4.5 The Ranked Alternatives by All Experts

4.2 Simple Additive Weighting (SAW) Method

The steps of SAW method which is conducted in the selection of DRE alternative on platform decommissioning are as follows:

a. Compilation of Situation Components

The results of problem identification are:

1) The Goal of Problems

The goal to be achieved in this bachelor thesis is the selection of DRE alternative on Attaka platform decommissioning owned by Chevron Indonesia Company in Makassar Strait.

2) Determine alternatives and criteria

To determine the best DRE alternative on platform decommissioning is taken some criteria (C) as consideration as in the following table:

Table 4.5 Selection Criteria

No	Criteria
C1	Environment
C2	Cost
C3	Convertion
C4	Safety

Based on the criteria provided, it can be determined that meet all these criteria as an alternative problem. The alternatives are selected as in the following table:

Tabel 4.6 Decision Alternatives

No	Alternatives
A1	Total Removal
A2	Partial Removal
A3	Leave in Place

Prior to weight ranking, given some consideration in giving the language weight of each criteria. Consideration based on expert opinion and research data that has been done.

a. Environmental and Coversion Criteria

Consideration of environmental and conversion criteria based on the journal by A. M Fowler, P.I Macreadie, D.O.B Jones and D.J Booth who are experts in the field of environment. The object of research was conducted on the Grace platform, California. The following is the Grace platform data.

Table 4.7 The Grace Platform Data

Platform Name	Grace
Location	Southern California 34.1795720 South, -119.4678280 East
Operator	Venoco
Dimension	3120 m^2 (bottom footprint)
Depth	97 m
Operation	1979

Figure 4.6 The Grace Platform Location

There are 14 environmental criteria used in the assessment of experts that are ranked based on environmental performance ie production of exploitable biomass, provision of reef habitat, protection from trawling, loss of developed community, enhancement of diversity, energy use, gass emission, contamination, spread of invasive species, alteration of tropic webs, facilitation of disease, smothering of soft bottom communities, alteration of hydrodynamic regimes, and habitat damage from scattering of debris. Here are the results of the assessment conducted;

Table 4.8 Experts Assessment Result

Alternatives	Total Approval Criteria
Leave in place	14
Partially remove, transport to shore, reuse	4
Partially remove, transport to shore, recycle	2
Partially remove, transport to shore, scrap	1
Partially remove, relocate to shallow water	10
Partially remove, relocate to deep water	5
Completely remove, transport to shore, reuse	2
Completely remove, transport to shore, recycle	2
Completely remove, transport to shore, scrap	2
Completely remove, relocate to shallow water	4
Completely remove, relocate to deep water	1

b. Cost Criteria

Consideration of cost criteria based on research by Rizqi August, 2017, which discusses the decommissioning analysis based on cost and time. The object of the study was conducted on the Ed-Well Tripod platform. Here is an Ed-Well Tripod platfrom data.

Table 4.9 Ed-Well Platform Data

Platform Name	Ed-Well Tripod
Location	ONWJ Field 005˚ 55' 05 South, 107˚ 56' 07.20'' East
Operator	Pertamina
Depth	142 ft
Operation	1979

Research result of cost estimation on decommissioning are:

Table 4.10 Research Result

Alternatives	Cost
Leave in place	Rp. 63.949.752.200
Partial Removal	Rp. 88.464.377.200
Total Removal	Rp. 112.268.652.200

c. Safety Criteria

Consideration of safety criteria as follows:

Table 4.11 Safety Considerations

Leave in place	- Serious problems when structures are used in fisheries activities such as deformation and corrosion resulting in loss of fishermen. In addition, trawls that are involved in the structure of the bridge are dangerous to the ship. (Fisheries Directorate of Norway) - Until 2013, there are 12 ship collision events with the platform that is no longer operating (Bakorkamla RI) - Slightly risky for fisheries and navigation (PTTEP)
Partial Removal	- No risk to fisheries and navigation (PTTEP)
Total Removal	- No risk to fisheries and navigation (PTTEP)

3) Determine the weight of each alternative and criteria.

Table 4.12 Specifying The Weight Scale of each Criteria

Intensity of Importance	Definition of Importance
1	Equal importance
2	Moderate importance
3	Strong importance
4	Very strong importance
5	Extreme importance

b. Problem Analysis

Analysis of SAW method is done with the following steps (Afshari et al, 2010):

- Respondent 1

  Step 1:

  In order tu calculate computing Weighted Sum Vector;

1) Construct a pairwise comparison matrix for criteria with respect to objective Saaty's scale.

2) For each comparison, we will decide which of two criteria is the most important, then assign a weight to show how much important it is.
3) Compute each element of the comparison matrix by its colomn total and calculate the prority vector by finding the row averages.
4) Weighted sum matrix is found by multiplying the pairwise comparison matrix and priority vector.
5) Dividing all the elements of the weighted sum matrix by their respective priority vector element.
6) Compute the average of this value to obtain λmax
7) Find the Consistency Index, CI, as (2.3)
8) Calculate the consistency ratio, CR, as (2.4)
9) Judgement consistency can be checked by taking CR of CI with the appropriate value in Table 2.2. The CR is acceptable, if it does not exceed 10%. If it more, the judgement matrix is inconsistent. To obtain a consisten matrix, judgements should be reviewed and improved. The result as Table

Table 4.13a Weights of Criteria by Comparison Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.09	0.05	0.19	0.12	0.109
Cost	0.44	0.23	0.44	0.19	0.325
Conversion	0.03	0.03	0.06	0.12	0.060
Safety	0.44	0.69	0.31	0.58	0.505

Table 4.13b The Weighted Criteria

C1	C2	C3	C4
0.109	0.325	0.060	0.505

Step 2:

Construct a decision matrix (m x n) that includes m alternative and n criteria. Calculate the normalized decision matrix. We will start following steps that will show of SAW method.

1) Create a match rating table of each alternative on each criteria.

Table 4.13c Match Rating of Each Alternative on Each Criteria

Alternatives	Criteria			
	C1	C2	C3	C4
A1	5	2	2	5
A2	3	4	3	4
A3	2	4	3	2

2) Create a decision matrix, X, formed from the match rating table of each alternative on each criterion. Matrix X:

$$X = \begin{pmatrix} 5 & 2 & 2 & 5 \\ 3 & 4 & 3 & 4 \\ 2 & 4 & 3 & 2 \end{pmatrix}$$

3) Normalize the decision matrix, X, by calculating the weighted normalized performance rating (rij) of alternative Ai on criteria Cj.

In this analysis, the criteria assumed benefit criteria are environment, conversion, and safety. Furthermore, normalization is as follows:

a. Normalize environmental criteria

$$r_{11} = \frac{5}{Max\{5;3;2\}} = \frac{5}{5} = 1$$

$$r_{21} = \frac{3}{Max\{5;3;2\}} = \frac{3}{5} = 0{,}6$$

$$r_{31} = \frac{2}{Max\{5;3;2\}} = \frac{2}{5} = 0{,}4$$

b. Normalize cost criteria

$$r_{12} = \frac{Min\{2;4;4\}}{2} = \frac{2}{2} = 1$$

$$r_{22} = \frac{Min\{2;4;4\}}{4} = \frac{2}{4} = 0{,}5$$

$$r_{32} = \frac{Min\{2;4;4\}}{4} = \frac{2}{4} = 0{,}5$$

c. Normalize conversion criteria

$$r_{13} = \frac{2}{Max\{2;3;3\}} = \frac{2}{3} = 0{,}67$$

$$r_{23} = \frac{3}{Max\{2;3;3\}} = \frac{3}{3} = 1$$

$$r_{33} = \frac{3}{Max\{2;3;3\}} = \frac{3}{3} = 1$$

d. Normalize safety criteria

$$r_{14} = \frac{5}{Max\{5;4;2\}} = \frac{5}{5} = 1$$

$$r_{24} = \frac{4}{Max\{5;4;2\}} = \frac{4}{5} = 0{,}8$$

$$r_{34} = \frac{2}{Max\{5;4;2\}} = \frac{2}{5} = 0,4$$

4) Result of normalized performance rating (rij) will form a normalized matrix (R). Matrix R:

$$R = \begin{pmatrix} 1 & 1 & 0,67 & 1 \\ 0,6 & 0,5 & 1 & 0,8 \\ 0,4 & 0,5 & 1 & 0,4 \end{pmatrix}$$

Step 3:

The SAW method evaluates each alternative,Ai, by using equation (2.2):

$$Ai = \sum_{j=1}^{n} w_j r_{ij}$$

where:

Ai = ranking each alternative

wj = weight each criteria

rij = normalized performance rating

So get the rank of Ai based on following table:

Table 4.13d The Ranked Alternatives

Alternatives	Criteria				Ai
	C1	C2	C3	C4	
A1	1	1	0.67	1	0.98
A2	0.6	0.5	1	0.8	0.69
A3	0.4	0.5	1	0.4	0.47

Based on the calculation result, the weight of A1 is the largest indicating that alternative A1 is the best alternative that is total removal.

