Waste Management Framework for Decommissioning of Offshore Installations in Malaysia

by

Moo Hong Shin

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the requirements for the
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Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

FINAL YEAR PROJECT DISSERTATION

Waste Management Framework for Decommissioning of Offshore Installations in Malaysia

Moo Hong Shin

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Civil Engineering

Supervisor: Dr. Noor Amila Wan Abdullah Zawawi

CERTIFICATION OF APPROVAL

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Approved by,

____

(Dr. Noor Amila Wan Abdullah Zawawi)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
May 2014

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgement, and that the original work contained herein have not been undertaken or done by unspecified sources or persons..

____*ADELINE*______
MOO HONG SHIN

Abstract

Malaysia's offshore platform decommissioning market is expected to significantly rise in the coming years as many of the offshore platforms are approaching their end-of-service life. It is inevitable that offshore platforms decommissioning generates a variety of wastes, hence decommissioning offshore platforms is expected to generate large quantities of waste in the years ahead. This study focuses on the waste management of offshore platform decommissioning which include the recycling, reusing and disposing of wastes after being brought onshore. The study will be based on the review of previous case studies in the Gulf of Mexico and the North Sea. This study covers the method of identification and quantification of waste products, mainly physical wastes from offshore platform decommissioning in Malaysia. It is found that the majority of the wastes from decommissioning an offshore platform are metal and non-metal wastes, which are the physical wastes. After the physical wastes are identified and quantified, this study also focuses on the recoverability of steel and reuse of offshore platform from decommissioning. The salvage of the scrapped steels and metals can help the operators to reduce the total price of managing the wastes. At the same time, the operators can consider the rig to reef alternative. This study also suggests a waste management framework based on practices of our local oil and gas industry.

Acknowledgement

Completion of this dissertation has definitely left an indelible mark on me in my undergraduate life. I would like to specially thank my Final Year Project supervisor, Dr Noor Amila, for her support and guidance that lead me to the completion of this Final Year Project. My project will not be completed without her dedicated time and effort in guiding me especially by organising some sharing sessions with the postgraduates in order to improve my understanding.

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Next, I would like to thank Dr Nurul Izma and Dr Raza, who are the FYP coordinators who always remind me about the FYP guidelines and timeline so that I will not miss any submission along the way.

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ABBREVIATIONS AND NOMENCLATURES

API	American Petroleum Institute
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
DOSH	Department of Occupational Safety and Health
DWH	Deep Water Horizon
EIA	Environmental Impact Assessment
GoM	Gulf of Mexico
IMO	International Maritime Organization
LSA	Low Specific Activity
NORM	Naturally Occurring Radioactive Materials
NWH	North West Hutton
PCB	Polychlorinated Biphenyl
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act
TENORM	Technologically-Enhanced, Naturally-Occurring Radioactive Material
WDP	Waste Documentation Pack
WSS	Waste Summary Sheet

CHAPTER 1 : INTRODUCTION

1.1 Background

Malaysia has close to 500 over offshore structures scattered around the South China Sea up to year 2000(Decom World, 2011). ExxonMobil and Shell are leading the way in production sharing joint partnership with PETRONAS-Carigali, the wholly owned subsidiary of PETRONAS. These companies are the joint owners of the majority of these platforms (Decom World, 2011). Most of these platforms are built to last for 25-30 years and only those platforms built after 1 Jan 1998 in accordance with the International Maritime Organization came with decommissioning design as a follow-up plan (Twomey, 2010). Operators are now facing the challenges of decommissioning as many of these platforms are reaching the end of their service-life. Thus far, only a handful of offshore platforms in Malaysian waters have been decommissioned mainly due to lack of regulatory framework and weak decommissioning plans (Zawawi, Liew, & Na, 2012).

Offshore decommissioning is the process of physical removal, dismantled and disposal of structures at the end of their service life. Thus, offshore decommissioning is a complex and costly business. This is due to each offshore installation is unique, a cost estimation for decommissioning needs a specific evaluation, risk assessment, environmental assessment, and cost analysis for each offshore facility (Twomey, 2010).According to the interview article from Decom World in 2011, the decommissioning costs in mature areas like Gulf of Mexico (GoM) or North Sea are roughly US$2.5-2.8 million, so the expected market value of this service in a relatively fresh market such as Malaysia is relatively higher. In the same interview, the Program Manager for Energy & Power Systems from Frost & Sullivan analyst firm, Mr Razeen Khalid said that offshore decommissioning can cost up to US$3 million or higher depending on the marine support costs, duration of the decommissioning process, experience and technical and operational aspects.

This study is interested in the waste management for offshore decommissioning projects. Each of the removal activity will produce or release scheduled waste material which most of them can be very hazardous to human and environment. If the hazardous quantities were not identified, cleaning will not take place offshore in order to achieve a balance of removing the wastes that pose risk to health during the process and to the environment during transportation(White & Goodman, 2010). Besides that, the parts or pieces from the decommissioned platforms have to be sent to the onshore waste yard in order to be disposed or recycled. This research will hopefully create more awareness towards the recycling and reusing of offshore platforms in line with sustainable development.

1.2 Problem statement

Oil operators in Malaysia are expecting a significant rise of offshore platforms to be decommissioned due to their end of service life. However, there is limited research in this topic of assessing the types and amount of wastes produced by decommissioning process especially in the case of the Malaysia offshore platforms. In addition, there is no substantial published literature on the governing legislations and waste management for decommissioning in Malaysia. One of the major challenges faced by the operators is the waste management of offshore decommissioning because improper waste management will impact the environment and pose effects on the worker's health during the decommissioning process. Besides that, with the rising concerns of environmental awareness and sustainable development concepts, the reputation of the oil operators will be affected if the decommissioning wastes are not being handled responsibly and properly. In terms of economic, more costs may be incurred for cleaning if there's any spillage or released of wastes into the environment during the transportation of the waste from offshore to onshore.

1.3 Objectives

The objectives of this study are as follows:

1. To identify and quantify waste products from decommissioning offshore platform in Malaysia
2. To study on the recoverability of steel from decommissioning and reuse of offshore platform
3. To critically assess other established waste management framework/waste management system and develop a waste management framework for the local industry

1.4 Scope of Study

This study is focused in the subject of waste management of offshore decommissioning in Malaysia. The waste generation of each component in the Decommissioning Work Breakdown Structure (DWBS) will be studied and analysed. Physical wastes from the decommissioning of offshore platform will be the main focus of the study. This study will be limited to Malaysia's offshore platforms which are mostly fixed platforms. Besides that, the options for offshore decommissioning will not be discussed. All waste will be disposed onshore. This study will also cover the subject of reviewing the legislations and framework of waste management in Malaysia.

1.5 Relevancy and Feasibility

In Malaysia, the number of offshore platforms that are reaching their end of service life is increasing. Thus, the decommissioning activities are expected to rise in the near future. Since Malaysia is very new to offshore decommissioning activities, the local oil operators and contractors are lacking the knowledge and experience in this area. This study focuses on the waste management of offshore decommissioning activities which will be informative to the oil operators as well as the contractors handling this activity in Malaysia. Besides that, the study on the recoverability of steel and reusing of platform from offshore decommissioning can help the oil operators to know the prospect of recycling and reselling the steels salvaged from decommissioned offshore platforms. This scope and objectives of this study are clearly defined. Hence, this study is feasible within the scope, time frame and budget given.

CHAPTER 2 : LITERATURE REVIEW

2.1 Decommissioning

According to the UK Offshore Operators Association (UKOOA), decommissioning is defined as:

"The process which the operator of an offshore oil and gas installation goes through to plan, gain government approval and implement the removal, disposal or re-use of a structure when it is no longer needed for its current purpose."

Decommissioning is a large complex multi-discipline project. Each decommissioning project is distinctive and each offshore platform has its own unique challenges. Thus, usually a decommissioning will be a long term process which involves the government bodies, oil company owner and decommissioning contractors.

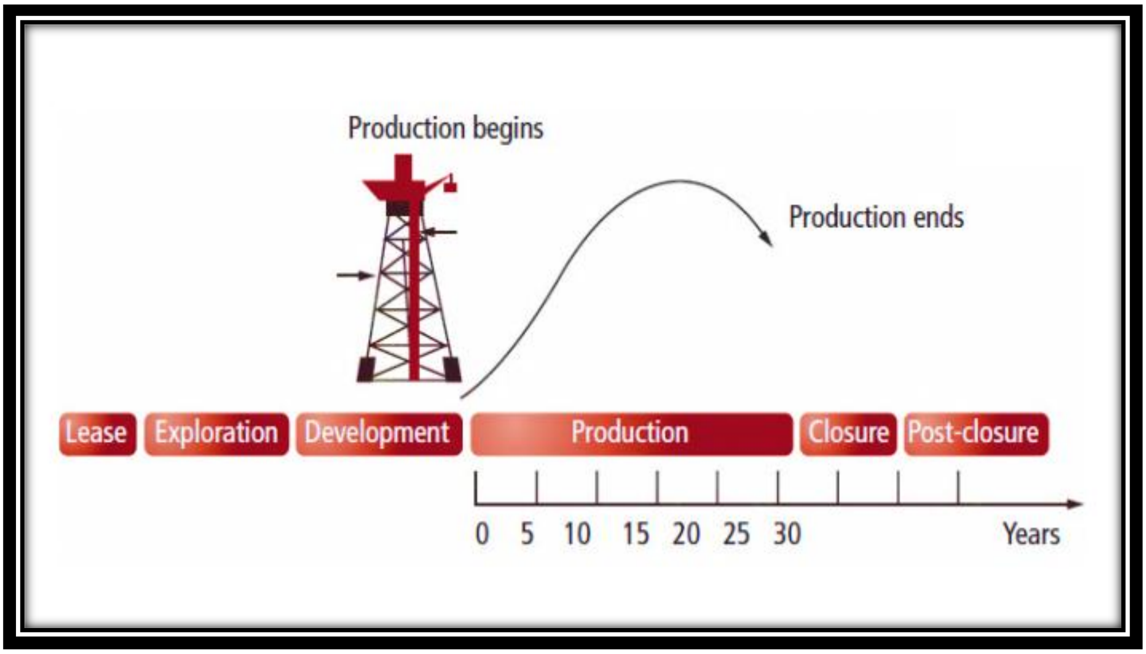


Figure 1 : Platform's Life Cycle

The figure above shows the life cycle of a platform from lease, exploration, development, production, closure and post-closure. Offshore installations and pipelines have a limited life of operation. Usually they have a lifespan of 25-30 years. For the past decade, many oil and gas fields are now entering into the mature phase of their productive lives. When the fields run out of production, the disused installations are to be removed. Thus, the operators are now facing the challenging task of decommissioning redundant oil and gas installations. They have to make decision to remove or dismantle or dispose the disused offshore installation. According to OSPAR Decision 98/3, disused offshore installations must be normally to be removed and disposed of on land. Whereas as the general rule, pipelines and cables may be left in situ provided that they do not possess any risks for bottom fisheries.

