



**DESIGN IMPROVEMENT AND FUNCTIONAL ANALYSIS OF PORTABLE OIL  
SPILL SKIMMER**

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering

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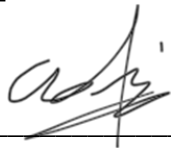
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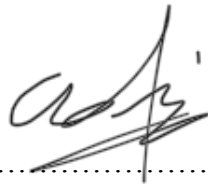
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I declare that this report entitled “Design Improvement and Functional Analysis of Portable Oil Spill Skimmer” is the result of my own research except as cited in the references.



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Date : 14 JULY 2021



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## APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:



## ABSTRACT

The portable oil spill skimmer is a device that used to make a cleanup spillage of oil on the surface of water. Different type of device in the reaction plan of oil spillage is currently used in compliance with the requirements of the waste and the procedures used, such as booms, skimmers, barriers, storage barges, tanks and even vessels. However, the existed oil spill skimmer have a weakness on its performance. It not suitable for wavy surface of water, the linear motion is not stable and need a long period to finish the cleanup. This report proposes and explain the information about redesign the new hull part, reduce the time taken for oil collection and improve the linear motion stability. One of the possibilities to improve the hull part is to embed the catamaran hull design due to high stability performance on the portable spill skimmer. For the oil collecting, the skimmer is most suitable and the material is polypropylene. The dimension of the polypropylene roller need to be increase to able the roller to collect more oil and reduce the time taken. The number of propeller motor can be use either single or more than one. The method used in this project is starting from brainstorming to identify the solution for the problem. Then, need to find out the requirement needs to improve the exsited product and continue to generate the design concept which have five different design of hull. The selection of design and propeller motor must go through the Analytic Hierarchy Process (AHP) method. In conclusion, the portable oil spill skimmer is proposed to be improved by redesign the hull, enlarge the size of skimmer and increase the linear motion stability. With the improvement that have been made, the portable oil spill skimmer could performed well on the wavy water surface and can reduced the period to complete the cleaning job.