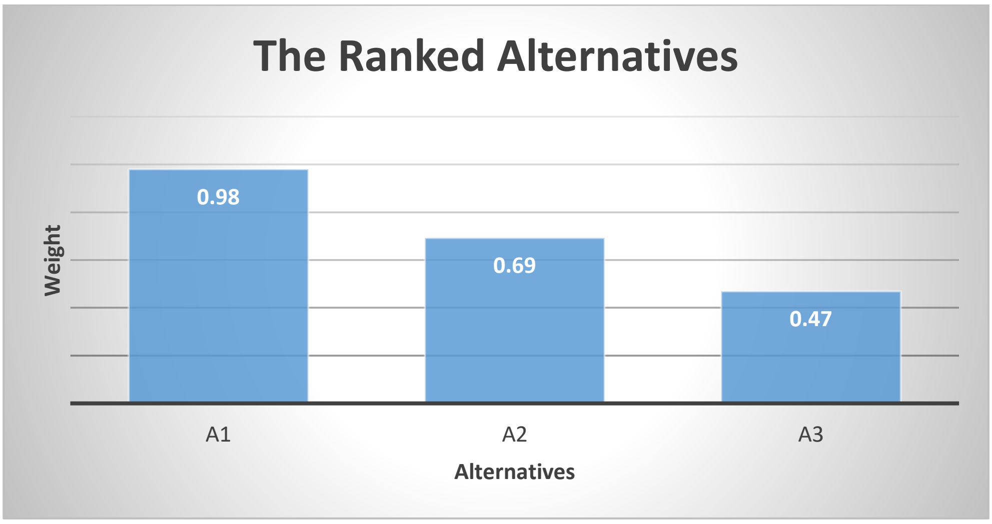

Figure 4.7 The Ranked Alternatives

- Respondent 2

  Step 1:

  In order tu calculate computing Weighted Sum Vector;

1) Construct a pairwise comparison matrix for criteria with respect to objective Saaty's scale.
2) For each comparison, we will decide which of two criteria is the most important, then assign a weight to show how much important it is.
3) Compute each element of the comparison matrix by its colomn total and calculate the prority vector by finding the row averages.
4) Weighted sum matrix is found by multiplying the pairwise comparison matrix and priority vector.
5) Dividing all the elements of the weighted sum matrix by their respective priority vector element.
6) Compute the average of this value to obtain λmax
7) Find the Consistency Index, CI, as (2.3)
8) Calculate the consistency ratio, CR, as (2.4)
9) Judgement consistency can be checked by taking CR of CI with the appropriate value in Table 2.2. The CR is acceptable, if it does not exceed 10%. If it more, the judgement matrix is inconsistent. To obtain a consisten matrix, judgements should be reviewed and improved. The result as Table

Table 4.14a Weights of Criteria by Comparison Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.394736842	0.5	0.375	0.375	0.411
Cost	0.078947368	0.1	0.125	0.125	0.107
Conversion	0.131578947	0.1	0.125	0.125	0.120
Safety	0.394736842	0.3	0.375	0.375	0.361
Total	1	1	1	1	1

Table 4.14b The Weighted Criteria

C1	C2	C3	C4
0.411	0.107	0.120	0.361

Step 2:

Construct a decision matrix (m x n) that includes m alternative and n criteria. Calculate the normalized decision matrix. We will start following steps that will show of SAW method.

5) Create a match rating table of each alternative on each criteria.

Table 4.14c Match rating of each alternative on each criteria

Alternatif	Kriteria			
	C1	C2	C3	C4
A1	4	3	4	3
A2	2	2	1	1
A3	1	1	2	1

6) Create a decision matrix, X, formed from the match rating table of each alternative on each criterion. Matrix X:

$$X = \begin{pmatrix} 4\ 3\ 4\ 3 \\ 2\ 2\ 1\ 1 \\ 1\ 1\ 2\ 1 \end{pmatrix}$$

7) Normalize the decision matrix, X, by calculating the weighted normalized performance rating (rij) of alternative Ai on criteria Cj.

In this analysis the criteria assumed benefit criteria are environment, conversion, and safety. Furthermore, normalization is as follows:

a. Normalize environmental criteria

$$r_{11} = \frac{4}{Max\{4;2;1\}} = \frac{4}{4} = 1$$

$$r_{21} = \frac{2}{Max\{4;2;1\}} = \frac{2}{4} = 0{,}5$$

$$r_{31} = \frac{1}{Max\{4;2;1\}} = \frac{1}{4} = 0{,}25$$

b. Normalize cost criteria

$$r_{12} = \frac{Min\{3;2;1\}}{3} = \frac{1}{3} = 0{,}33$$

$$r_{22} = \frac{Min\{3;2;1\}}{2} = \frac{1}{2} = 0{,}5$$

$$r_{32} = \frac{Min\{3;2;1\}}{1} = \frac{1}{1} = 1$$

c. Normalize conversion criteria

$$r_{13} = \frac{4}{Max\{4;1;2\}} = \frac{4}{4} = 1$$

$$r_{23} = \frac{1}{Max\{4;1;2\}} = \frac{1}{4} = 0{,}25$$

$$r_{33} = \frac{2}{Max\{4;1;2\}} = \frac{2}{4} = 0{,}5$$

d. Normalize safety criteria

$$r_{14} = \frac{3}{Max\{3;1;1\}} = \frac{3}{3} = 1$$

$$r_{24} = \frac{1}{Max\{3;1;1\}} = \frac{1}{3} = 0{,}33$$

$$r_{34} = \frac{1}{Max\{3;1;1\}} = \frac{1}{3} = 0{,}33$$

8) Result of normalized performance rating (rij) will form a normalized matrix (R). Matrix R:

$$R = \begin{pmatrix} 1 & 0{,}33 & 1 & 1 \\ 0{,}5 & 0{,}5 & 0{,}25 & 0{,}33 \\ 0{,}25 & 1 & 0{,}5 & 0{,}33 \end{pmatrix}$$

Step 3:

The SAW method evaluates each alternative,Ai, by using equation (2.2):

$$Ai = \sum_{j=1}^{n} w_j r_{ij}$$

where:

Ai = ranking each alternative

wj = weight each criteria

rij = normalized performance rating

So get the rank of Ai based on following table:

Table 4.14d The Ranked Alternatives

Alternatives	Criteria				Ai
	C1	C2	C3	C4	
A1	1	0	1.00	1	0.93
A2	0.5	0.5	0	0.3	0.41
A3	0.3	1.0	1	0.3	0.39

Based on the calculation result, the weight of A1 is the largest indicating that alternative A1 is the best alternative that is total removal.

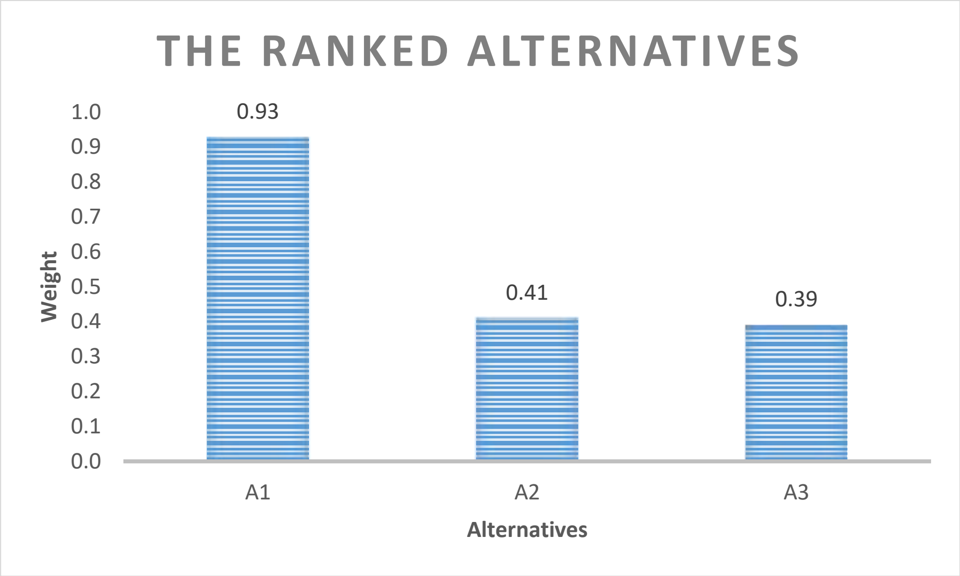

Figure 4.8 The Ranked Alternatives

- Respondent 3

  Step 1:

  In order tu calculate computing Weighted Sum Vector;

1) Construct a pairwise comparison matrix for criteria with respect to objective Saaty's scale.
2) For each comparison, we will decide which of two criteria is the most important, then assign a weight to show how much important it is.
3) Compute each element of the comparison matrix by its colomn total and calculate the prority vector by finding the row averages.
4) Weighted sum matrix is found by multiplying the pairwise comparison matrix and priority vector.
5) Dividing all the elements of the weighted sum matrix by their respective priority vector element.
6) Compute the average of this value to obtain λmax
7) Find the Consistency Index, CI, as (2.3)
8) Calculate the consistency ratio, CR, as (2.4)
9) Judgement consistency can be checked by taking CR of CI with the appropriate value in Table 2.2. The CR is acceptable, if it does not exceed 10%. If it more, the judgement matrix is inconsistent. To obtain a consisten matrix, judgements should be reviewed and improved. The result as Table

Table 4.15a Weights of Criteria by Comparison Matrix

Factor A Element	Factor B Element				Weight
	Environment	Cost	Conversion	Safety	
Environment	0.06	0.02	0.08	0.09	0.062
Cost	0.50	0.16	0.42	0.13	0.301
Conversion	0.06	0.03	0.08	0.13	0.075
Safety	0.39	0.79	0.42	0.65	0.561

Table 4.15b The Weighted Criteria

C1	C2	C3	C4
0.062	0.301	0.075	0.561

Step 2:

Construct a decision matrix (m x n) that includes m alternative and n criteria. Calculate the normalized decision matrix. We will start following steps that will show of SAW method.

9) Create a match rating table of each alternative on each criteria.

Table 4.15c Match rating of each alternative on each criteria

Alternatif	Kriteria			
	C1	C2	C3	C4
A1	4	3	5	5
A2	3	2	4	3
A3	1	1	1	1

10) Create a decision matrix, X, formed from the match rating table of each alternative on each criterion. Matrix X:

$$X = \begin{pmatrix} 4 & 3 & 5 & 5 \\ 3 & 2 & 4 & 3 \\ 1 & 1 & 1 & 1 \end{pmatrix}$$

11) Normalize the decision matrix, X, by calculating the weighted normalized performance rating (rij) of alternative Ai on criteria Cj.

this analysis the criteria assumed benefit criteria are environment, conversion, and safety. Furthermore, normalization is as follows:

a. Normalize environmental criteria

$$r_{11} = \frac{4}{Max\{4;3;1\}} = \frac{4}{4} = 1$$

$$r_{21} = \frac{3}{Max\{4;3;1\}} = \frac{3}{4} = 0,75$$

$$r_{31} = \frac{1}{Max\{4;3;1\}} = \frac{1}{4} = 0,25$$

b. Normalize cost criteria

$r_{12} = \frac{Min\{3;2;1\}}{3} = \frac{1}{3}$ = 0.33

$r_{22} = \frac{Min\{3;2;1\}}{2} = \frac{1}{2}$ = 0,5

$r_{32} = \frac{Min\{3;2;1\}}{1} = \frac{1}{1}$ = 1

c. Normalize conversion criteria

$r_{13} = \frac{5}{Max\{5;4;1\}} = \frac{5}{5}$ = 1

$r_{23} = \frac{4}{Max\{5;4;1\}} = \frac{4}{5}$ = 0.8

$r_{33} = \frac{1}{Max\{5;4;1\}} = \frac{1}{5}$ = 0.2

d. Normalize safety criteria

$r_{14} = \frac{5}{Max\{5;4;2\}} = \frac{5}{5}$ = 1

$r_{24} = \frac{3}{Max\{5;4;2\}} = \frac{3}{5}$ = 0,6

$r_{34} = \frac{1}{Max\{5;4;2\}} = \frac{1}{5}$ = 0,2

12) Result of normalized performance rating (rij) will form a normalized matrix (R). Matrix R:

$$R = \begin{pmatrix} 1 & 0.33 & 1 & 1 \\ 0.75 & 0.5 & 0.8 & 0.6 \\ 0.25 & 1 & 0.2 & 0.2 \end{pmatrix}$$

Step 3:

The SAW method evaluates each alternative,Ai, by using equation (2.2):

$$Ai = \sum_{j=1}^{n} w_j r_{ij}$$

where:

Ai = ranking each alternative

wj = weight each criteria

rij = normalized performance rating

So get the rank of Ai based on following table:

Table 4.15d The Ranked Alternatives

Alternatives	Criteria				Ai
	C1	C2	C3	C4	
A1	1	0	1.00	1	0.80
A2	0.8	0.5	1	0.6	0.59
A3	0.3	1.0	0	0.2	0.44

Based on the calculation result, the weight of A1 is the largest indicating that alternative A1 is the best alternative that is total removal.