There are more than 6500 offshore installations worldwide, with an estimated overall cost of 20 billion USD (Osmundsen & Tveteras, 2003). All of these offshore installations will one day reach their end of service life. Due to each offshore installation is unique; cost estimation for decommissioning needs a specific evaluation, risk assessment, environmental assessment, and cost analysis for each offshore facility.

2.2 International Rules on Offshore Decommissioning

The choice of decommissioning decisions is subjected to stringent and extensive international regulations.

2.2.1 Geneva Convention on the Continental Shelf in 1958

The Geneva Convention on the Continental Shelf in 1958 appeared as the first international removal standard, in its Article 5(5) which reads: Any installations which are abandoned or disused must be entirely removed. This article makes it mandatory for state parties (57 of them, including Malaysia (Hamzah, 2003).

2.2.2 UN Law of the Sea Convention (UNCLOS) 1982

In addition, 1982 UN Law of the Sea Convention (UNCLOS) is established as a comprehensive international treaty on ocean governance as it covers most legal aspects of ocean space and its uses. Article 60.3 of UNCLOS reads: Any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation, fishing and protection for the marine environment based on the international standards established. (Hamzah, 2003).

2.2.3 International Maritime Organization (IMO) 1989

In 1989, International Maritime Organization (IMO) had developed a guidelines for offshore decommissioning, known as "Guidelines and Standards of the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone" (Hoyle & Griffin, 1989). IMO Guidelines can be separated into two parts: Guidelines and Standards. The ''Guidelines'' provide for a case-by-case decision on whether to remove the abandoned installation or not with emphasis on the platform's criteria whereas the "Standards" state that complete removal is required of all installations standing in less than 75 m of water and weighing less than 4000 ton in air, and all installations placed on the seabed after 1998 standing in less than 100 metres of water and weighing less than 4000 ton.

2.2.4 Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)

The Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) issued new guidelines and measures in a notice to lessees and operators (NTL 2010-G05) for decommissioning idle wells and structures on active leases in the OCS Gulf of Mexico with an effective date of Oct. 15, 2010. NTL 2010-G05 states the following:

I. For wells that have not produced for five years or more, operators will have 3 years to either permanently or temporarily abandon the well.
II. For structures that have not produced for five years or more, operators will have 5 years to remove the structures.

In the next few years, NTL 2010-G05 requires the decommissioning activity to focus on idle infrastructure. In the long term, this new regulations will impact cost outlays and impose uncertain consequences for the oil and gas development and production (Kaiser & Narra, 2011).

2.2.5 London (Dumping) Convention

The 1972 London Convention (and the subsequent 1996 protocol) gave a generic guidance for any wastes that can be dumped at sea and specified different classes of waste, including platforms and other man-made waste. The main objective of the London Convention is to prevent indiscriminate disposal at sea of wastes that could be liable for creating hazards to human health; harming living resources and marine life; damaging amenities; or interfering with other legitimate uses of the sea.

2.3 Decommissioning Process

There are ten steps to the process of offshore decommissioning.

Firstly, it starts with project management. Project management, engineering and planning for decommissioning normally starts three years before the well ceases production. The process usually involves the review of contractual obligations, engineering analysis, operational planning and contracting.

After that, operators have to prepare an Execution Plan which includes the environmental information and field surveys of the specific project site. The Execution Plan has to state the schedule of decommissioning activities, equipment and labour needed in order to secure permits from the government. When the permits from government are granted, then operators can proceed with platform preparation. The topsides of the platform which include the tanks, processing equipment and piping have to be flushed and cleaned in order to make sure there is no residual hydrocarbon.

After the topsides preparation, well plugging and abandonment will take place. This involves the well entry preparations, filling the well with fluid, removal of down hole equipment, cleaning out the wellbore, plugging of annular space and placement of fluid between plugs. Followed by the removal of conductor and platform. One of the key components in platform removal is mobilization and demobilization of derrick barges. If the platform is small in size, the topsides can be removed in one piece by single lift onto the derrick barge.

Else, topsides can be cut into several pieces and removed with platform cranes. Followed by the removal of the jacket as the second step and then pipeline and power cable decommissioning. Last but not least is the material disposal and site clearance. Disused platform materials can be recycled, reuse or dispose of in specified landfills. In order to have proper site clearance, operators have to conduct the post decommissioning survey which identifies any environmental damage.

2.4 Decommissioning Options

Generally, a typical platform comprises the topsides and substructures. Topside contains the drilling, processing, utilities and accommodation facilities whereas the substructure is mainly the jacket of the platform. The basic decommissioning options are as follows:

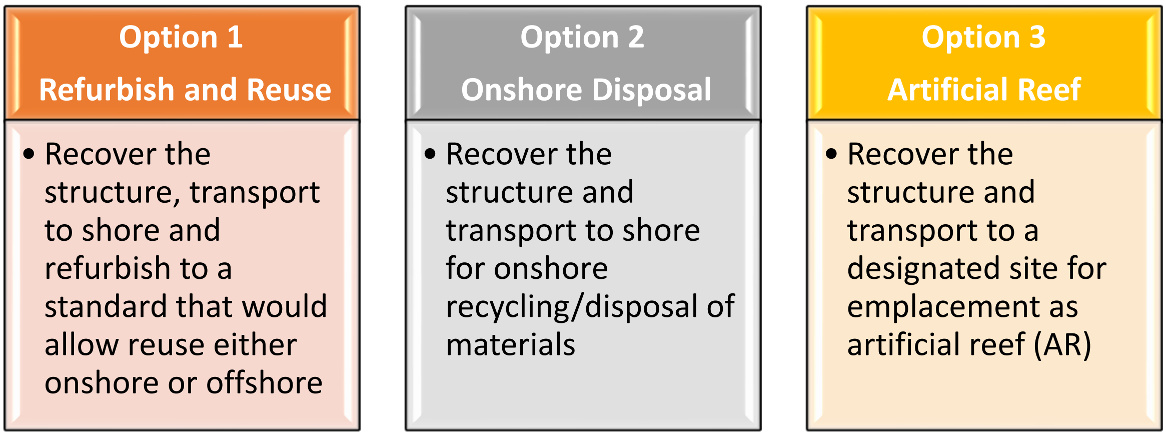


Figure 2: Options for Topsides and Substructures

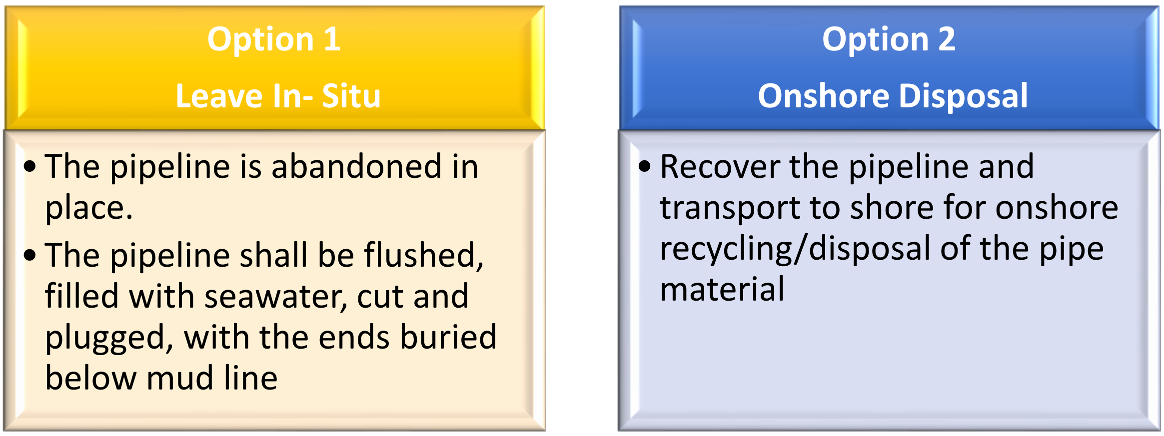


Figure 3: Options for Pipelines

If installations are not left in place or re-use directly, they must be removed to shore and delivered to approved waste treatment plants.