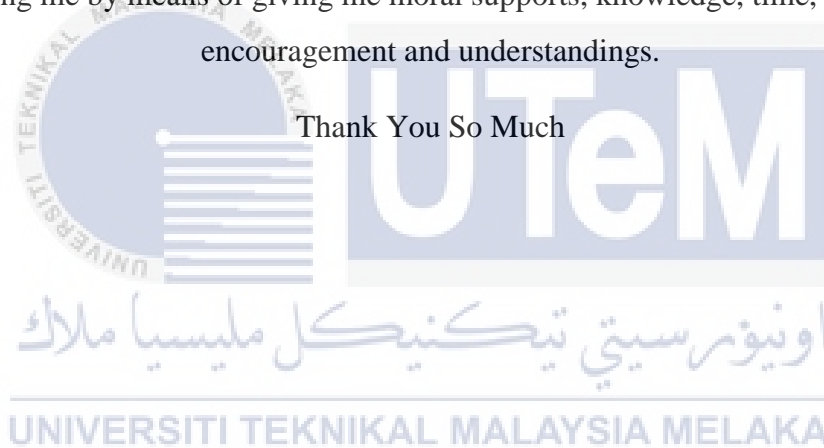
## ABSTRAK

Skimmer tumpahan minyak mudah alih merupakan alat yang digunakan untuk membuat pembersihan tumpahan minyak di atas permukaan air. Pelbagai jenis alat dalam rancangan tindak balas tumpahan minyak saat ini digunakan sesuai bergantung kepada keadaan tumpahan dan prosedur yang digunakan, seperti *booms*, *skimmer*, penghalang, dayung, tangki dan bahkan kapal. Namun, *skimmer* tumpahan minyak yang sedia ada mempunyai kelemahan pada prestasinya. Ia tidak sesuai untuk permukaan air yang bergelombang, gerakan linier tidak stabil dan memerlukan masa yang lama untuk menyelesaikan pembersihan. Laporan ini mencadangkan dan menjelaskan maklumat mengenai reka bentuk semula bahagian lambung baru, mengurangkan masa yang diambil untuk pengumpulan minyak dan meningkatkan kestabilan gerakan linier. Salah satu kemungkinan untuk memperbaiki bahagian lambung adalah menyisipkan reka bentuk lambung catamaran kerana prestasi kestabilan yang tinggi pada skimmer tumpahan minyak mudah alih. Untuk pengumpulan minyak, *skimmer* paling sesuai dan bahannya adalah *polypropylene*. Dimensi penggelek *polypropylene* perlu ditingkatkan agar penggelek dapat mengumpulkan lebih banyak minyak dan mengurangkan masa yang diambil. Bilangan motor *propeller* boleh digunakan sama ada tunggal atau lebih dari satu. Kaedah yang digunakan dalam projek ini adalah bermula dari percambahan idea untuk mengenal pasti penyelesaian untuk masalah tersebut. Kemudian, perlu mengetahui keperluan-keperluan untuk meningkatkan produk yang sudah sedia ada dan terus menghasilkan konsep reka bentuk yang mempunyai lima reka bentuk lambung yang berbeza. Pemilihan reka bentuk dan motor *propeller* mesti melalui kaedah *Analytic Hierarchy Process (AHP)*. Kesimpulannya, *skimmer* tumpahan minyak mudah alih dicadangkan untk diperbaiki dengan merancang semula bahagian lambung, memperbesar ukuran *skimmer* dan meningkatkan kestabilan gerakan linier. Dengan penambahbaikan yang telah dilakukan, alat ini dapat bekerja dengan baik di atas permukaan air bergelombang dan dapat mengurangkan waktu untuk menyelesaikan kerja-kerja pembersihan

## DEDICATION

I wholeheartedly dedicate this study  
to my beloved father, Azhar Bin Ahmad; to my mother, Azizah Binti Yusof;  
to my family;  
to my helpful classmates and friends;  
to my honorable and resourceful supervisor, Dr. Khairul Fadzli Bin Samat  
for assisting me by means of giving me moral supports, knowledge, time, cooperation,  
encouragement and understandings.

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My completion of this project could not have been accomplished without the support from my family that always support me to finish this report. Same goes to my friends who help and give me some guide during completing this report.

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## TABLE OF CONTENT

<u>CONTENT</u>	<u>PAGE</u>
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>ABSTRACT</b>	i
<b>ABSTRAK</b>	ii
<b>DEDICATION</b>	iii
<b>ACKNOWLEDGEMENTS</b>	iv
<b>CHAPTER 1 : INTRODUCTION</b>	1
1.1 Background Study	1
1.2 Problem Statement	2
1.3 Objectives	4
1.4 Scope	4
1.5 Significance of Study	4
1.6 Project Schedule	5
1.7 Thesis Organization	7
<b>CHAPTER 2 : LITERATURE REVIEW</b>	8
2.1 Introduction	8
2.2 Float Mechanism	9
2.2.1 Design of Hull	9
2.2.2 Dimension of Hull	11
2.2.3 Material of Hull	12
2.3 The Skimmer	12
2.3.1 Type of Skimmer	13
2.3.2 Material of the Skimmer	19
2.4 Maneuverability System	21
2.4.1 Number of Motor Used	21
2.4.2 Power Supply	22
<b>CHAPTER 3 : METHODOLOGY</b>	23