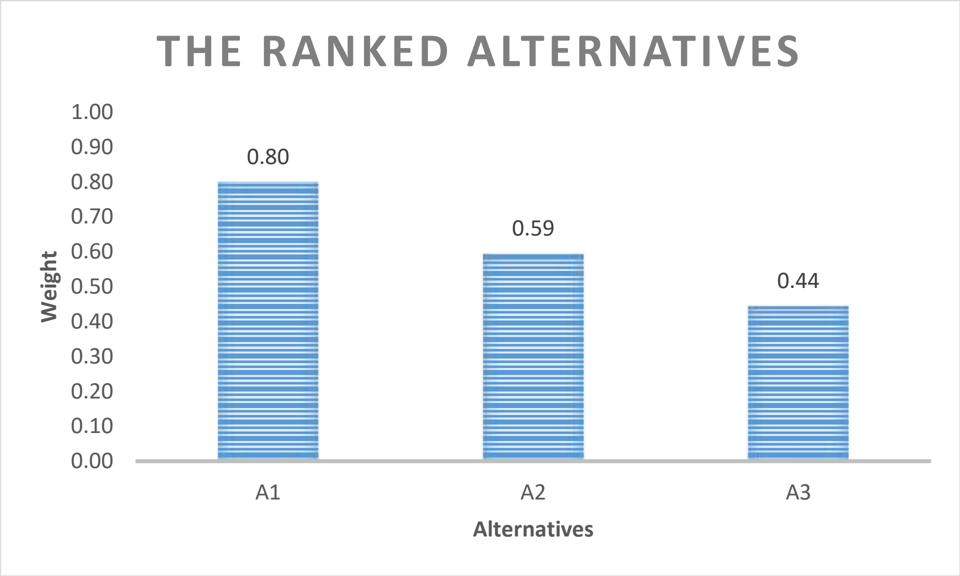

Figure 4.9 The Ranked Alternatives

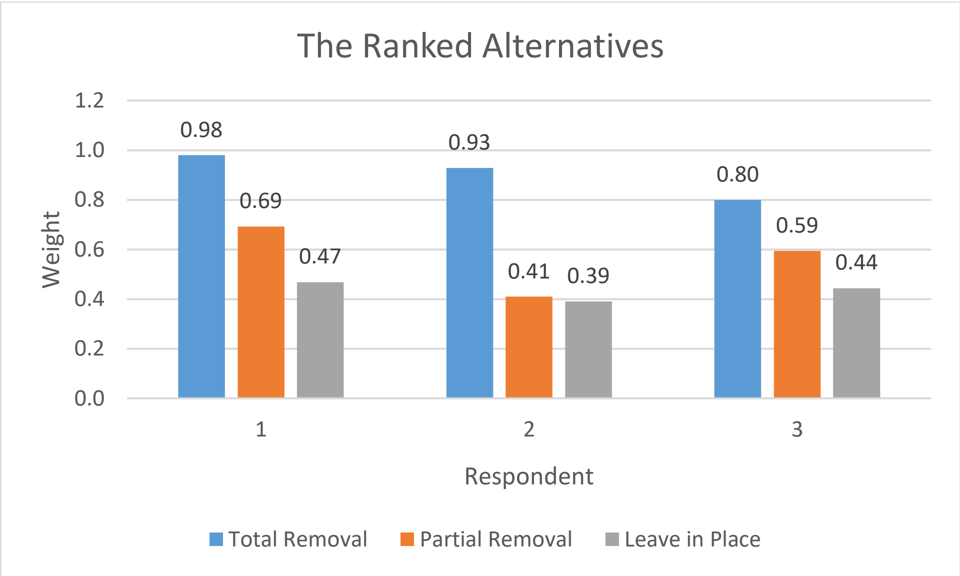

Figure 4.10 The Ranked Alternatives by All Experts

Table 4.16 The Ranked Alternatives

Alternatives	Respondent			Final Weight
	1	2	3	
	0.19	0.72	0.08	
Total Removal	0.98	0.93	0.80	0.93
Partial Removal	0.69	0.41	0.59	0.48
Leave in Place	0.47	0.39	0.44	0.41

Based on table 4.16 obtained the best DRE alternative on platform decommissioning with calculating the average of all weight evaluation from experts. The best alternative based on SAW method is total removal because it has the highest all weight evaluation.

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CHAPTER V
CONCLUSION

5.1 Conclusions

From the analysis of decision making that have been done with AHP and SAW methods in Chapter IV, it can be concluded to answer the problems are determined in this bachelor thesis. These conclusions are:

1. The best decision result in alternative selection of dismantlement, repair, and engineering (DRE) on decommissioning of fixed platform with Analitycal Hierarchy Process (AHP) method is total removal.
2. The best decision result in alternative selection of dismantlement, repair, and engineering (DRE) on decommissioning of fixed platform with Simple Additive Weighting (SAW) method is total removal.

5.2 Suggestions

Suggestions that can be given for further research are as follows:

1. It is recommended to increase the number of respondents more when using AHP & SAW methods so that the data analysis can be more valid. In addition, it is also necessary to pay more attention to the expertise of respondents in providing an assessment of the questionnaire.
2. It is advisable to increase the number of reference and journal data when analyzing the decision making so that the analysis results can be more accurate.
3. It is advisable to add alternatives, criteria and other subcriteria for decision making considerations.

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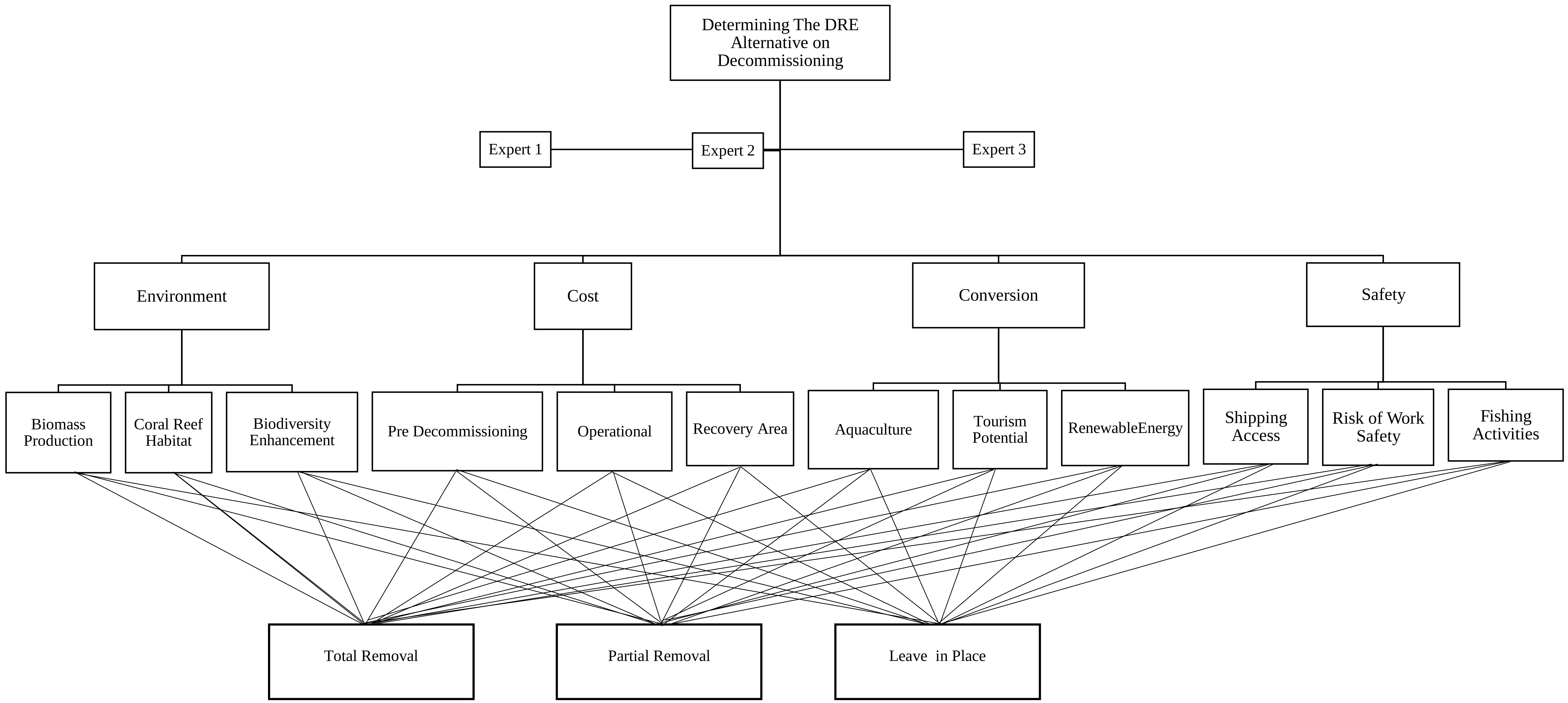

Figure 4.1 Hierarchy Arrangement of Determining The Best Alternative on Decommissioning

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Indonesian

Head of Geosciences & Reservoir, Peciko & Bekapai Asset, + 12 years of experiences

CAREER PROFILE

More than 12 years of experiences in geosciences and reservoir engineering domain with geographic exposure in 4 continents. Currently, leading a team of 30 geoscientists and reservoir engineers to optimize the asset value of Peciko and Bekapai fields. Fluent in English, French and Indonesian.