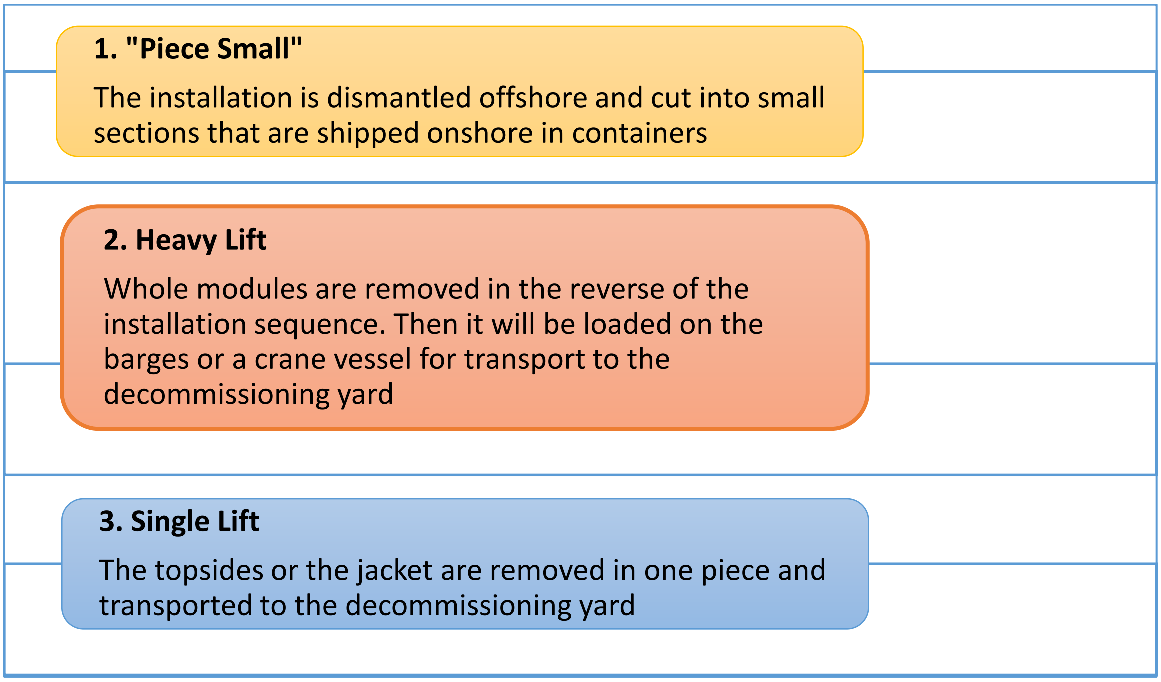


Figure 4: Method Used for Dismantling Installations

2.5 Waste Management of Offshore Decommissioning

Waste management is the collection, transportation and disposal of waste products. In general, waste management encompasses management of all processes and resources for proper handling of waste materials, from transportation to waste dumping facility in order to compliance with health codes and environmental regulations. In offshore decommissioning, it is very challenging to identify and quantify materials presents and to have a strategy in place for the removal of hazardous waste offshore (White & Goodman, 2010). It is understood that the ultimate fate of wastes from decommissioning is depending on the nature of the wastes as well as the characteristics of the recipient environment.

Zaher(2008) states that in offshore fields, all the oil and gas companies are facing the challenges of managing wastes due to the marine environment is known of its fragile and sensitivity to pollution. Most of these wastes may have significant negative impacts to the environment. Besides that, handling of materials related to decommissioning including chemicals, oils, explosive, waste management and junk yards equipped and dedicated for decommissioning are high on risk assessment and management initiatives(Decom World, 2011). According to Chaplin(1997), offshore surveys are needed to be done in getting a realistic view of the content of structures that are going to be received at onshore. Then detailed surveys are needed to be carried out when the structures arrive onshore during reception process and dismantling process. The information on the modifications of the structures as compared to the information on the original structures have to be taken into considerations during the assessment of the waste quantity.

Although each offshore platform installations are unique, David(2012) states that Deep Water Horizon(DWH) experience has demonstrated crucial findings on the key elements needed to develop effective Waste Management Programs and strategies. The study shows that there are five key areas from the Deep Water Horizon experience.

First key area is the team member skills. A waste management team is often formed within the internal company experts, external waste management firms and environmental consultants. The team requires a mix of personnel with management and leadership skills and also individuals with strong technical skills in the areas of waste characterization as well as environmental permitting. These people are expected to be able to design and implement innovative programs like recycling and reuse initiatives.

Second key area is the linkages to operations. A successful waste management program has to ensure its close linkage between the planning and operation sections. When the waste management program is implemented by operations, the feedback from the operations team in the field is very crucial because it will allow the planning section to modify or improve the waste management program.

Third key area is the data management system. It is understood that managing waste streams from offshore platforms generates a large amount of data which will be related to characterization, tracking volumes, and record keeping associated with environmental compliance. Thus, detailed scheduling of equipment and other resources to and from offshore operations area is needed.

Fourth key area is to maintain compliance. In offshore environment, maintaining compliance with environmental laws and regulations related to waste management can be very tough task due to numerous waste streams being generated and engagement with multiple regulatory agencies. Thus in Deep Water Horizon experience, a waste disposal/recycling facility auditing program was developed to ensure that recovered materials will be sent to approved facilities. Each facility used to manage waste has to undergo a standard site evaluation and approval process.

The last key area is green alternatives. Green alternatives are included in the overall waste management strategy in order to minimise waste generation and to develop a comprehensive recycling, reuse, and recovery approach.

2.6 Waste management hierarchy

The waste management hierarchy is an internationally accepted guide that widely used for prioritising waste management practices with the objective of achieving optimal environmental outcomes. It is a process used to protect the environment as well as to conserve resources through a priority approach established in waste policy and legislation. Waste hierarchy is introduced because waste management cannot be solved only with technical end-of-pipe solutions but with an integrated approach. In waste management hierarchy, the progression of a material or product through successive stages of waste management and the latter part of the life-cycle for each product is captured. That is why the aim of waste management hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. This applies to the wastes that come from offshore platforms as well. However, different countries/locations may have some differences in terms of the components in the waste management hierarchy.

According to Zaher(2008), the waste management hierarchy adopted in offshore Abu Dhabi is as such:

1. Source reduction

   The volume and toxicity of wastes are to be eliminated and reduced by using alternative materials and or more efficient processes, practices or procedures
2. Reuse

   The waste materials or products are to be reuse in their original form
3. Recycling/Recovery

   The wastes are to be converted or extracted into reusable materials
4. Treatment

   The waste residues are to be destroyed, detoxified or neutralised via physical, biological, thermal and chemical methods.

However, White and Goodman (2010) show that the waste hierarchy used in decommissioning of the largest fixed steel jacket platforms (North West Hutton) are as such:

- Maximise the amount of material from the platform which was reused or recovered/recycled
- Minimise the environmental impact of its activities
- Achieve the publicly stated objectives of reusing or recovering/recycling the recovered material.

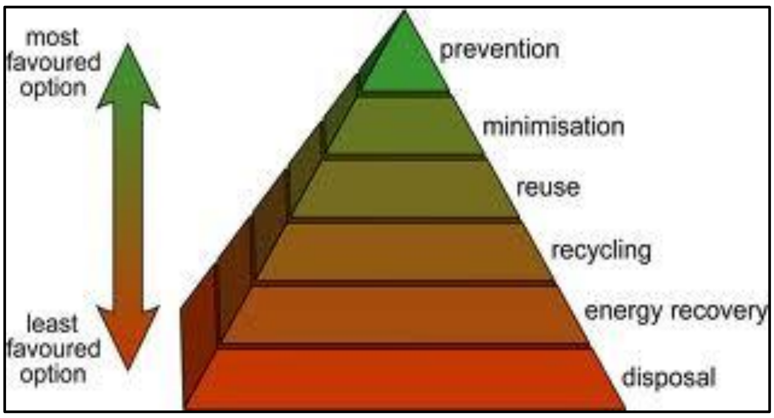


Figure 5: The Waste Management Hierarchy

A detailed Waste Management Strategy and Plan was development during the detailed design phase of North West Hutton (NWH) decommissioning in order to make sure the alignment between the operator, decommissioning contractor and onshore disposal contractor on the processes and deliverables that needed to manage the transfer of materials from NWH topsides and jacket to an onshore location for dismantling, recovery and disposal (White & Goodman, 2010). In fact, the waste transfers from NWH offshore to the onshore final disposal point are divided into two:

Waste Transfer 1: Shipment from Offshore to Onshore Dismantling and Disposal Contractor's Yard. This is done by the Decommissioning Contractor.

Waste Transfer 2: Shipment from Onshore Dismantling and Disposal Contractor's Yard to the Final Disposal Point. This is done by the Onshore Dismantling and Disposal Contractor

2.7 Waste identification

The offshore decommissioning wastes are usually the same wastes that are associated with the offshore platform production wastes. In order to identify them, the categories of the wastes must first be known. Philippe, Mitchel, Catherine and Jean(1998) shows that the waste production is diversified into the following groups:

Group 1 : Hazardous waste (chemicals, painting residues, used oils, polluted packing, medical waste, soils and contaminated mud)

Group 2 : General and inert waste (used fluids, metals, packing, non biodegradable waste, biodegradable waste, clean materials from civil works).

Group 3 : Radioactive waste.

Drilling residues (oil base mud cuttings, mud from recycling fluids) are considered as particular waste, and included in the inventory (group I or 2 according to their toxicity). However, there is also a list of materials involved in decommissioning tabulated by Chaplin (1999).