3.1 Introduction	23
3.2 Flowchart	24
3.3 Product Planning	25
3.4 Identification of the Requirement	25
3.5 Generate the Design Concept	26
3.6 Concept Selection	27
3.6.1 Selection of Hull Design	27
3.6.2 Selection of Motor	28
3.6.2.1 List of Propeller Motor	29
3.7 Analytic Hierarchy Process (AHP)	30
3.8 Designing the Hull Part	32
3.9 Final Conceptual Design	33
3.10 Analysis	34
3.10.1 Buoyant Force Analysis	34
3.10.2 Rate of Oil Collection Analysis	34
3.10.3 Maximum Oil Occupied Analysis	35
<b>CHAPTER 4 : RESULT AND DISCUSSION</b>	<b>36</b>
4.1 Introduction	36
4.2 Selection of Hull Design	36
4.3 Selection of Propeller Motor	43
4.4 Analysis	51
4.4.1 Buoyant Force	51
4.4.2 Maximum Oil Occupied	53
4.4.3 Rate of Oil Collection	54
4.5 Final 3D Design of Improved Portable Oil Spill Skimmer	55
<b>CHAPTER 5 : CONCLUSION AND RECOMMENDATION</b>	<b>56</b>
5.1 Conclusion	56
5.2 Recommendation	57
Reference	58
Appendix	61

## LIST OF TABLE

<u>TABLE</u>	<u>TITLE</u>	<u>PAGE</u>
1.1	Gantt chart PSM 1	5
1.2	Gantt chart PSM	6
2.1	Recovery rate based on oil type	13
2.2	Thickness of oil film on skimmer	20
3.1	Requirement need for hull part	25
3.2	Requirement need for motor	25
3.3	Specification of reference propeller motor	28
3.4	List of propeller motor	29
3.5	Pairwise comparison matrix	30
3.6	Synthesizing judgements	31
4.1	Pairwise matrix (Stability on water)	37
4.2	Synthesizing judgements (Stability on water)	37
4.3	Pairwise matrix (Buoyancy)	38
4.4	Synthesizing judgements (Buoyancy)	38
4.5	Pairwise matrix (Complexity)	39
4.6	Synthesizing judgements (Complexity)	39
4.7	Pairwise matrix (Speed)	40
4.8	Synthesizing judgements (Speed)	40
4.9	Pairwise matrix (Criteria)	41
4.10	Synthesizing judgements (Criteria)	41
4.11	Developing an overall priority ranking (Hull design)	42
4.12	Final AHP ranking of alternative (Hull design)	42
4.13	Pairwise matrix (Torque)	44
4.14	Synthesizing judgements (Torque)	44
4.15	Pairwise matrix (Speed)	45
4.16	Synthesizing judgements (Speed)	45
4.17	Pairwise matrix (Power)	46
4.18	Synthesizing judgements (Power)	46
4.19	Pairwise matrix (Weight)	47
4.20	Synthesizing judgements (Weight)	47

4.21	Pairwise matrix (Criteria)	48
4.22	Synthesizing judgements (Criteria)	48
4.23	Developing an overall priority ranking (Propeller motor)	49
4.24	Final AHP ranking of alternative (Propeller motor)	49
5.1	Result from the objective	57



## LIST OF FIGURE

<u>FIGURE</u>	<u>TITLE</u>	<u>PAGE</u>
1.1	Reference model of Portable Oil Spill Skimmer	3
2.1	Meshing data for catamaran hull	9
2.2	Design of Catamaran hull	10
2.3	Device that using Catamaran hull	10
2.4	Length and width of the catamaran hull	11
2.5	Height of the catamaran hull	11
2.6	Characteristic of balsa wood	12
2.7	Rotary disc type skimmer	14
2.8	Drum type skimmer	15
2.9	CAD diagram for belt type skimmer	16
2.10	Portable oil spill skimmer belt type	16
2.11	Weir type skimmer	17
2.12	Floated brush type skimmer	18
2.13	Activated carbon mixed with water	20
2.14	Polymer belt skimmer	20
3.1	Flowchart of process planning	24
3.2	Design concept 1	26
3.3	Design concept 2	26
3.4	Design concept 3	26
3.5	Design concept 4	26
3.6	Reference of hull design	27
3.7	Reference motor	28
3.8	Motor 1	29
3.9	Motor 2	29
3.10	Motor 3	29
3.11	Motor 4	29
3.12	Hierarchy framework	30
3.13	Flowchart of designing the hull	32
3.14	Final conceptual design	33
4.1	Hierarchy of decision for hull design	36