2013 – Now	***Head of Geosciences & Reservoir Department, TOTAL E&P INDONESIE***
2011 – 2013	***Chef de Projet Géosciences, TOTAL SA, FRANCE***
2010 – 2011	***Geosciences Project Coordinator, TOTAL E&P NORGE***
2008 – 2010	***Head of Gas Field Managemet, TOTAL E&P NIGERIA***
2007 – 2008	***Sr. Reservoir Engineer, TOTAL E&P NIGERIA***
2003 – 2007	***Reservoir Engineer, TOTAL E&P INDONESIE***
2002 – 2003	***Jr. Reservoir Engineer, TOTAL SA, FRANCE***

PROFESSIONAL EXPERIENCES

Position 1 : Jr. Reservoir Engineer (Internship) - TOTAL SA, FRANCE, 2002 – 2003

- **Performed dynamic synthesis and reservoir modeling in several fields in Asia Pacific region.**

Position 2 : Reservoir Engineer - TOTAL E&P INDONESIE , INDONESIA, 2003 – 2007

- **Highly involved in Handil revival project that allowed increasing Handil oil production from 12,500 bopd in mid 2003 to 24,000 bopd in early 2006 through light work over, infill wells and EOR optimization.**

Position 3 : Sr. Reservoir Engineer - TOTAL E&P NIGERIA, NIGERIA, 2007 – 2008

- **Supervised field operation and proposed development strategy for OML 100 conventional offshore block, Nigeria.**

Position 4 : Head of Gas Field Managemet - TOTAL E&P NIGERIA, NIGERIA, 2008 – 2010

- **Managed a reservoir & petroleum engineering team to optimize the production and the development of TOTAL's gas assets in onshore Nigeria**
- **Sanctioned OML 58 Up-grade development project to increase the plant capacity by 50% and boast up the production from 100k boepd to 150k boepd.**

Position 5 : Geosciences Project Coordinator - TOTAL E&P NORWAY, NORWAY, 2010 - 2011

- **Coordinated a team of geoscientists and reservoir engineers to propose field development plans of several discoveries in the North Sea, Norway, including Atla fast track development. The development sanction of the later was only one year after the discovery (125 BCF of 2P reserves).**
- **Subsurface representative for Oseberg JV and Tune JV, operated by Statoil. Both JVs produced 180k boepd in 2010.**

Position 6 : Chef de Projet Géosciences for Gladstone LNG Project - TOTAL SA, FRANCE, 2011 - 2013

- Managed a team of geoscientists and reservoir engineers to optimize the development of Gladstone LNG megaproject in Queensland, Australia (~20 billion USD development project where TOTAL is partner with 27.5% of interest).
- Member of Alternate Development Philosophy project to define new development philosophy to improve the project's value. Seconded in Santos' office in Brisbane, Australia for 6-month period.
- Helped the group to develop and build knowledge on Coal Bed Methane; unconventional theme.

Position 7 : Head of Geosciences and Reservoir Engineering, Peciko & Bekapai Asset - TOTAL E&P INDONESIE, INDONESIA , 2013 - Now

- Managing and optimizing the asset value of Peciko and Bekapai fields in offshore Mahakam; 2014 production of 400 MMscfd and 15,000 bopd with 180 active wells, 16 platforms and 3 jack-up rigs.
- Sustained the production of Peciko at 350 MMscfd and increased the production of Bekapai from 6,000 bopd to 12,000 bopd, the highest production figure in the past 25 years, through well intervention and infill wells.
- Team management of 30 geoscientists and reservoir engineers.
- 4C&D stream leader for Geosciences and Reservoir division, coordinating several initiatives and champions to optimize the cost of the affiliate.

EDUCATION

"B.Sc in Engineering"

1996 – 2000 Parahyangan University, Bandung, Indonesia

"M.Sc in Petroleum Engineering & Project Development (DEG)"

2001 – 2002, IFP-School, France

RELEVANT SKILLS

- **Followed a 6-month Business Skills training in Paris & Shanghai, TOTAL & HEC, Paris & Shanghai, 2012**

RELEVANT PROFESSIONAL ACTIVITIES

- **Program Director, STT Migas Petroleum School, Balikpapan, Indonesia 2004 – 2005**
  Set-up a petroleum engineering under-graduate program in a university in Balikpapan.
- **Member of TOTAL Professeurs Associes (TPA), 2004 - Now**
  Delivered guest lecturers in several universities, in Indonesia and Norway.
- **President of Society of Petroleum Engineer (SPE), Balikpapan Section, Indonesia, 2006 - 2007**

PROFESSIONAL ARTICLES

- **October 2004, World Petroleum Congress 1st Youth Forum, Beijing, China**
  "Optimization of EOR Lean Gas Injection Project in Handil Field, Indonesia, a Nine Year Project Experience", ISBN 7-900394-87-7, Author

- **April 2005, SPE, Asia Pacific Oil & Gas Conf. & Exhibition, Jakarta, Indonesia**

  "Integrated Management of Water, Lean Gas and Air Injection: The Successful Ingredients to EOR Projects on the Mature Handil Field", SPE–92858–PP, Author with Marcel Duiveman and Patrick Grivot

  Winning 3rd Prize of 2005 Prix de la communication, Total

- **November 2007, SPE, Asia Pacific Oil & Gas Conf. & Exhibition, Jakarta, Indonesia**

  "Reviving the Mature Handil Field: From Integrated Reservoir Study to Field Application", SPE–110882–PP, Author with Emmanuel Cassou and Hotma Yusuf

  Published in Journal of Petroleum Technology, SPE, January 2008 Edition

- **October 2014, SPE, Asia Pacific Oil & Gas Conf. & Exhibition, Adelaide, Australia**

  "Dynamic Behavior of a Multi-Layered Coal Seams Gas Reservoir in the Bowen Basin", SPE–171538–MS, Author with Francois Gouth and Irina Belushko

MISCELLANEOUS

- **SCUBA diving Instructor, Professional Association of Diving Instructors (PADI), Registration No: 261014**
- **Tae Kwon Do Instructor, Black Belt-Dan 1, World Tae Kwon Do Federation**

CURRICULLUM VITAE

PERSONAL DATA

Name	: Febi Febrian Putra
Place & Date of birth	: Padang, February 28, 1981
Religion	: Islam
Nationality	: Indonesian
Sex	: Male
Marital Status	: Married
Address	: Buana Gardenia C3/25 Pinang, Ciledug Tangerang (28884)
Mobile Phone	: 0856-93682380
E-mail	: febrian_ftk@yahoo.com
Other Supporting Skill	: PC Literate (Windows Programs) Microsoft office, Auto CAD, Caesar II, PDMS
Language	: Indonesia - Fluent : English - Fluent
Strong Points	: Honest, responsible, hardworking, able to work in a Team, mature, fast learner, pleasant personal and strong leadership.
Driving License	: SIM A : 810212057444
Profesional Engineer	: IPP (Insinyur Profesional Pratama)

OBJECTIVES

Challenging career opportunity where I can contribute my knowledge for the Company's profit and improvement, also improve my knowledge and experience.

EDUCATION

- 2000-2004 : Darma Persada University, Jakarta, Majoring Marine Engineering (Bachelor Degree)
- 1996-1999 : SeniorHigh School, SMK Baharione, Jakarta
- 1993-1996 : Junior High School, SLTP Negeri 3 Sumbar
- 1987-1993 : Elementary School, SD 08, Sumbar

COURSE AND SEMINAR

SI	DATE	COURSE/SEMINAR	ORGANIZER
1	November 2016	Mariant Smartplant	Pec Tech
2	April 2016	Internal Auditor ISO 9001:2015	SAI Global
3	March 2016	Offshore Project Engineering Module 15	Technip University
4	November 2015	PULSE for Engineers	Technip Group (In house)
5	October 2015	Internal Auditor ISO 27001:2013	Bureau Veritas (BV)
6	December 2014	Risk Management Fundamental	Technip University
7	August 2014	Quartz – Project Quality Awareness	Technip Indonesia
8	April 2014	PULSE for the Workforce	Technip Indonesia
9	March 2014	Project Risk Management	CMT
10	August 2013	Professional Engineer	The Institution of Engineers Indonesia (PII)
11	June 2011	Oil Storage Design & Analysis API 650	INTERGRAPH
12	July 2010	SAP Business Introduction	PT. SPV
13	June 2009	PDMS (Piping Design)	Oil Institute
14	November 2008	Safety and Design (SID)	PT. Chevron Pacific Indonesia (CPI)
15	July 2008	Pipe Stress Analysis	PT. Rekayasa Engineering
16	May 2008	Piping Designer	Ministry Of Industry (B4T)
17	2004	AutoCAD	BINUS School

EXPERIENCE

- **November 2016 – Present**

PT. Sateri Viscose International
Petrochemical Company
Position: Mechanical Project Engineer

APRIL

Project
Project : Chemical Plant (Natural Gas Based Carbon Disulphide Production)
Sateri Viscose International

- Review piping and equipment layout designs created by engineering consultant
- Assistance with preperation of piping and mechanical scope of work for offering
- Review of piping and equipment documentation, information, communications, data sheets, engineering specifications, material requisitions, and ensuring conformance to SVI requirements
- Technical evaluation of Vendor quotations including preparation of technical bid comparisons
- Technical support for negotiations with equipment vendors
- Review and comment on vendor documentation, compilation of comments from other disciplines (if any)

- Participation in kick-off, pre-production and pre-inspection meetings (PIM) and supplier coordination meetings, and carrying out quality audits of suppliers execution activities
- Participate for HAZID/HAZOP/SIL workshop.
- Monitor the execution of the quality piping & equipment by Contractor for conformance to project requirements.