Table 1:Types of Materials Involved in Decommisioning

Waste Categories	Material Type
Steel	High Grade, Various Structural Sections And Tubular
Other Metal	Copper, Cupro-Nickel, Aluminum, Zinc And Numerous Recyclable Materials.
Other Material	Equipment, Pipeline, Caisson
Hydrocarbon	Production hydrocarbon light to heavy sludge, sludge operational gearbox oils, greases, transformer oils (PCB), hydrocarbon gas
Oil	Diesel Oil, Hydraulic Oil, Spent Lubricating Oil
Deposits	Spent Acid And Alkaline, ,Spent Solvent, Hydrocarbon sludge, Scale, Sediment, Sand, calcium salt scales,
Production Chemical	Muds, Drilling Chemical, lubes, anti-freeze, biocides, drill additives/acids, corrosion inhibitors, gases, oxy scavengers, paints, solvents, Chemical mix with halogen, Metal mix chemical, etc.
Hazardous Materials	Heavy metal, PFOs, PVC, Asbestos, mercury, pyrotechnics, biocides and many small quantities of materials contained in electrical system.
Radioactive Waste	LSA/NORMs Scale, TENORM,
Other	Marine Growth, batteries, Phthalates (plasticisers in flooring and cables), Light Bulb

Identifying and understanding the waste streams involved in decommissioning will drive the oil and gas industry towards sustainable development and its three dimensions (economic, environmental and social). Environmental indicators cover the performance of both inputs and outputs (emissions, effluents, waste) and thus it will improve the company environmental performance, and ultimately the waste management, towards a green economy (OGP, 2008).

However, for Frigg Decommissioning, removal of its topsides and substructures applied different methods from single lifts to ‘piece small’ dismantling. Strict restrictions were set for material management(Michael,2011). They identified and managed materials by applying an environment accounting system (TEAMS) with the particular feature of tracking material from the offshore location through a demolition site and finally to the disposal site. This system also used to log all other environmentally related data as energy consumption, discharges, emissions to air as well as the waste materials. In Frigg Decommissioning, the waste handling is largely performed onshore due to the limited space at offshore for waste segregation. A thorough job has been done onshore to check the residual of hazardous waste prior to further deconstruction and segregation of waste. According to American Petroleum Institute (API), the wastes most commonly associated with offshore exploration and production activities include drilling fluids, drill cuttings, produced water, treatment, workover and completion fluids, deck drainage, produced sand, naturally occurring radioactive materials (NORM), hydrostatic test water as well as other assorted waste.

2.8 Quantification of Residual Waste

A residual waste survey was conducted to identify the remaining hazardous waste within the structures, pipe work and vessels during the decommissioning of NWH (White & Goodman, 2010). The survey resulted the remaining hazardous materials as follows:

1. Residual hydrocarbon/sludge
2. Naturally Occurring Radioactive Material (NORM) Scale
3. Production Chemical
4. Drilling Chemicals

5. Diesel Oil
6. Heating Medium
7. Hydraulic Oil
8. Lube Oil
9. Seal Oil
10. PCBs
11. Mercury
12. Asbestos

For residual hydrocarbons and NORM scale, they occurrence mainly due to the platform processing system whereas for production chemicals, drilling chemicals and diesel oil which are recognised to be present in the tanks, vessels and equipment of the platform. For PCBs and mercury, they are estimated based on the content of hazardous materials within each unit in the platform and asbestos is estimated by specific survey done on the platform.

2.9 Onshore Disposal – Recycle and Reuse

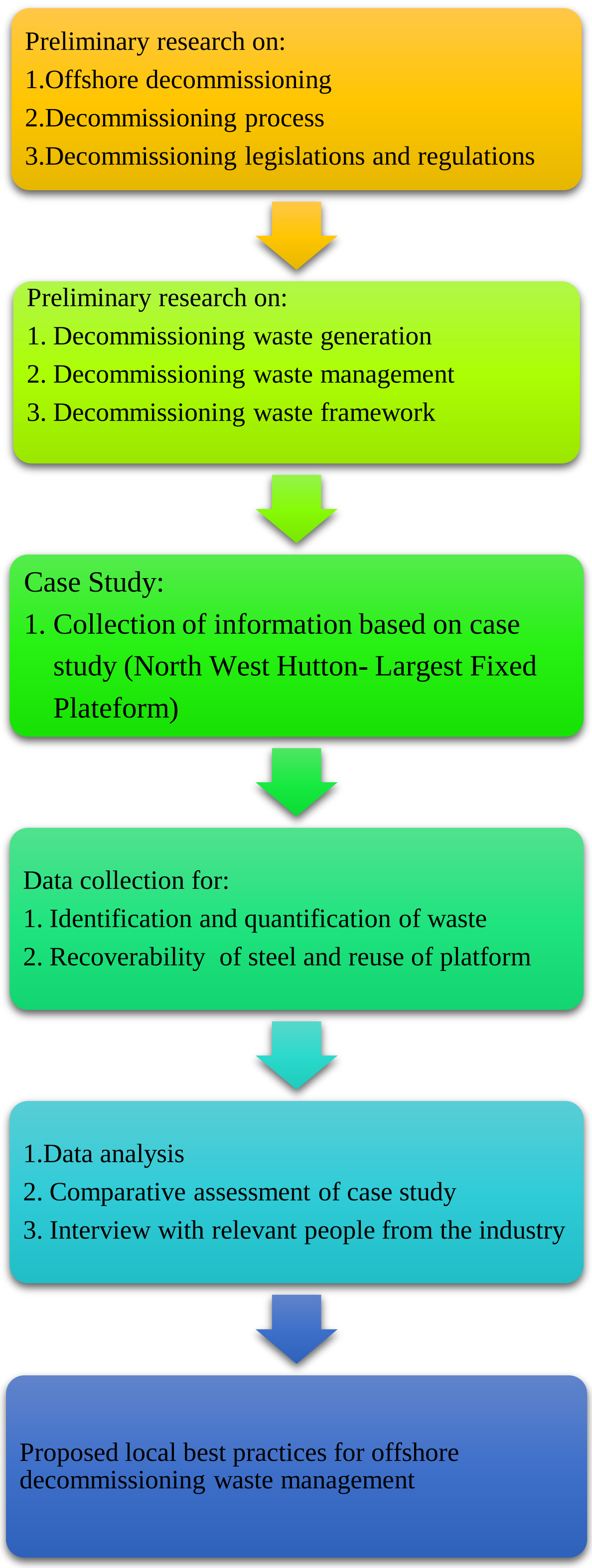
In U.S., although many types of offshore wastes can be legally discharged into the sea, companies still bring some types of wastes back to shore for disposal(John, 2000). This is due to some of the wastes such as oil-based drilling fluids and cuttings, or NORM sludge and scale, produced sand, are prohibited from discharge by the permits. Besides that, it is known that the most important type of materials used in the offshore structures is steel and alloys. The high content of high grade steel and exotic metals causes the recovery of materials into the available pool of attractive resources(Chaplin,1997).

In addition, according to ASCOPE Decommissioning Guidelines, if an opportunity for reuse of platform can be identified, a preliminary assessment should be performed to evaluate its feasibility. When assessing the reuse of facilities in-situ, the concessionaire should consider, but not limited to the following:

- The facility design life along with structural condition and integrity
- The cleanliness of the facility
- The transfer of liabilities

CHAPTER 3: METHODOLOGY

3.1 Research Methodology and Project Activities



3.2 Key Milestones

The planned schedules for Final Year Project I are as follows:

Topic selected	**Week 1**
Objective and Scope of Study Determined	**Week 3**
Done Research on Decommissioning Waste Management	**Week 4**
Submission of Extended Proposal	**Week 6**
Research on Identification and Quantification of Types of Waste Produced in Decommissioning	**Week 7**
Proposal Defense	**Week 9**
Submission of Interim Draft Report	**Week 13**
Submission of Interim Report	**Week 14**

The planned schedules for Final Year Project II are as follows:

Data Gathering of Platform Weight Report	**Week 1**
Data Analysis and Projection of Recoverability of Steel	**Week 2**
Critically Assess Established Case Studies	**Week 4**
Arrangement for Interview Session	**Week 6**
Submission of Progress Report	**Week 7**
Pre-Sedex	**Week 10**
Submission of Draft Report	**Week 12**
Submission of Final Report	**Week 14**

3.3 Gantt Chart

The Gantt Chart for FYP 1 are as follows:

No	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Title	■	■												
2	Identify Problem Statement, Objectives and Scope of Study		■	■											
3	Collection of Literature Review			■	■	■	■								
4	Submission of Extended Proposal						■								
5	Research on Identification and Quantification of Types of Waste Produced in Decommissioning							■	■						
6	Proposal Defence									■					
7	Submission of Draft Report										■	■	■	■	
8	Submission of Final Report														■

The Gantt Chart for FYP 2 are as follows:

No	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Stakeholder Identification and Survey Engagement	■	■	■												
2	Comparative Assessment of Case Study and Local Best Practices				■	■										
3	Analyse Results Obtained and Discussion						■	■								
4	Submission of Progress Report							■								
5	Pre- Sedex										■					
6	Submission of Draft Final Report											■				
7	Submission of Dissertation												■			
8	Submission of Technical Paper												■			
9	viva													■		
10	Submission of Project Final Dissertation															■

CHAPTER 4 : RESULT AND DISCUSSION

Objective 1

To identify and quantify waste products from decommissioning offshore platform in Malaysia

Waste Identification

In general, waste identification is the most important step prior to the waste management. This applies to the offshore decommissioning waste management as well. Before planning on how to manage the waste from decommissioning offshore installations, the operator has to identify the potential types of waste involved in the decommissioning activities. With that, the operator can anticipate the types of waste involved during the actual decommissioning activities. As shown in Figure 6, the types of waste involved in offshore decommissioning are classified into six main categories. These wastes are categorised according to their nature i.e. metal, non-metal, WEEE/batteries, equipment, residual chemical, and hazardous waste. The wastes are identified by characterizing each waste stream from where the waste comes from to what processes generate it and how much is being discarded. After the wastes are identified, then the methods of treating the wastes can be determined according to their nature and ultimately the wastes will be either reused, recycled, resale or transported to landfills.