4.2	Improved drawing of selected design	42
4.3	Hierarchy of decision for propeller motor	43
4.4	Motor 3	49
4.5	Buoyant force	51
4.6	Dimension of skimmer	54
4.7	Final 3D Design of Improved Portable Oil Spill Skimmer	55



## LIST OF ABBREVIATION

CAD	-	Computer-aided design
PVC	-	Polyvinyl chloride
PE	-	Polyethylene
PP	-	Polypropylene
DC	-	Direct current
AHP	-	Analytic Hierarchy Process



## LIST OF SYMBOL

%	- Percentage
Mm	- Millimetre
N/mm <sup>2</sup>	- Newton per millimetre square
kg/mm <sup>3</sup>	- Kilogram per millimetre cube
N/A	- Not available
Hr	- Hours
ml/min	- Millilitre per minute
Rpm	- Revolution per minute
NaCl	- Sodium chloride
V	- Volt
Nm	- Newton metre
F	- Force
P	- Density
M	- Mass
$M_{max}$	- Maximum mass of oil can be occupied
g	- Acceleration due to gravity (9.81 m·s <sup>-2</sup> ).
S	- Speed
d	- Distance
t	- Time
Π	- Pi
Vs	- Volume of submerge
ρ	- Density
$F_b$	- Buoyant force
L	- Litre
kg/L	- Kilogram per litre
r	- Radius
h	- Height
m <sup>2</sup>	- Metre square
m <sup>3</sup>	- Metre cubic
N	- Newton



# CHAPTER 1

## INTRODUCTION

### 1.1 Background Study

One of the natural resources that contain in earth is oils. Over the years, however, demand for oil and transport has risen (Cakir et al., 2021). The disadvantages of oil is it non-renewable energy which is oil will finish from earth in future. Oils may be characterised as any acidic, nonpolar chemical material, which is hydrophobic as well as lipophilic in the shape of viscous liquid in the ambient temperature. The oil that obtained from the seabed is called as crude oil/raw oil. The oil need to be process to produces petroleum, petrol, kerosene, butane gas and etc.

The waste generators must use the appropriate containers to ensure proper handling of the waste. Then, the guidelines have been developed for oil and chemical handling. Before the oil is shipped, reinjected or stored somewhere, it is treated on the ground, the oil is reused or stored anywhere, the oil is handled on the field or oil is handled at the processing facility before it is transported, reinjected or stored anywhere, the oil is reused in the field, or is handled at the construction site until oil is transported, reinjected or stored somewhere (Muizis, 2013).

Oil spill were one of the world's greatest issues for a long time and be the main cause of water pollution (Singh et al., 2020). Oil spill may cause the underwater ecosystem damage (Huang et al., 2019). These are disasters for industry and the community. Ocean water has been tainted with liquid petroleum hydrocarbons as a result of a collision involving vessels

and oil plants, causing disruption to the atmosphere for decades. Although only big injuries leading to pollution are the main subject of concern, there are frequent events of certain minor and repeated cases. It also takes months of oil washing to restore the areas surrounding the event to normal.

An oil skimmer is an oil removing instrument from a sheet of grease. The usage of robot can help in cleaning the spillage of oil on surface of water (Shukla & Karki, 2016). The water saturation scent can be reduced by eliminating the top layer of the oils and the unexpected surface scum. Depending on the nature, skimmers are also needed before further treatments with respect of the environmental discharge to extract oils, grates and fats in industrial applications. In order to increase wastewater discharge quality, an oil skimmer placed before the oily water treatment system can achieve greater overall oil separation performance.

## 1.2 Problem Statement

An oil spill skimmer are used to separate the floating oil on the surface of water from a body of water. Nowadays, there are a few system used to clean up the spillage such as drum skimmer, wire skimmer, brush skimmer and disc skimmer. Every system have their advantages and disadvantages. The system were selected by considering the limitation of the usage such as the variable space and radius of spillages.