- **January 2013 – October 2016**
  PT. TECHNIP INDONESIA
  Engineering, Procurement, Construction and Installation (EPCI) Company

  - December 2013 – October 2016
    Position: **HSES Engineer**

    Job description:
    - Assist in the preparation of Project HSE Plan and ensure compliance with Client's requirements
    - Assist in monitoring the implementation of Corporate HSE Manual by conducting inspections and audits
    - Recommend the acceptable Personnel Protective Equipment (PPE) for safe work practices
    - Maintain good filing system for all HSE related records
    - Enforcement of corporate policies on health, safety and envir environment
    - Report any significant hazard identified in the home office
    - If assigned as Project HSE Representative, coordinate with the site HSE/Safety Officers for the correct implementation of site HSE Plan and procedures.
  - June 2014 – November 2015
    Position: **Package Engineer**

    Project Completed
    Client : ENI
    Project : Jangkrik Complex
    Engineering, Procurement, Commissioning, and Installation of:
    - 36 kilometers of flexible risers and flowlines with diameters ranging from 4" to 14"
    - 195 kilometers of pipeline with diameter ranging from 4" to 24",
    - Subsea equipment which includes mid-water arch and flowline end termination
    - Onshore receiving facility (ORF) including pig traps, metering systems and utilities.

    Job description:
    - Completing all assigned tasks as delegated by the Package Manager
    - Coordination of internal and external project activities and the interdisciplinary interfaces in close coordination with the discipline teams leaders
    - Ensure technical requirements defined in the contract are properly incorporated in the package
    - Ensure the design and support of products and equipment to meet client, quality & operational requirements, with particular consideration given to safety, reliability, timeliness, cost effectiveness and functionality

- Support of operations and projects with regard to problem solving and responding to operational problems as appropriate. Manage and facilities
- Reviews Subcontractor bids; interviews and assigns personnel to specific phases and elements of the project. Through project coordination meetings and other forms of communication, oversees and coordinates the technical aspects of the project
- Monitor the execution of the quality for conformance to project requirements.
- Coordination and of internal and external claims and technical issues
- Prepared proposal Scope of work for Subcontractor
- Act as the overall coordinator for all internal department on projects as required and responsible.
- Participate for equipment package HAZOP workshop and Constructability Review

❖ January 2013 – June 2014
Position: **Project Engineer**

Project completed
Client : PT. Pertamina Hulu Energi West Offshore Madura (PHEWMO)
Project :
1. FEED (Front End Engineering Design) for Braced Monopod PHE-29 Platform Develop ment West Offshore Madura
2. FEED (Front End Engineering Design) for Braced Monopod PHE-44 and PHE-48 Platforms Development West Offshore Madura
3. FEED (Front End Engineering Design) for 4 legs CPP2 Processing Platform Development West Offshore Madura.
4. FEED (Front End Engineering Design) for Braced Monopod PHE-7, PHE-12 and PHE24 Platforms Development West Offshore Madura

Client : PETRONAS CARIGALI SDN.BHD
Project : FEED and Detail Engineering for 4 (four) Legs Generic Satellite Wellhead Platform (GSWP) Offshore Terengganu Phase 1

Job description:
- Completing all assigned tasks as delegated by the Project Manager
- Coordination of internal and external engineering activities and the interdisciplinary interfaces in close coordination with the discipline teams leaders.
- Ensure technical requirements defined in the contract are properly incorporated in the engineering deliverables.
- Manage and facilities communications across the engineering functions to ensure that the project objectives and needs are met.
- Coordinates Internal and External Design Reviews.
- Support the Project Control and forecasting activities in the engineering disciplines.
- Monitor the execution of the quality for conformance to project requirements.
- Coordination and of internal and external claims and technical issues
- Conduct weekly engineering project meetings.
- Act as the overall coordinator for all internal and external engineering on projects as required and responsible for the successful integration of the engineer disciplines.
- Participate for HAZID/HAZOP/SIL workshop.

- **July 2010 – December 2012**
  PT. SOUTH PACIFIC VISCOSE
  Petrochemical Company
  Position : **Project Engineer**

  Project completed
  1. Spinbath L-5 80.000 TPA (Fabrication, Installation Piping &Equipment)
  2. Spinbath L-4 Expansion 210 TPA (Fabrication, Installation Piping & Equipment)

  Job description:
  - Develops plan for the project execution & determines project engineering organization
  - Monitor & Control project budget/scheduling, including labour, trends, change order, and progress Main Contractor &sub-Contractor
  - Prepare Piping Engineering Manning Schedule, Piping Master and Detail Schedule, Piping Material Requisition Schedule
  - Prepare data sheet from Equipment
  - Participate in Project Detail Schedule Review
  - Control Manning Schedule and Mobilization
  - Control Correspondence Documents from Main Contractor and Monitoring of Document Change.
  - Coordinate between Main Contractor and Piping Matter
  - Participate Engineering Meeting
  - Finalize Material P/O Quantity (MR).
  - Solve a problem for Project Trouble
  - Develop Approval Plot Plan (from FEED Deliverable)
  - Make Work Order for contractor
  - Supervising of construction and review work procedure Main contractor.
  - Develops and maintains the Work Plan. Establish need dates for assignment of all personnel.
  - Review equipment layout
  - Prepare End of Assignment Evaluations

- **Aug 2008 – June 2010**
  PT.WAHANAKARSA SWANDIRI
  Construction Company
  - December 2013 – Present
    Position: **Construction/Project Engineer**

    Project completed
    Client : PT CHEVRON PACIFIC INDONESIA (CPI)
    Project :
    1. EPC (Engineering, Procurement and Construction)of Design, Fabrication and Construction of Tanks API-650 For Kota Batak Gathering Station
    2. (Engineering, Procurement and Construction)of Minas Surfactant Design, Fabrication and Construction of Tanks and Vessels.

Job description:

- Preparation subcontract change order including estimates, negotiate change orders, obtain required Client approvals.
- Prepared Data Sheet of Tanks & Vessels
- Monitor engineering progress against forecasted schedule
- Prepared construction Material take off
- Supervising of issuance all engineering deliverables until Client approval
- Support the Project Control and forecasting construction activities
- Prepared and Issued Engineering Close-out Report
- Participate for Client Engineering Meeting
- Prepared a construction procurement schedule, major material and equipment purchases.

❖ Aug 2008 – May 2009
Position: **Piping & Mechanical Engineer**

Project completed
Client : PT CHEVRON PACIFIC INDONESIA (CPI)
Project

1. EPC (Engineering, Procurement and Construction)Pipeline, Water Injection at Pungut Stage 1.
2. EPCI (Engineering, Procurement, Construction and Installation) Well Test, Gathering Station and Water Injection at Pungut Stage 2
3. EPC (Engineering, Procurement and Construction) Pig Launcher and Receiver for Pipeline 18" at Minas Field

Job description:

- Sketched additional piping route based on actual at field, designs untill approval for construction (AFC) by Company
- Assessment/supervision of dismantle.
- Prepared Piping Plan, Piping layout and Isometric drawings until Approval for Construction (SFC) by Company
- Prepared Piping welding Joint isometric drawings
- Control documents issued by Company (Piping Material Specification, datasheets, standard drawing, Procedures Installation)
- Prepare calculation report, design for Tanks & issued till get Approval Construction by Company

  The design tanks are as follows :
  - Surge Tank (T-0301) 5400 BBL, (T-6D) 6800 BBL.
  - Skimming Tank (T-0201) 4450 BBL, (T-6C) 380 BBL.
  - Recycle Tank (T-0501) 776 BBL.
  - Wash Tank (T-0102) 6700 BBL.
  - Shipping Tank (T-0401) 1700 BBL.
- Prepared structure drawings based on with Safety In Design (SID) as requirement by Company in Gathering Station Facility
- The drawings should be referred SID are :
  - Fence and Gate Area.
  - Structure Equipment

- Ladder, Walk way, Platform, Spiral way, work space, access road and construction activities.

▪ Hook Up With Instrument and as built drawing post construction.
▪ Participate for commissioning and Start-Up

➢ **Jan 2008 – July 2008**
PT. REKAYASA ENGINEERING
Engineering Company
Position : **Piping Designer**

Project completed
Client : PT. VICO INDONESIA
Project : Nilam Satelite #6 Pipeline Installation

Job description:
- Assistant of drawing design from P&ID to Plot Plan, Piping Plan and isometric till get approval by Company.
- Prepared Piping standards (JIS, ANSI, DIN etc.)
- Drawing set up procedure applicable to the job for CAD operator.
- Conceptualize Plan, details & sections to accurately convey construction or fabrication requirements with minor instruction from Piping Engineering
- Checking drawings produced by CAD Operator
- Coordination with Piping Engineers regarding supplied drawings, specifications or information from Company
- Assist Piping Engineers with initial design & drawing requirements for a complex area of the project.

➢ **Aug 2006 – Dec 2007**
PT. Berkatindo Jaya Kreasi
General Contractor
Position **: Project Supervisor**
Project completed
1. National Convention CNI Expo
2. National Convention Amway
3. BUMN expo
4. SCTV Liga Jarum
5. Indocom Tech Expo
6. Manufacturing expo
7. Oil & Gas expo

Job description:
- Prepared construction planning measures, document necessary information and utilize reports to Site manager
- Interface with Clients Representative to answer questions or solve problems

- Manage tool and consumables materials inventory for project and ensure unused materials are accounted for and reported to the Site Manager
- Identifying and supervise consruction and implementing corrective actions.

➢ **Apr.2004 - Jul. 2006**
PT. MURINDA IRON STEEL– Jakarta
General Contractor & Steel Structure
Position : **Draftsman**

Project completed:

1. Office Building of Menara Satrio-Jakarta
2. Development (I) Project of Sultan Mahmud Badaruddin II International Airport

KUESIONER PENELITIAN
TUGAS AKHIR

Bapak/Ibu Responden yang terhormat,

Terima kasih atas kesediaannya mengisi kuesioner ini. Kuesioner ini merupakan bagian dari penelitian tugas akhir dengan judul "Analisa Pengambilan Keputusan dalam Pemilihan Teknik Pembongkaran Anjungan Lepas Pantai dengan Metode *Analytical Hierarchy Process* dan *Simple Additive Weighting"*. Penelitian ini dibimbing oleh Prof. Ir. Daniel M. Rosyid, P.hd dan Ir. Murdjito, M.Sc untuk memenuhi persyaratan akademik dalam memperoleh gelar Sarjana Strata I (S1) pada Departemen Teknik Kelautan, Fakultas Teknologi Kelautan, Institut Teknologi Sepuluh Nopember Surabaya.

Semua pertanyaan harap diisi dengan lengkap sesuai dengan petunjuk yang diberikan. Saya sangat menghargai partisipasi responden untuk mengisi kuesioner ini.