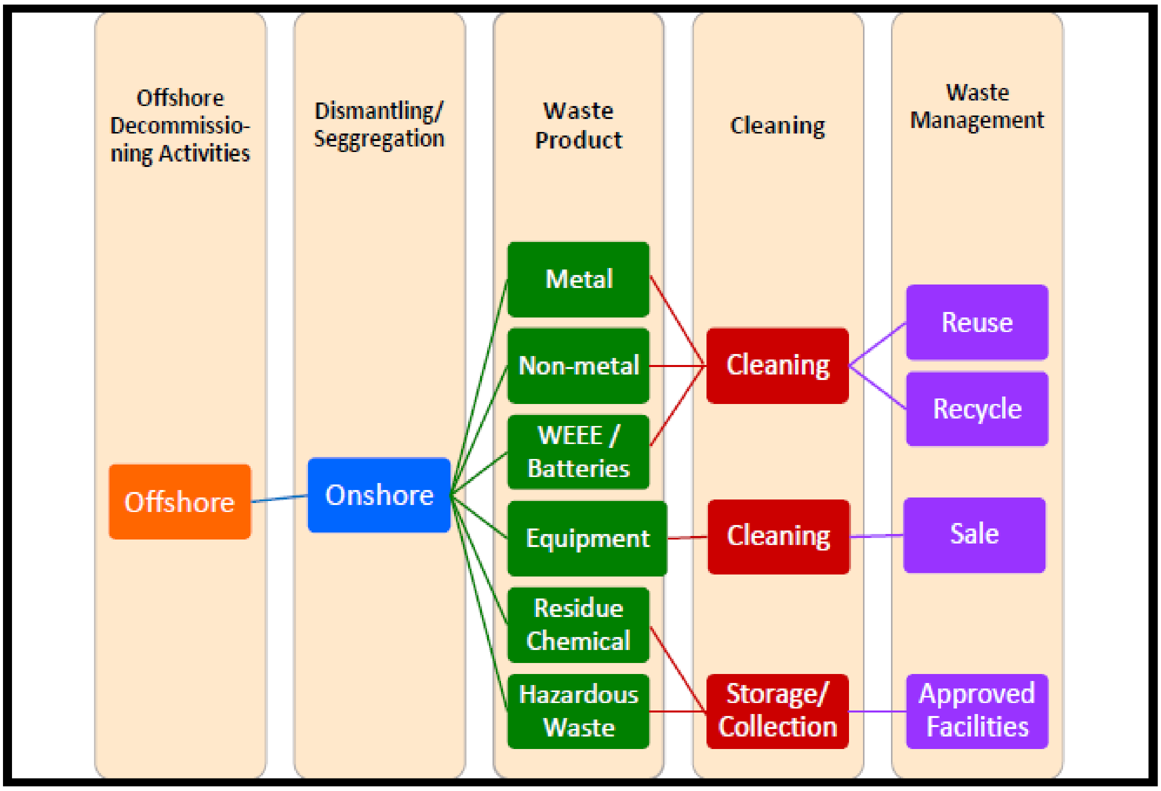


Figure 6: Onshore Decommissioning Potential Process

As for this study, the focus will be on the identification of the physical wastes that are comprised of metals and non-metals. This is because when the offshore platform installations are decommissioned and bring back ashore for waste management, there are about 97% of the total weight of wastes are from physical wastes. Also, from these wastes of metals and non-metals, the analysis on the recoverability of steels and the reuse of platform can be performed. From previous study, it shows that 98% of these physical wastes from offshore structures can be recycled and reuse.

Table 2: List of Metals and Non-Metals Waste

No	Waste Type	North Sea	GOM	Australia	Nigeria	Malaysia
	Metallic (Support Structure)					
1	Bulk Steel	x	x	x	x	x
2	Value Metal		x			
	- Alloy Steel (Jacket)	x				
	- Zinc (Anodes) [1] [2]	x			x	
	- Aluminum (Anode)	x	x		x	
	- Carbon Steel	x	x			
	-Cement (Grout)	x				
	-Iron	x				
	-Titanium	x				
	- Stainless Steel	x			x	
	- Cunifer	x				
	- Monel	x				
	- Copper (Cable)	x	x		x	
	- High Grade Steel		x			
	-Pipeline	x	x	x		
	Non-Metallic			Oil Waste		
	Salable Component					
1	-Equipment					
	• Rotating Equipment • Injection Pump • Prime Movers • Compressor • Gas turbine • Alternator • MV/HV Transformers	x	x	x	x	x

The table above is the list of metal and non-metal waste identified from offshore decommissioning. Since there are limited studies and researches for the Malaysia's offshore platform, thus this study is focussing on the Malaysia's offshore platform. In order to predict the potential wastes from offshore decommissioning, the above list is generated by comparing the available decommissioning waste generated from the decommissioning projects of the 4 different regions namely North Sea, Gulf of Mexico, Australia and Nigeria. It can be seen that the physical wastes consist of metallic waste such as bulk steel and value metals, and non-metallic such as the used equipments from the modules.

Besides that, the outcome from the interview session with Mr Azam from Malaysia Petroleum Management, PETRONAS, shows that there are serious concerns about the hazardous wastes involved in the decommissioning process especially the mercury and asbestos. This is because mercury and asbestos are the major toxic elements found in waste from the oil platforms. They have a wide range of environmental and health impacts. Once mercury is disposed into the atmosphere, it will start transforming into various forms and then move upward in the food chain causing mercury poisoning. For asbestos, inhalation of even relatively small amounts of it will elevate the risk of getting diseases like asbestosis and cancer. Thus, there are two reference documents (technical standards) from PETRONAS in order to govern the handling methods for these two hazardous waste products.

1. PTS 18.33.03 Asbestos
2. PTS 18.33.05 Mercury Management Guidelines

However, knowing that none of the offshore platforms are similar to each other, thus the identification of waste for decommissioning offshore platforms has to be done by case to case approach. Therefore, further detailed identification of potential wastes specifically for Malaysia's offshore platform will be done with the engagement and interview session with the relevant people from the industry.

Waste Quantification

Waste quantification will take place after the waste identification is done. Waste quantification is very important because it determines the waste disposal routes to be taken. Waste quantification can help in evaluating the true size of the decommissioned offshore installation wastes and thus making the suitable decisions for waste minimization and sustainable management. This also enables a more adequate planning of the waste receiving yard facilities and the related logistics.

Based on the case study (North West Hutton Platform) adopted, the waste quantification is done by the following methods:

- Weight Report
- Physical Samples of Residual Waste
- Visual Inspections
- Manufacturer's Data
- Survey

As mentioned earlier, in this study, the author is focusing on the physical wastes of the decommissioning offshore platforms which mainly comprise of metal and non-metal wastes. The wastes will be quantified in term of their weights.

Table 3: Estimated Weights of Material Comprising Support Structures

Item	Material	Weight (t)
Alloy jacket, caissons, risers and j-tubes	Steel	5070
Drilling template	Steel	9000
Piles	Steel	290
Anodes	Aluminium / Zinc / Steel	2200
Grout	Cement	400
Total estimated weight		16960

The estimated weight of material comprising the North West Hutton support structures is shown in Table 3. It is the weight report of the platform's support structures. Similarly, in Malaysia scenario, the operator can also quantify the metal and non-metal waste by having the weight report of the jacket of the platform. With the estimated weight of metal wastes especially in terms of weight steel, the operators can prepare the local treatment facilities to handle the wastes effectively and efficiently. This will definitely help the operators to have clearer image on how to and where to manage the wastes during the planning stage of the decommissioning process.

<u>Objective 2</u>

To study on the recoverability of steel from decommissioning and reuse of offshore platform

<u>Recoverability of Steel and Reuse of Platform</u>

In Malaysia, an offshore platform is constructed out of 1000-20000 tonnes or more of steel on average (mostly fixed platforms). After the platform is decommissioned, it will be wasteful is the operators choose to abandon these used but might be still functional steel structures. Thus the idea of recoverability of steel structures came into the picture because of the high content of high grade steels and metals make the point recovery and recycle of materials very attractive. Besides that, recycling and reusing of steels can contribute in energy savings, reducing usage of raw material and CO2 emissions.

Table 4: Estimation of Weight of Jackets To be Decommissioned

Year	Total Weight (T)
2000	4324
2005	10251
2010	102116
2015	32672
2020	110389
2025	50416
2026	2822
2030	6058
2038	100747
2040	22787
2047	4017

The table shows the estimation of weight of jackets to be decommissioned based on the PETRONAS Platform Abandonment Master Plan Study 1997. It shows that in year 2020, it is expected to have the highest weight of jackets to be decommissioned due to many platforms are approaching their end of service life.