The design of hull are not suitable for wavy surface of water such as ocean. The existing oil skimmer were design with flat hull and it will limit the movement of the oil skimmer (Manivel & Sivakumar, 2020). Beside that, the time taken to clean up the spillage are to long because of the rate of oil collection are too small. The existing oil spill skimmer consists a complex maneuver system which is made by 2-propeller system. There are some difficulty was discovered on the maneuverability due to uneven power distribution due to installation of 2-propeller system and caused the oil spill skimmer sailing in improper desired direction.

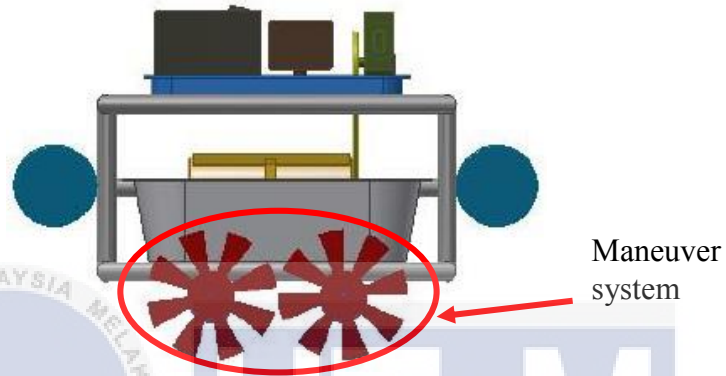
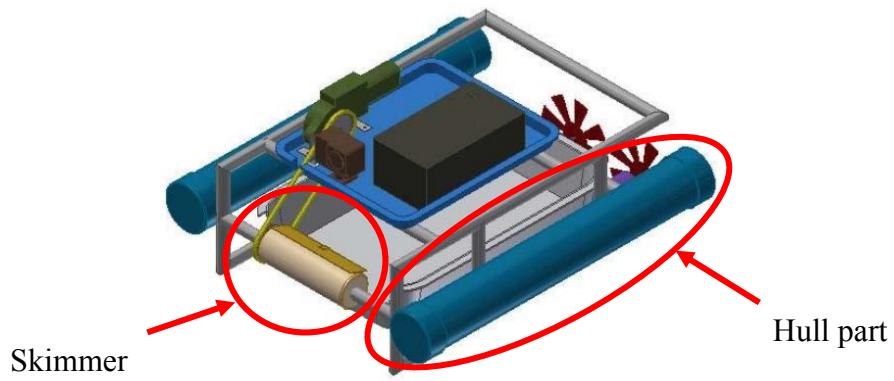


Figure 1.1: Reference model of existing Portable Oil Spill Skimmer (Santuso, 2018)



### **1.3 Objectives**

Objectives of this task are;

- To design a new hull part of the portable oil spill skimmer that following the catamaran hull design.
- To evaluate the selection process of the propeller motor by using Analytic Hierarchy Process (AHP) method.
- To analyse the buoyant force of the hull and the oil collection rate.

### **1.4 Scope**

This study will focus on designing new improvement for the oil spill skimmer. The scope for this study are:

1. The dimension of hull is subjected to the existing design of skimmer and its suitability. Catamaran is a combination of two hull on port side and starboard side. The skimmer need to be located at between of the hulls.
2. Without changing the type of skimmer, the suggestion to increase the rate of oil collection is by enlarge the dimension of polypropylene roller such as the diameter and the length of skimmer.
3. Simplify and ease the maneuverability system which relate to analysis on the propeller system. The idea to reduce the number of propeller could be considered in this project.

### **1.5 Significance of Study**

The aims of the project is to make the reaction and recovery teams of oil spills easy to manage, and clean the spilled oil on water surface by making the improvement of the existing portable oil spill skimmer. The time to complete the skimming process is expected to be reduced with the implementation of new improved design of portable oil spill skimmer.