Hormat Saya,

Tommy Saputra

4313100148

KUESIONER METODE *ANALYTICAL HIERARCHY PROCESS* (AHP)

<u>MULAI</u>

Tanggal Pengisian : 1 Mei 2017

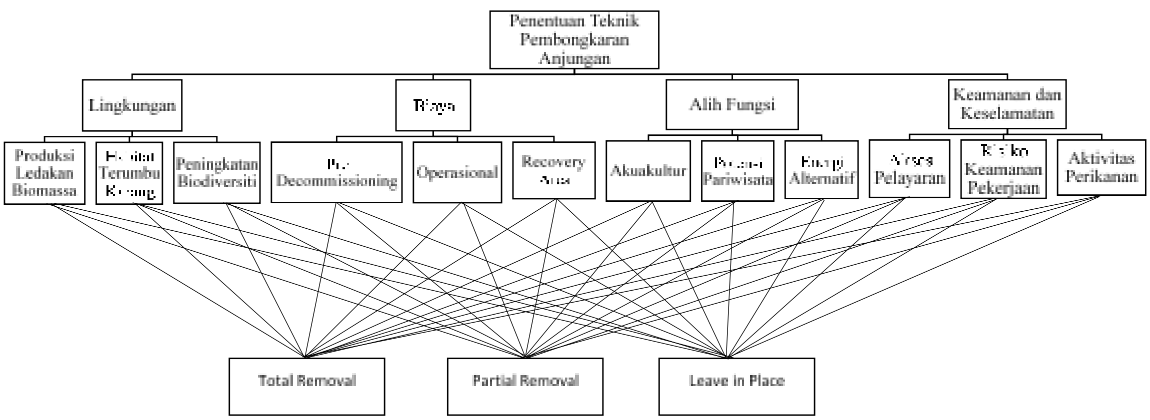
Nama Responden : Henricus Herwin

Jabatan Responden : Kepala Divisi Geosciences and Reservoir Development

Pengalaman Kerja : 15 tahun

I. PENGANTAR

Pengisian kuesioner ini bertujuan untuk menentukan alternatif teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai dengan metode ***Analytical Hierarchy Process*** **(AHP)**. Alternatif pembongkaran yang akan dipilih adalah ***total removal/partial removal/leave in place.*** Landasan utama pengisian kuesioner ini adalah hirarki yang telah disusun sebagai berikut.



Gambar 1. Susunan Hirarki Penentuan Teknik Pembongkaran Anjungan Terbaik

II. PETUNJUK PENGISIAN

a. Umum

1. Isi kolom identitas yang terdapat pada halaman depan kuesioner
2. Berikan skor terhadap hirarki
3. Pemberian skor dilakukan dengan membandingkan tingkat kepentingan/peran komponen dalam satu level hirarki yang berkaitan dengan komponen-komponen level sebelumnya menggunakan skala penilaian yang terdapat pada petunjuk bagian b.
4. Pemberian skor dilakukan dengan mencentak(v)/menyilang(x) pada kolom yang telah disediakan.

b. Skala Skor

Definisi dari skala skor adalah sebagai berikut :

Intensitas Kepentingan (A dibandingkan B)	Definisi
1	A **sama penting** dengan B
3	A **sedikit lebih penting** daripada B
5	A **lebih penting** daripada B
7	A **jelas lebih penting** daripada B
9	A **mutlak penting** daripada B

III. TABEL ISIAN

Dalam pengisian kuesioner dalam tabel berikut, Bapak/Ibu diminta untuk membandingkan mana yang lebih penting dari elemen faktor A dan faktor B, lalu memberikan skor berdasarkan petunjuk. Keluaran dari kuesioner ini adalah memprioritaskan salah satu elemen berdasarkan pendapat responden.

Contoh pengerjaan:

1. Membandingkan tingkat kepentingan elemen-elemen **Kriteria** dibawah ini berdasarkan **Tujuan : Penentuan Teknik Pembongkaran Anjungan Minyak dan Gas Lepas Pantai.**
   Diantara kriteria-kriteria berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

   Jawaban responden:
   - Biaya **lebih penting** daripada lingkungan

   Maka pada tabel diisi sebagai berikut :

No	Kriteria Lingkungan				=	Kriteria Biaya			
a	9	7	5	3	1	3	**5 v**	7	9

1. Membandingkan tingkat kepentingan elemen-elemen **Kriteria** dibawah ini berdasarkan **Tujuan : Penentuan Teknik Pembongkaran Anjungan Minyak dan Gas Lepas Pantai.**
   Diantara kriteria-kriteria berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Kriteria Lingkungan				=	Kriteria Biaya			
a	9	7	5	3	1	3	**5v**	7	9

No	Kriteria Lingkungan				=	Kriteria Keamanan			
b	9	7	5	3	1	3	**5v**	7	9

No	Kriteria Lingkungan				=	Kriteria Alih Fungsi			
c	9	7	5	**3v**	1	3	5	7	9

No	Kriteria Biaya				=	Kriteria Alih Fungsi			
d	9	**7v**	5	3	1	3	5	7	9

No	Kriteria Biaya				=	Kriteria Keamanan			
e	9	7	5	3	1	**3v**	5	7	9

No	Kriteria Alih Fungsi				=	Kriteria Keamanan			
f	9	7	5	3	1	3	**5v**	7	9

2. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Lingkungan**.
   Diantara subkriteria-subkriteria lingkungan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Produksi Ledakan Biomassa				=	Habitat Terumbu Karang			
a	9	7	**5v**	3	1	3	5	7	9

No	Produksi Ledakan Biomassa				=	Peningkatan Biodiversiti			
b	9	7	**5v**	3	1	3	5	7	9

No	Habitat Terumbu Karang				=	Peningkatan Biodiversiti			
c	9	7	**5v**	3	1	3	5	7	9

3. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Biaya**.
   Diantara subkriteria-subkriteria biaya berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Pre Decommissioning				=	Operasional			
a	9	7	5	3	1	3	**5v**	7	9

No	Pre Decommissioning				=	Recovery Area			
b	9	7	5	3	1	3	**5v**	7	9

No	Operasional				=	Recovery Area			
c	9	7	**5v**	3	1	3	5	7	9

4. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Alih Fungsi (*Reuse*)**.
   Diantara subkriteria-subkriteria alih fungsi berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akuakultur				=	Potensi Pariwisata			
a	9	7	**5v**	3	1	3	5	7	9

No	Akuakultur				=	Energi Alternatif			
b	9	7	5	3	1	3	**5v**	7	9

No	Potensi Pariwisata				=	Energi Alternatif			
c	9	7	5	3	1	3	**5v**	7	9

5. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Keamanan dan Keselamatan**.
   Diantara subkriteria-subkriteria keamanan dan keselamatan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akses Pelayaran				=	Aktivitas Perikanan			
a	9	7	**5v**	3	1	3	5	7	9

No	Akses Pelayaran				=	Risiko Keamanan Kerja			
b	9	7	5	3	1	3	**5v**	7	9

No	Aktivitas Perikanan				=	Risiko Keamanan Kerja			
c	9	7	5	3	1	3	**5v**	7	9

6. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Produksi Ledakan Biomassa**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi produksi ledakan biomassa dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	**5v**	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

7. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Habitat Terumbu Karang**.
Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi habitat terumbu karang dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

8. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Peningkatan Biodiversiti (Keanekaragaman Hayati)**.
Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi peningkatan biodiversiti dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

9. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Pre Decommissioning**.
Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya pre decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

10. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Operasional Decommissioning**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya operasional decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

11. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Recovery Area.**
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya recovery area dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	**5v**	7	9

12. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akuakultur**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akuakultur dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal	=	Partial Removal

a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	**5v**	7	9

13. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Potensi Pariwisata (Diving,Fishing dll).**
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi potensi pariwisata dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

14. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Energi Alternatif**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi energi alternatif dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5v**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	**5v**	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	**5v**	7	9

15. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akses Pelayaran**.

Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akses pelayaran dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	**5v**	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	**9v**	7	5	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	**7v**	5	3	1	3	5	7	9

16. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Risiko Keamanan Pekerjaan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi risiko keamanan pekerjaan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	**7v**	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	**9v**	7	5	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

17. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Keamanan dan Keselamatan Aktivitas Perikanan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi keamanan dan keselamatan aktivitas perikanan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	**7v**	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	**9v**	**7**	5	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5v**	3	1	3	5	7	9

IV. SARAN

Pada bagian ini Bapak/Ibu responden diminta untuk memberikan alasan penilaian secara umum, saran dan masukan terhadap penelitian ini.

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SELESAI

Terima Kasih

KUESIONER METODE *SIMPLE ADDITIVE WEIGHTING* (SAW)

MULAI

Tanggal Pengisian : 1 Mei 2017

Nama Responden : Henricus Herwin

Jabatan Responden : Kepala Divisi Geosciences and Reservoir Development

Pengalaman Kerja : 15 tahun

A. PENGANTAR

Pengisian kuesioner ini bertujuan untuk menentukan alternatif teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai dengan metode ***Simple Additive Weighting*** **(SAW)**. Alternatif pembongkaran yang akan dipilih adalah ***total removal/partial removal/leave in place.*** Landasan utama pengisian kuesioner ini adalah hirarki yang telah disusun sebagaimana yang telah dilampirkan.

B. PETUNJUK PENGISIAN

a. Umum

- Isi kolom identitas yang terdapat pada halaman depan kuesioner.
- Memberikan penilaian terhadap hirarki.
- Penilaian dilakukan dengan memberikan nilai dalam satu level hirarki yang berkaitan dengan komponen-komponen level sebelumnya menggunakan skala prioritas bobot penilaian yang terdapat pada petunjuk bagian b.

b. Skala Prioritas Penilaian Pembobotan (W)

Dibawah ini adalah bilangan *Fuzzy* dari setiap bobot alternatif dalam pemilihan teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai pada setiap kriteria. Definisi dari skala penilaian untuk **alternatif** adalah sebagai berikut :

Nilai	Definisi
1	Sangat Buruk
2	Buruk
3	Cukup
4	Baik
5	Sangat Baik

Sedangkan tingkat kepentingan setiap kriteria, juga didefinisikan dari skala penilaian untuk **kriteria** sebagai berikut :

Nilai	Definisi Tingkat Kepentingan
1	Sangat Rendah
2	Rendah
3	Cukup
4	Tinggi
5	Sangat Tinggi

C. TABEL ISIAN

Dalam pengisian kuesioner dalam tabel berikut, Bapak/Ibu diminta untuk melakukan penilaian dari semua elemen kriteria berdasarkan skala penilaian. Keluaran dari kuesioner ini adalah memprioritaskan salah satu elemen berdasarkan pendapat responden.