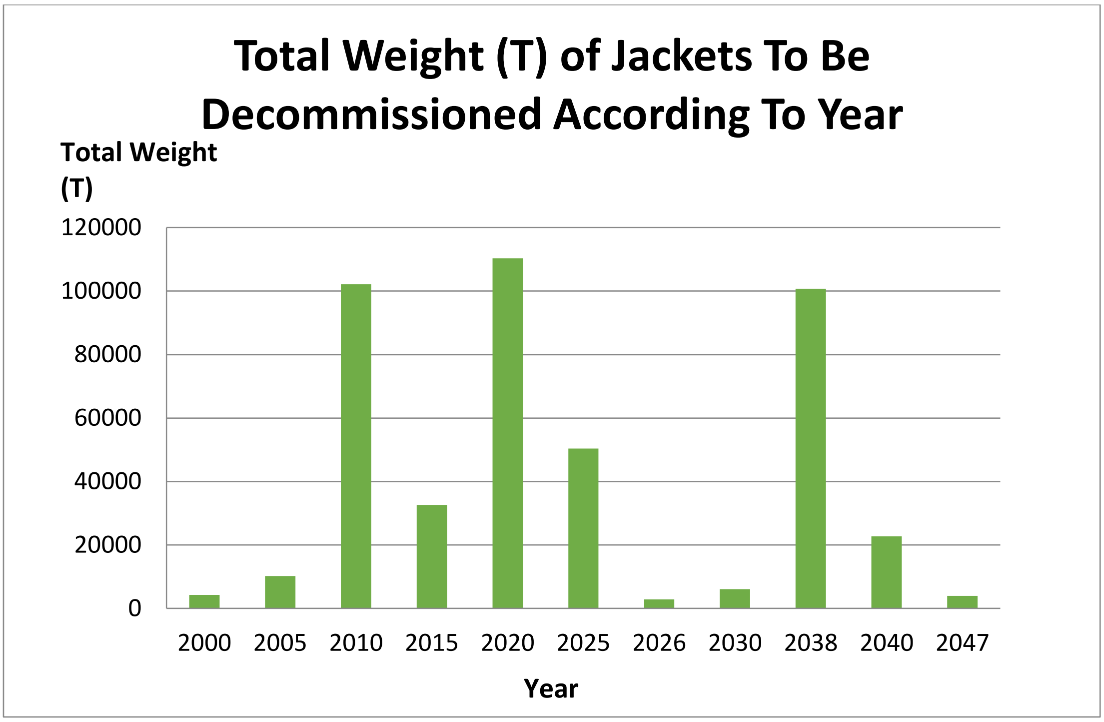


Figure 7: Trend of Decommissioning in Malaysia for Near Future

This graph is produced with the following assumptions:

1. The year is referring to the year of Cessation of Production of the platform without any life extension or Enhanced Oil Recovery (EOR)
2. The total jacket weight = weight of jacket +weight of piles+ weight of conductor

Table 5: Estimation of Weight of Recovered Steel

Year	Total Weight of Steel(T)	Total Recovered Steel (T)
2000	4324	4238
2005	10251	10046
2010	102116	100074
2015	32672	32019
2020	110389	108181
2025	50416	49408
2026	2822	2766
2030	6058	5937
2038	100747	98732
2040	22787	22331
2047	4017	3937

From Table 5, the total number of recovered steel is estimated based of 98% of the jacket's weight. This is because jacket is made of steel and it is proven that 98% of the waste steel can be recovered. Based on recent report, the resell value of a metric tonne of scrap steel is ranged from US $270-350. A decommissioned platform that made of 20000 tonnes structural steel will roughly has a resell value of US$ 6.2 million by taking an average value of US$310 per metric tonne of scrap steel.

Reuse of Platform

Reuse of platform takes place when end-of-life steel is reclaimed and reused after decommissioning. It is one of the important aspects of sustainability since the energy need for refurbishment and remanufacture the reuse platform is relatively lesser than the energy needed to build a platform. The study on reusing decommissioned offshore platforms in Malaysia is needed as there are opportunities of platform reuse in Malaysia. The practice of reusing offshore platforms in marginal fields is common outside of Asia, especially in the Gulf of Mexico. This is due to the economic benefits brought by reusing a platform that is still technically efficient after its lifespan. Reusing a platform can help to save up to 40% cost of the facilities as given the current steel prices and fabrication prices of a new platform and reduce project time. Besides that, the energy conservation achieved through reusing a platform and the environmental benefits of complete removal enable reuse of platform a politically and environmentally acceptable business opportunity.

A decommissioned platform can be given a new life by refurbishing or modifying it for installation at a new field. At the same time, the reusable equipment can be salvaged and reused as well, instead of simply scrapping it onshore. Reusing of platform can also brings safety and environmental aspects as the environmental impacts can be reduced due to the absence of onshore scrapping and reduced the safety concerns since most refurbishment works are done onshore.

Apart from refurbishment of the decommissioned platforms, the decommissioned platforms also can be used as artificial reefs. The oil operators called this as Rig to Reef. Rig to Reef is a process by which the oil operators choose to donate the decommissioned platform rather than scrap. Decommissioned platforms are usually toppled in place, partially removed near the surface or even towed to existing reef sites or reef planning areas. It is proven that artificial reefs can attract various fish and other marine life as found on natural reefs. In Malaysia, there are over 100 artificial reefs in the coastal water of the country. Of these existing artificial reefs, currently 76 sites have been identified and marked on the in-house location map. By adding the redundant platforms to the nearest existing artificial reef enhances the reef, minimise transportation costs. The costs can be further reduced by creating new artificial reefs at platform location. In addition, Rig to Reef can be adopted for the purpose of recreational fisheries and tourist attraction in Malaysia because Malaysia is one of the richest marine environments in the Indo-Pacific Basin.

Up to date, there are only two major Rig to Reef programmes in Malaysian waters, namely Tukau and Siwa which located in Sarawak.

Objective 3

To critically assess other established waste management framework/waste management system and develop a waste management framework for the local industry

Case Study

There is limited research in this topic of assessing the types and amount of wastes produced by decommissioning process in the case of the Malaysia offshore platforms. In addition, there is no substantial published literature on the governing legislations and waste management for decommissioning in Malaysia.

Therefore, offshore platform decommissioning case studies are adopted from the mature decommissioning market in order to achieve the third objective for this study, which is to critically assess other established waste management framework from places such as Gulf of Mexico, North Sea and etc.

Norway

The Norwegian Sea general decommissioning policies are selected as one of the case studies because of published reports and data containing the details on decommissioning. Besides that, according to the Decommissioning of Offshore Installations Report (2011), the Norwegian authorities are well known with the record of high environmental standards which will help to contribute as guidelines in developing a sustainable decommissioning policy for the local industry in future. The common procedure for decommissioning decisions starts with the detailed decommissioning plan provided by the operator. This plan is to evaluate and study the decommissioning options and conclude with the most suitable decommissioning option. Then, this plan is submitted to the government for approval and also circulated to the environmental and fisheries organisations for comments. The Ministry of Petroleum and Energy will then review the plan with the considerations in terms of environmental, technical, economic and resources as well as the international obligations. The Stortingent (the Norwegian parliament) will give the final recommendation to the operator.

In Norway, there are many environmental concerns to be considered throughout the decommissioning process, from planning and shutting down the operations and installations to waste disposal. These environmental concerns are such as emissions to air, discharges to sea, water or ground which will cause biological or ecological impacts, waste management and resource utilization, impacts on fishing and local community (Steinar, Even, & Bente, 2002). Based on the operators' experiences, the most of the unexpected environmental problems are usually arise when demolition starts onshore. This is because the building materials, paints and other materials used in the platform modules were built 30-40 years ago were very different from those materials used nowadays. These materials can cause various problems during the decommissioning stage. In addition, there may be hazardous waste in construction elements that are unidentified before dismantling. Thus, it is very difficult to have an overview of what wastes that the platform contains before it is brought back to shore.

There are many hazardous materials in an offshore platform. Thus during decommissioning, one of the most concerned hazardous materials in Norway's platforms is asbestos. It is a type of crystalline silicate minerals that are fibrous and carcinogenic. Asbestos is widely used in offshore installations for various heat insulation and surface materials because it is an effective insulator. The concern of asbestos materials is strong because inhalation of relatively small amounts of certain types of asbestos dust has proved to lead to several types of diseases especially cancer and asbestosis. The operators have to take extra care during inspection of materials before installations are dismantled. Waste containing asbestos must be only delivered to the approved waste facilities and landfills.

Besides that, there are also radioactive substances found in the context of Norway's platforms decommissioning. Based on the information, these radioactive substances are the same as those radioactive substances found during oil and gas operations which mainly consist of radium isotopes and the lead isotopes. Basically these are known as low specific activity (LSA) materials. They may be found in many different parts of the platform processing equipment, including the valves, wellheads, risers, separators, hydrocyclones and piping. LSA materials can pose great risk to human body and thus the operators handled these wastes extremely careful in order to avoid the spread of these materials to the environment.

On top of the LSA materials, mercury is also found to be occurred in the reservoir, pipelines and equipment. It is a type of heavy metal that is particularly toxic because it can cause damage to kidney, nervous system and chronic effects. Prior to decommissioning, the operators usually practice the identification of materials that contaminated with mercury and then seal those materials before transporting them to the approved waste facilities.

In addition, offshore installations also found to have a wide variety of anti-corrosion coatings are used on the steel structures in order to prevent rusting. These paints and coatings may contain toxic components such as PCBs (polychlorinated biphenyls), heavy metals such as lead, barium, zinc, copper etc. Thus during decommissioning, it is necessary to remove these paints and coatings before any cuttings on the particular areas in order to prevent the toxic release from them.

All the above mentioned hazardous wastes are the common groups of wastes involved in decommissioning across the globe. The possible difference between the platforms across the globe is the specific types of hazardous waste in the platforms of the particular areas. Since no platforms are identical to each other, thus the types of hazardous wastes involved will be identified according to case-to-case approach depending on the types of platforms and the types of production of the platforms.

North West Hutton Platform

On the other hand, handling of hazardous wastes also highlighted in the case study of the decommissioning of the North West Hutton (NWH) platform. According to White and Goodman (2010), it is found that the oil operator managed to identify and quantify the residual waste especially the hazardous materials by conducting the residual waste survey. The survey is conducted within the structures, pipe work and vessels in order to estimate the remaining levels of the following hazardous materials such as hydrocarbon residual, production chemicals, drilling chemicals, diesel oil, hydraulic oil, lube oil, seal oil, naturally occurring radioactive material (NORM) scale, PCBs, mercury and asbestos. Since the NWH platform consists of many modules, further work was then carried out after the survey was done in order to estimate the split of total residual wastes of each type in each module. This included by having the expertise to make reasoned assumptions to the percentage of each waste material in each module based on the locations of key elements of the relevant systems.