## 1.6 Project Schedule

Table 1.1: Gantt chart PSM 1

No.	Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
1	Title approval	■															
2	Chapter 1 (Introduction)	■	■	■	■	■											
3	1.1 Background study	■	■														
4	1.2 Problem statement	■	■	■													
5	1.3 Objective	■	■	■	■												
6	1.4 Scope	■	■	■	■	■											
7	1.5 Significant of study	■	■	■	■	■											
8	Chapter 2 (Literature review)	■	■	■	■	■	■	■	■	■							
9	Chapter 3 (Methodology)	■	■	■	■	■	■	■	■	■	■	■	■	■			
10	3.1 Introduction	■	■	■	■	■	■	■	■	■	■	■	■	■			
11	3.2 Flowchart	■	■	■	■	■	■	■	■	■	■	■	■	■			
12	3.3 Product planning	■	■	■	■	■	■	■	■	■	■	■	■	■			
13	3.4 Identify the requirement	■	■	■	■	■	■	■	■	■	■	■	■	■			
14	3.5 Generate design concept	■	■	■	■	■	■	■	■	■	■	■	■	■			
15	3.6 Concept selection	■	■	■	■	■	■	■	■	■	■	■	■	■			
16	3.7 Analytic Hierarchy Process	■	■	■	■	■	■	■	■	■	■	■	■	■			
17	3.8 Designing the hull	■	■	■	■	■	■	■	■	■	■	■	■	■			
18	3.9 Final conceptual design	■	■	■	■	■	■	■	■	■	■	■	■	■			
19	3.10 Analysis	■	■	■	■	■	■	■	■	■	■	■	■	■			
20	Thesis writing	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
21	PSM 1 presentation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
22	PSM 1 report submission	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Table 1.2: Gantt chart PSM 2

No.	Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
1	PSM 1 correction	■	■														
2	Chapter 4 (Result and discussion)			■	■	■	■	■	■	■	■	■	■	■			
3	4.1 Introduction			■													
4	4.2 Selection of hull design				■	■											
5	4.3 Selection of propeller motor						■	■									
6	Solidwork drawing								■	■	■	■					
7	4.4 Buoyant force											■					
8	4.5 Maximum oil collected												■	■			
9	4.6 Rate of oil collection													■	■		
10	Chapter 5 (Conclusion)													■	■	■	
11	5.1 Conclusion													■	■		
12	5.2 Recommendation														■	■	
13	Thesis writing			■	■	■	■	■	■	■	■	■	■	■	■	■	■
14	PSM 2 presentation														■	■	
15	PSM 2 report submission																■

## 1.7 Thesis Organisation

This thesis consist of five (5) chapters that reports all the related theories, finding and analysis in respects of the stated objectives in this study. Below shows the organisation of this thesis.

### Introduction

- Explain the aim of this study, problem statement, objectives, and scope.

### Literature Review

- Review the theories that related to this project from the previous research and journals.

### Methodology

- Describe the details explanation of methods and process flow that is used to complete this project well and successful.

### Result and Discussion

- Discuss about the result and analysis obtained from this project.

### Conclusion

- Summarizing the contributions and significant findings related to the objective in this project.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction

The response and recovery system for oil spills are a system for purifying and preventing oil spills from spreading further and wider in the ecosystem. Few kinds of recovery system are in operation. One of them is skimmers. Depending on the form of oil and environmental conditions, mechanical methods may be successful. The best choice for the atmosphere may be seen, as waste from the sea is directly removed. Therefore, considering heavy investment in resources and complicated operations, mechanical approaches are deemed to be the most common anti-oil spill measures (Y. Wang et al., 2018). The methods and processes used to clean up oil spills are different based on the types of systems used (Cho, 2013). There are a few mechanism and components need to be improve from the existing oil spill skimmer.

Oil skimmers of boat type will include hull, rollers sections and scrapper, cover, transmission, gear box, tank set, tank stage indicator for bearing, belt and pulley. The scooter is covered the roller is perpendicular to the scrapper with a Teflon board, Adjustable for adjusting the location and method of withdrawal. The rotary roller part attached to a bearing and connected to a belt and pulley to the engine. The scrapper is put in the slope tank and roller close. The engine is located on the boat stuff of any component is added to the boat's back (Manivel & Sivakumar, 2020).