Contoh pengerjaan:

Diantara kriteria-kriteria berikut ini, berikanlah penilaian berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

Kriteria	Nilai
Lingkungan	
Biaya	
Alih Fungsi	
Keamanan dan Keselamatan	

Jawaban responden:

- Lingkungan : tingkat kepentingan **cukup**
- Biaya : tingkat kepentingan **sangat tinggi**
- Alih Fungsi : tingkat kepentingan **sangat rendah**
- Keamanan dan keselamatan : tingkat kepentingan **tinggi**

Maka pada tabel diisi sebagai berikut :

Kriteria	Skor
Lingkungan	3
Biaya	5
Alih Fungsi	1
Keamanan dan Keselamatan	4

1. Diantara kriteria-kriteria teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai berikut ini, berikanlah penilaian berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Skala penilaian :

Nilai	Definisi Tingkat Kepentingan
1	Sangat Rendah
2	Rendah
3	Cukup
4	Tinggi
5	Sangat Tinggi

   Jawaban responden:

Kriteria	Nilai
Lingkungan	3
Biaya	5
Alih Fungsi	3
Keamanan dan Keselamatan	4

2. Berikanlah penilaian alternatif dari kriteria-kriteria yang sudah ditentukan berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Skala penilaian:

Nilai	Definisi
1	Sangat Buruk
2	Buruk
3	Cukup
4	Baik
5	Sangat Baik

Jawaban Responden:

Pilihan Alternatif	Kriteria			
	Lingkungan	Biaya	Alih Fungsi	Keamanan Pelayaran dan Keselamatan Kerja
Total Removal	5	2	2	5
Partial Removal	3	4	3	4
Leave in Place	2	4	3	2

D. SARAN

Pada bagian ini Bapak/Ibu responden diminta untuk memberikan alasan penilaian secara umum, saran dan masukan terhadap penelitian ini.

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SELESAI

Terima Kasih

KUESIONER METODE *ANALYTICAL HIERARCHY PROCESS* (AHP)

<u>MULAI</u>

Tanggal Pengisian : 8 Juni 2017

Nama Responden : Agus Ponco Kartiko

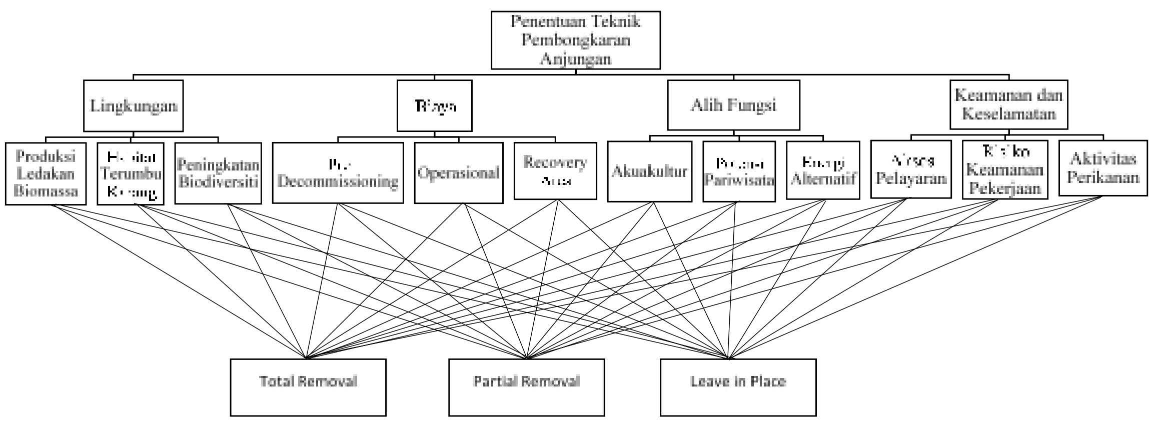
Jabatan Responden : Head of Operation North Asset Services

Bidang Keahlian : Proyek dan konstruksi

Pengalaman Kerja : 24 tahun

I. PENGANTAR

Pengisian kuesioner ini bertujuan untuk menentukan alternatif teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai dengan metode ***Analytical Hierarchy Process*** **(AHP)**. Alternatif pembongkaran yang akan dipilih adalah ***total removal/partial removal/leave in place.*** Landasan utama pengisian kuesioner ini adalah hirarki yang telah disusun sebagai berikut.



Gambar 1. Susunan Hirarki Penentuan Teknik Pembongkaran Anjungan Terbaik

II. PETUNJUK PENGISIAN

a. Umum

1. Isi kolom identitas yang terdapat pada halaman depan kuesioner
2. Berikan skor terhadap hirarki
3. Pemberian skor dilakukan dengan membandingkan tingkat kepentingan/peran komponen dalam satu level hirarki yang berkaitan dengan komponen-komponen level sebelumnya menggunakan skala penilaian yang terdapat pada petunjuk bagian b.
4. Pemberian skor dilakukan dengan mencentak(v)/menyilang(x) pada kolom yang telah disediakan.

b. Skala Skor

Definisi dari skala skor adalah sebagai berikut :

Intensitas Kepentingan (A dibandingkan B)	Definisi
1	A **sama penting** dengan B
3	A **sedikit lebih penting** daripada B
5	A **lebih penting** daripada B
7	A **jelas lebih penting** daripada B
9	A **mutlak penting** daripada B

III. TABEL ISIAN

Dalam pengisian kuesioner dalam tabel berikut, Bapak/Ibu diminta untuk membandingkan mana yang lebih penting dari elemen faktor A dan faktor B, lalu memberikan skor berdasarkan petunjuk. Keluaran dari kuesioner ini adalah memprioritaskan salah satu elemen berdasarkan pendapat responden.

Contoh pengerjaan:

1. Membandingkan tingkat kepentingan elemen-elemen **Kriteria** dibawah ini berdasarkan **Tujuan : Penentuan Teknik Pembongkaran Anjungan Minyak dan Gas Lepas Pantai.**
   Diantara kriteria-kriteria berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

   Jawaban responden:
   - Biaya **lebih penting** daripada lingkungan

   Maka pada tabel diisi sebagai berikut :

No	Kriteria Lingkungan				=	Kriteria Biaya			
a	9	7	5	3	1	3	**5**	7	9
							v		

1. Membandingkan tingkat kepentingan elemen-elemen **Kriteria** dibawah ini berdasarkan **Tujuan : Penentuan Teknik Pembongkaran Anjungan Minyak dan Gas Lepas Pantai.**
   Diantara kriteria-kriteria berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Kriteria Lingkungan				=	Kriteria Biaya			
a	9	7	5	3	1	3	5	7	9
			v						

No	Kriteria Lingkungan				=	Kriteria Keamanan			
b	9	7	5	3	1	3	5	7	9
					v				

No	Kriteria Lingkungan				=	Kriteria Alih Fungsi			
c	9	7	5	3	1	3	5	7	9
				v					

No	Kriteria Biaya				=	Kriteria Alih Fungsi			
d	9	7	5	3	1	3	5	7	9
					v				

No	Kriteria Biaya				=	Kriteria Keamanan			
e	9	7	5	3	1	3	5	7	9
						v			

No	Kriteria Alih Fungsi				=	Kriteria Keamanan			
f	9	7	5	3	1	3	5	7	9
						v			

2. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Lingkungan**.
   Diantara subkriteria-subkriteria lingkungan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Produksi Ledakan Biomassa				=	Habitat Terumbu Karang			
a	9	7	5	3	1	3	5	7	9
							v		

No	Produksi Ledakan Biomassa				=	Peningkatan Biodiversiti			
b	9	7	5	3	1	3	5	7	9
							v		

No	Habitat Terumbu Karang				=	Peningkatan Biodiversiti			
c	9	7	5	3	1	3	5	7	9
					v				

3. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Biaya**.
   Diantara subkriteria-subkriteria biaya berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Pre Decommissioning				=	Operasional			
a	9	7	5	3	1	3	5	7	9

						v			

No	Pre Decommissioning				=	Recovery Area			
b	9	7	5	3	1	3	5	7	9
				v					

No	Operasional				=	Recovery Area			
c	9	7	5	3	1	3	5	7	9
			v						

4. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Alih Fungsi (*Reuse*)**.
   Diantara subkriteria-subkriteria alih fungsi berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akuakultur				=	Potensi Pariwisata			
a	9	7	5	3	1	3	5	7	9
				v					

No	Akuakultur				=	Energi Alternatif			
B	9	7	5	3	1	3	5	7	9
				v					

No	Potensi Pariwisata				=	Energi Alternatif			
c	9	7	5	3	1	3	5	7	9
					v				

5. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Keamanan dan Keselamatan**.
   Diantara subkriteria-subkriteria keamanan dan keselamatan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akses Pelayaran				=	Aktivitas Perikanan			
a	9	7	5	3	1	3	5	7	9
			v						

No	Akses Pelayaran				=	Risiko Keamanan Kerja			
B	9	7	5	3	1	3	5	7	9
					v				

No	Aktivitas Perikanan				=	Risiko Keamanan Kerja			
c	9	7	5	3	1	3	5	7	9
							v		

6. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Produksi Ledakan Biomassa**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi produksi ledakan biomassa dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
				v					

7. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Habitat Terumbu Karang**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi habitat terumbu karang dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
				v					

No	Total Removal				=	Leave in Place			

b	9	7	5	3	1	3	5	7	9
				v					

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

8. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Peningkatan Biodiversiti (Keanekaragaman Hayati)**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi peningkatan biodiversiti dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
				v					

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
				v					

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

9. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Pre Decommissioning**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya pre decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

10. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Operasional Decommissioning**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya operasional decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

11. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Recovery Area.**
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya recovery area dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

12. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akuakultur**.
Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akuakultur dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
				v					

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
				v					

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

13. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Potensi Pariwisata (Diving,Fishing dll).**
Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi potensi pariwisata dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
				v					

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
				v					

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

14. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Energi Alternatif**.

Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi energi alternatif dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
				v					

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
				v					

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

15. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akses Pelayaran**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akses pelayaran dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

16. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Risiko Keamanan Pekerjaan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi risiko keamanan pekerjaan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

17. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Keamanan dan Keselamatan Aktivitas Perikanan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi keamanan dan keselamatan aktivitas perikanan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	9
			v						

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	7	9
			v						

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	7	9
					v				

IV. SARAN

Pada bagian ini Bapak/Ibu responden diminta untuk memberikan alasan penilaian secara umum, saran dan masukan terhadap penelitian ini.

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SELESAI

Terima Kasih

KUESIONER METODE *SIMPLE ADDITIVE WEIGHTING* (SAW)

<u>MULAI</u>

1. Diantara kriteria-kriteria teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai berikut ini, berikanlah penilaian berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Jawaban responden:

Kriteria	Nilai
Lingkungan	5
Biaya	3
Alih Fungsi	4
Keamanan dan Keselamatan	5

2. Berikanlah penilaian alternatif dari kriteria-kriteria yang sudah ditentukan berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Jawaban Responden:

Pilihan Alternatif	Kriteria			
	Lingkungan	Biaya	Alih Fungsi	Keamanan Pelayaran dan Keselamatan Kerja
Total Removal	5	2	2	5
Partial Removal	3	3	2	3
Leave in Place	2	4	3	2

KUESIONER METODE *ANALYTICAL HIERARCHY PROCESS* (AHP)

MULAI

Tanggal Pengisian : 04 Mei 2017

Nama Responden : Febi Febrian

Jabatan Responden : Sr. Project Engineer

Pengalaman Kerja : 13 Tahun

1. Membandingkan tingkat kepentingan elemen-elemen **Kriteria** dibawah ini berdasarkan **Tujuan : Penentuan Teknik Pembongkaran Anjungan Minyak dan Gas Lepas Pantai.**
   Diantara kriteria-kriteria berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Kriteria Lingkungan				=	Kriteria Biaya			
a	9	7	5	3	1	3	5	7	**9**

No	Kriteria Lingkungan				=	Kriteria Keamanan			
b	9	7	5	3	1	3	5	**7**	9

No	Kriteria Lingkungan				=	Kriteria Alih Fungsi			
c	9	7	5	3	**1**	3	5	7	9

No	Kriteria Biaya				=	Kriteria Alih Fungsi			
d	9	7	**5**	3	1	3	5	7	9

No	Kriteria Biaya				=	Kriteria Keamanan			
e	9	7	5	3	1	3	**5**	7	9

No	Kriteria Alih Fungsi				=	Kriteria Keamanan			
f	9	7	5	3	1	3	**5**	7	9

2. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Lingkungan**.
   Diantara subkriteria-subkriteria lingkungan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Produksi Ledakan Biomassa				=	Habitat Terumbu Karang			
a	9	7	5	3	1	3	5	7	**9**

No	Produksi Ledakan Biomassa				=	Peningkatan Biodiversiti			
b	9	7	5	**3**	1	3	5	7	9

No	Habitat Terumbu Karang				=	Peningkatan Biodiversiti			
c	**9**	7	5	3	1	3	5	7	9

3. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Biaya**.
   Diantara subkriteria-subkriteria biaya berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Pre Decommissioning				=	Operasional			
a	9	7	5	3	1	3	5	**7**	9

No	Pre Decommissioning				=	Recovery Area			
b	9	7	5	3	1	**3**	5	7	9

No	Operasional				=	Recovery Area			
c	9	**7**	5	3	1	3	5	7	9

4. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Alih Fungsi (*Reuse*)**.
   Diantara subkriteria-subkriteria alih fungsi berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akuakultur				=	Potensi Pariwisata			
a	9	7	5	3	1	**3**	5	7	9

No	Akuakultur				=	Energi Alternatif			
b	9	7	5	3	1	3	5	**7**	9

No	Potensi Pariwisata				=	Energi Alternatif			
c	9	7	5	3	1	3	5	**7**	9

5. Membandingkan tingkat kepentingan elemen-elemen **Subkriteria** dibawah ini berdasarkan **Kriteria Keamanan dan Keselamatan**.
   Diantara subkriteria-subkriteria keamanan dan keselamatan berikut ini, manakah yang lebih penting dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Akses Pelayaran				=	Aktivitas Perikanan			
a	9	7	5	3	1	3	**5**	7	9

No	Akses Pelayaran				=	Risiko Keamanan Kerja			
b	9	7	5	3	1	3	5	**7**	9

No	Aktivitas Perikanan				=	Risiko Keamanan Kerja			
c	9	7	5	3	1	3	5	7	**9**

6. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Produksi Ledakan Biomassa**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi produksi ledakan biomassa dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	**3**	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	**5**	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	**3**	1	3	5	7	9

7. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Habitat Terumbu Karang**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi habitat terumbu karang dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	**7**	9

No	Total Removal				=	Leave in Place			
b	9	7	5	**3**	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5**	3	1	3	5	7	9

8. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Peningkatan Biodiversiti (Keanekaragaman Hayati)**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi peningkatan biodiversiti dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	**3**	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	**3**	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5**	3	1	3	5	7	9

9. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Pre Decommissioning**.
   Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya pre decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	**5**	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	**3**	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	**3**	1	3	5	7	9

10. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Operasional Decommissioning**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya operasional decommissioning dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal	=	Partial Removal

a	9	**7**	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	**3**	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	**3**	5	7	9

11. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Biaya Recovery Area.**
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi biaya recovery area dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	**5**	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	**5**	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5**	3	1	3	5	7	9

12. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akuakultur**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akuakultur dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	**3**	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	**3**	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	**3**	1	3	5	7	9

13. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Potensi Pariwisata (Diving,Fishing dll).**

Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi potensi pariwisata dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	**3**	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	**7**	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	3	5	**7**	9

14. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Energi Alternatif**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi energi alternatif dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	**7**	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	**7**	5	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5**	3	1	3	5	7	9

15. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Akses Pelayaran**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi akses pelayaran dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	**9**	7	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	**7**	5	**3**	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	**5**	3	1	3	5	7	9

16. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Risiko Keamanan Pekerjaan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi risiko keamanan pekerjaan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	9	7	5	3	1	3	5	7	**9**

No	Total Removal				=	Leave in Place			
b	**9**	7	5	3	1	3	5	7	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	**3**	1	3	5	7	9

17. Membandingkan tingkat kepentingan elemen-elemen **Alternatif** dibawah ini berdasarkan **Subkriteria Keamanan dan Keselamatan Aktivitas Perikanan**.
    Diantara alternatif-alternatif berikut ini, manakah yang lebih penting jika ditinjau dari segi keamanan dan keselamatan aktivitas perikanan dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?

No	Total Removal				=	Partial Removal			
a	**9**	7	5	3	1	3	5	7	9

No	Total Removal				=	Leave in Place			
b	9	7	5	3	1	3	5	**7**	9

No	Partial Removal				=	Leave in Place			
c	9	7	5	3	1	**3**	5	7	9

I. SARAN

Pada bagian ini Bapak/Ibu responden diminta untuk memberikan alasan penilaian secara umum, saran dan masukan terhadap penelitian ini.

Saran : Mengidentifikasi pihak-pihak yang terkait yang akan dilibatkan dalam menentukan teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai,
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SELESAI

Terima Kasih

KUESIONER METODE *SIMPLE ADDITIVE WEIGHTING* (SAW)

<u>MULAI</u>

Tanggal Pengisian : 04 Mei 2017

Nama Responden : Febi Febrian

Jabatan Responden : Sr. Project Engineer

Pengalaman Kerja : 13 tahun

1. Diantara kriteria-kriteria teknik pembongkaran (*decommissioning*) anjungan minyak dan gas lepas pantai berikut ini, berikanlah penilaian berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Jawaban responden:

Kriteria	Nilai
Lingkungan	4
Biaya	3
Alih Fungsi	1
Keamanan dan Keselamatan	5

2. Berikanlah penilaian alternatif dari kriteria-kriteria yang sudah ditentukan berdasarkan skala dalam menentukan teknik pembongkaran anjungan minyak dan gas lepas pantai ?
   Jawaban Responden:

Pilihan Alternatif	Kriteria			
	Lingkungan	Biaya	Alih Fungsi	Keamanan Pelayaran dan Keselamatan Kerja
Total Removal	4	3	5	5
Partial Removal	3	2	4	3
Leave in Place	1	1	1	1

A. SARAN

Pada bagian ini Bapak/Ibu responden diminta untuk memberikan alasan penilaian secara umum, saran dan masukan terhadap penelitian ini.

Kriteria-kriteria teknik pembongkaran (*decommissioning*) alternatif perlakuan terhadap anjungan lepas pantai seperti pembongkaran keseluruhan (complete removal) dan pembongkaran sebagian (partial removal) yaitu dengan memanfaatkan bagian anjungan yang tidak dibongkar untuk dimanfaatkan dalam bentuk lain diantaranya karang buatan, budidaya perikana atau wisata berdasarkan studi kelayakan secara mendetail

Masukan : Peneliti menggambarkan faktor-faktor yang mempengaruhi kelayakan salah satu jenis pemanfaatan alternatif anjungan migas lepas pantai pasca pembongkaran

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SELESAI

Terima Kasih

AUTHOR PROFILE

Tommy Saputra, the first child of three siblings was born in Lubuk Sikaping on December 11, 1993. The author's formal education begins with the completion of basic education at SDN 19 Ambacang Anggang in 2006 and SMP Negeri 1 Lubuk Sikaping in 2012. Then finish the secondary education level at SMA Negeri 1 Lubuk Sikaping. After graduating from high school, the author went to the undergraduate level at Ocean Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember (ITS) Surabaya and registered as a student by NRP 4313100138. During the course of lectures, the author has been active in several student organizations and committees. The author has earned the mandate as the Head of External Affairs Department of Student Executive Board, Faculty of Marine Technology, ITS for the period 2015-2016 and Chief Executif of Petrosmart 2015. The author has also received scholarships from PPA Kemenristekdikti, Society Petroleum Engineer Java Section and Karya Salemba Empat. Not only in the academic field, the author has also been elected as The Ambassador of BPJS Ketenagakerjaan. The author had followed on job training at PT. PAL Indonesia for 2 months. The issues raised by the author is fundamental to one area of expertise in the Ocean Engineering Department namely Design and Production.

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