The waste management strategy that was adopted in NWH platform has ensured good alignment between the operator which is BP, the Decommissioning Contractor and the Onshore Dismantlement and Disposal Contractor on the processes and deliverables that were used to manage the transfer of materials from offshore to onshore.

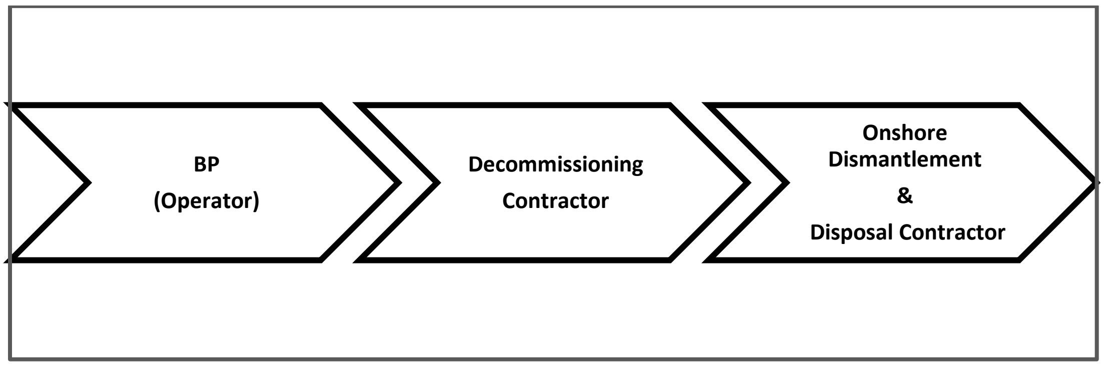


Figure 8: Party Involved in Waste Management

Among the most significant ones is the documents used as the formal mechanism by which BP provided the Decommissioning Contractor with the detailed estimates of waste types, quantities and relevant information. BP provided the detailed plan for the removal and shipment of modules from offshore and onshore to the Decommissioning Contractor.

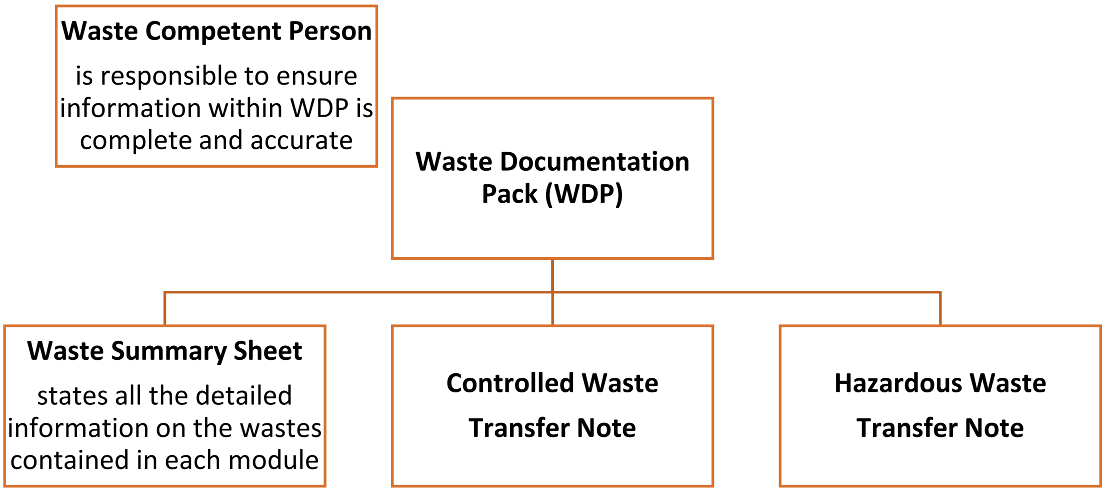


Figure 9: Waste Documentation Pack

As shown in the figure above, the Decommissioning Contractor will ship the modules in groups on a number of separate cargo barges with the creation of Waste Summary Sheet (WSS) that states all the detailed information on the wastes contained in each module. With this practice, a Waste Documentation Pack (WDP) is created for each barge shipment and the Contractors can trace the wastes easily with the available information. Besides that, the Controlled Waste Transfer Note and Hazardous Waste Transfer Note also will be included in the WDP in order to keep track all waste materials being transferred from one party to another. Before the waste materials leave the platform, a Waste Competent Person Offshore is appointed and he is responsible to ensure that the information contained within the WDP was as accurate and complete as possible. It was learned that BP has prepared a detailed set of responsibilities in terms of preparation, sign off and handling over of the waste materials.

On top of that, NWH platform also comply with the Duty of Care which requires any party in the waste chain to provide detailed information on the nature of waste to the next party who receives. This applies to anyone in the UK, who produces, imports, transports, stores, treats or disposes of waste.

The lesson learnt from North West Hutton platform is that some significant uncertainties have to be included to the final estimates of the amount of residual waste due to the range of levels of contamination that may be present in different areas of the platform. Besides that, the Duty of Care practice helps in increasing the accuracy of information available on the waste material at every stage of the waste management process.

Frigg Decommissioning

The waste handling in Frigg Decommissioning emphasised on the waste segregation onshore since the main part of the decommissioned platform were landed as complete modules or structures. When the modules or structures arrive onshore, mapping and removal of hazardous waste will be done prior to further deconstruction and segregation of waste. The unique part of Frigg Decommissioning is that the Total Environmental Reporting and Management System (TEAMS) software is used to record, process and report environmental data. This software is very useful tool in waste management because it can be used as a logistic database to record all material transfers from the offshore installation to the final destination such as waste yard, landfill and etc. The experience in using TEAMS software to estimate the quantities of waste in Frigg Decommissioning shows that the accuracy of the software is very high because the actual waste received is very close to the estimated waste.

Gulf of Mexico

In the Gulf of Mexico, the common removal method is to cut the deck from the jacket and then lift and place the deck for removal to shore or an artificial reef site. The structures located in the state waters are governed by the state agencies whereas the structures located in the federal waters are governed by the Minerals Management Service (MMS). In The Decommissioning Market Report 2008, US

Gulf of Mexico is a matured basin where many offshore platforms were installed and at the same time many offshore platforms were decommissioned. The common practice of the operator in decommissioning always starts with the removal of the residue waste from the platform by cleaning the deck and the production equipment thoroughly. This cleaning may take a week or more depending on the size and complexity of the platform. It is learned that this cleaning will help to reduce the inventory of wastes when the structure is removed and arrived onshore. Then the Environmental Protection Agency (EPA) is authorised by Resource Conservation and Recovery Act (RCRA) to regulate hazardous waste from generation to ultimate disposal which known as cradle to grave. Those who generate, transport, treat, store or dispose of hazardous waste will be held full responsibility under the RCRA (Markus and John, 2004).

Field Decommissioning in Austria

It was learned that in their experience of field decommissioning, a waste management plan was established for all abandonment activities origin and disposal of all waste involved in decommissioning. This waste management plan includes the inventory of installations, tanks and pipes with respect of their size, capacity and structure. All produced wastes were recorded with respect of their nature, quantity, origin and disposal destination. The waste management specialist did a professional assessment of all produced wastes and their disposal or treatment method then a balance sheet of the estimated quantity and actual disposed quantity was provided. However, in this case study of field decommissioning in Austria, the operator was very concerned about their final wastes disposal destinations, which are the landfills. They were afraid of the release of endangering potential of contaminants to the underground which may affect the groundwater. In order to prevent this, they analysed the groundwater conditions and compositions before, while and after working on the landfill. Then the excavated areas to be used as landfills for the waste disposal were then cultivated with clean soil. Throughout the process, all measures and quantities were properly documented.

Decommissioning in Thailand

Thailand is the neighbour country of Malaysia, thus its offshore decommissioning is considered very similar to Malaysia because there are mainly fixed platforms just like Malaysia. Most of the installations were returned to shore for reuse, recycling and landfill. A lay down area is provided in order to separate hazardous and non-hazardous modules when the installations received onshore. Then these modules will be scrapped and dismantled and eventually being sent to the landfills or steel rolling mills for cycling. The scenario now in Thailand shows they have no onshore infrastructure for dismantling and scrapping facilities available in the country. This situation proved that offshore decommissioning is very new in this region and Malaysia is not excluded as we are also lacking of competent onshore dismantling facilities. Thus it is suggested that by developing local onshore dismantling facilities will bring potential business opportunity within this region.

Comparative Assessment of Case Study

The findings from these case studies will be mainly based on the authorities involved, the waste management process as a whole and also the rules and regulations involved in the decommissioning process. Besides that, the lesson learnt and challenges stated in these case studies will be studied and provide as the foundation for the local waste management framework in this study.

Based on the case study above, it can be seen that in Norway, there must be a detailed decommissioning plan provided by the operator and to be submitted to the government for approval and also circulated to the environmental and fisheries organizations before the decommissioning project starts. Then the Ministry of Petroleum and Energy will review the plan formally and the parliament will give the final recommendations. It is slightly different in the Malaysia's scenario, where the operators only required to notify the Department of Occupational Safety and Health (DOSH) about the proposed decommissioning plan prior 6 months to the commencement of decommissioning. In the proposed decommissioning plan, the operators have to provide the preliminary inventory of that specific platform as well as the Environmental Impact Assessment (EIA) to DOSH and also inform the Department of Environment (DOE) as there will be various types of wastes involved.

Currently, oil operators in Malaysia have not established waste management framework or procedure for decommissioning of offshore installations. The major operator in Malaysia, PETRONAS, is now in the process of drafting the waste management framework for offshore decommissioning. Unlike in the North Sea, BP, the operator has established their waste management strategy and used it to the decommissioning of the largest fixed platform in the world, North West Hutton(NWH). Their strategy has successfully ensured good alignment between the operator, decommissioning contractor and the onshore disposal contractor. They have detailed estimates of waste types, quantities and relevant information by having the Waste Summary Sheet (WSS). WSS states all the information on the wastes contained in each module and BP provides a competent person to be responsible in handling the wastes and signing off at each stage during the transportation of the waste from offshore to onshore. Besides that, from the case study of Frigg Decommissioning, it was learned that the operator also has waste management software known as Total Environmental Reporting and Management System(TEAMS). This software is very useful because it can be used as a logistic database to record all material transfers from offshore to onshore.

In Malaysia, no governing legislation is available for offshore decommissioning. But, once the wastes from offshore are transported to the onshore dismantle and disposal yard, the waste management is governed by certain authorities and legislation. The authorities are DOSH and DOE. These two departments are concerned about the treatment and handling of wastes after arriving onshore. If the wastes contain radioactive materials, the oil operators have to notify the Atomic Energy Licensing Board(AELB) whereas if the wastes contain scheduled wastes, the oil operators have to notify the DOE. For legislations, the oil operators have to comply with the Environmental Quality Act 1974, Natural Resources and Environmental Ordinance and Conservation of Environment Enactment. Similarly, in the Gulf of Mexico(GoM), the oil operators also have to comply to the Environmental Protection

Agency(EPA). EPA is authorised by Resource Conservation and Recovery Act(RCRA) to regulate hazardous waste from generation to disposal of the waste.

Apart from that, there are many challenges that the local oil operators are facing since offshore decommissioning is very new to Malaysia. Most of the offshore platforms that are reaching their end of service life are mostly built in 20 years ago. To start with the detailed decommissioning plan, the operators must have the platform's data, drawings and inventory. However, it is very difficult for the operators to collect or retrieve back that information because they may not be documented systematically back then. Thus, the operators have to do as-built drawings for that particular platform and to ensure that all data needed is as accurate as possible. In addition, due to its complexity, offshore decommissioning is a long process which involves the government bodies, operators and contractors. The cost involved in decommissioning project is very high and most of the operators will view decommissioning as a liability rather than an investment to the company. The operators have to consider carefully in all aspects during the planning stage in order to avoid any additional cost to be incurred during the decommissioning process. Besides that, the availability of local competent facilities for handling the wastes especially hazardous waste and scheduled waste from decommissioning is also a main challenge. These two types of waste have to be handled with care so that the impacts to the environment can be reduced. The problem is that these waste treatment facilities in Malaysia may not have to capacity to treat the amount of wastes coming back from offshore. However, PETRONAS has the list of licensed waste contractors and facilities under the PETRONAS Waste Management License. All these waste contractors and facilities are also registered with Department of Environment(DOE).

Proposed Framework for Offshore Waste Management Plan

Knowing that Malaysia now has no waste management plan for offshore decommissioning in place, the following is the proposed framework for developing waste management plan for the local industry. This proposed framework is also in accordance to the waste management plan from the American Petroleum Institute (API) guidelines.

Step 1: Company Management Approval

The oil operators have to prepare the decommissioning proposal plan and notify the Department of Occupational Safety and Health(DOSH) and Department of Environment(DOE).

Step 2: Waste Management and Pollution Prevention Policy

The oil operators should comply with the Environment Quality Act(EQA) 1974 when dealing with waste management at the onshore waste treatment facilities

Step 3: Area Definition

The oil operators should defined the area of the offshore platform which decommissioning activities will take place clearly

Step 4: Waste Identification

The oil operators should identify the types of waste that will be involved during the decommissioning activities

Step 5: Waste Classification

The oil operators should classify the wastes into these categories: either can be recycled, reuse, refurbished and to landfill

Step 6: List and Evaluate Waste Management and Disposal Options

The oil operators should do a proper waste management planning where all methods of treatment and disposal are evaluated and select the most suitable one to be used in the decommissioning project

Step 7: Waste Minimisation

The oil operators should follow the waste management hierarchy: best option starts with prevention, then reuse, recycling and last option is landfill

Step 8: Select Preferred Waste Management Practices

The oil operators should adopt the preferred waste management practices according to the result from the evaluation of the waste treatment and disposal methods

Step 9: Prepare and Implement An Area Waste Management Plan

The oil operators should prepare a detailed waste management plan and implement it accordingly

Step 10: Monitor, Audit, Review, and Update Waste Management

The oil operators should assign personnel incharge of the audit and review the waste management plan

CHAPTER 5 : CONCLUSION

When an offshore facility is determined to be decommissioned, the operator has to make the disposal and reuse options of the facility as part of the overall assessment. This decision is to be made based on location, time, economic, technology available and regulatory conditions. Thus, the basic idea in waste management of offshore decommissioning is to maximize the value of the waste stream by reducing the structure according to the acceptable disposal hierarchy.

This study concludes that it is very important to identify and quantify the wastes involved in decommissioning process. This is crucial as during the planning stage of decommissioning, the decommissioning contractor and operator can anticipate the types and amount of waste that they will be dealing with. Thus the preparedness or readiness of transporting and managing the wastes is present during the decommissioning process. With the results gathered, it is found that physical wastes from the offshore platform comprise of 97% of its total waste. Therefore, the treatment for the physical wastes namely the metals and non- metals should be given the priority as they are majority waste. Besides metals and non-metals waste, there are also WEEE/batteries, equipment, residual chemical, and hazardous waste. Generally decommissioning of offshore installations can be categories into these six types of wastes. In order to quantify the metals waste, it is learned from the case study of North West Hutton Platform that the metals waste of a fixed offshore platform can be quantified by adopting the physical weight report of the platform. This is because the metals waste from a fixed platform is mostly from the jacket of the platform.

In addition, this study also shows the idea of recoverability of steel structures from the platform because of the high content of high grade steels and metals make the point recovery and recycle of materials very attractive. The operator can expect the amount of cost that can be recovery by recycling the metals and steels.Based on recent report, the resell value of a metric tonne of scrap steel is ranged from US $270-350. Besides that, recycling and reusing of steels can contribute in energy savings, reducing usage of raw material and $CO2$ emissions.

In a nut shell, this study is to provide the operators with the idea of the current practice of waste management in the matured decommissioning market such as Gulf of Mexico and North Sea. The proposed waste management framework is compiled with the local current practice in Malaysia and also in accordance with the American Petroleum Institute (API) guidelines. The significance of this study is to benefit both the local operators and service providers in terms of understanding the waste management process of decommissioning. Thus, the objectives are achieved.

Recommendation

With the rapidly developing offshore decommissioning market in Malaysia, the government, community and industry should be aware of the opportunities provided by the offshore decommissioning. However, oil operators should adopt effective and efficient waste management plan for offshore decommissioning in order to minimize the impacts of wastes generated from offshore decommissioning activities to the environment. At the same time, this good practice will portray a good image of oil operators by showing the responsibility of handling waste. For the scenario in Malaysia, due to lack of experience in decommissioning, all parties involved should play their part responsibly and adopt best practices from the mature decommissioning markets. Especially to the local service providers, they should be prepared and equip themselves for providing the technical services needed in offshore decommissioning. However, it has to be reminded that none of the offshore platforms are similar to each other, thus the identification of wastes for decommissioning offshore platforms has to be done by case to case approach

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APPENDIX

Interview Questionnaire

This interview is designed to facilitate the assessment of the current situation of waste management in offshore decommissioning activities in Malaysia. The information collected by this interview can help in establishing a waste management framework for offshore decommissioning in the local oil and gas industry. This interview will be focusing on the physical wastes of decommissioning offshore structures which are mainly fall into metals and non-metals groups.

1. How do oil operators identify and quantify waste products into categories of metal and non metal waste from offshore decommissioning activities?

2. Knowing that no offshore platforms are alike, generally in Malaysian offshore platforms, what types of metal contents are more prevalent to be found in the offshore facilities?

3. By referring to the following table, are these common waste type found in the Malaysian offshore platform?

No	Waste Type	North Sea	GOM	Australia	Nigeria	Malaysia
	Metallic (Support Structure)					
1	Bulk Steel	x	x	x	x	x
2	Value Metal		x			
	- Alloy Steel (Jacket)	x				
	- Zinc (Anodes) [1] [2]	x			x	
	- Aluminum (Anode)	x	x		x	
	- Carbon Steel	x	x			
	-Cement (Grout)	x				
	-Iron	x				
	-Titanium	x				
	- Stainless Steel	x			x	
	- Cunifer	x				
	- Monel	x				
	- Copper (Cable)	x	x		x	
	- High Grade Steel		x			
	-Pipeline	x	x	x		
	Non-Metallic			Oil Waste		
	Salable Component					
1	-Equipment					
	• Rotating Equipment • Injection Pump • Prime Movers • Compressor • Gas turbine • Alternator • MV/HV Transformers	x	x	x	x	x

4. From previous decommissioning activities in Malaysia, how were the waste products (metal and non-metal) being handled? (Onshore waste management)

5. What are the prospects of steel recoverability from the decommissioning activities from the oil operator point of view?

6. Do the oil operators encourage the reuse of decommissioned platforms in Malaysia? Reasons.

7. Who are the authorities involved in terms of waste management for offshore decommissioning in Malaysia?

8. Is there any waste management framework that the local oil operators are following to in terms of offshore decommissioning?

9. What are the main concerns/challenges of the local oil operators in decommissioning activities especially in terms of waste management?

10. What types of waste management facilities needed for Malaysia offshore decommissioning?

11. Any other comments/suggestions to researchers in relation to the study of waste management in offshore decommissioning in Malaysia?