

THE AWARENESS AND PERCEPTION OF SHIP-OWNER
TOWARD GREEN VESSEL TECHNOLOGY

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Alhamdu lillah. This dissertation is dedicated to my beloved father Hj Muhammad Nasir bin Hj Lope Pihie and my mother Hjh Kalsom binti Hj Anas who are always an encouragement and full support in anything I do, since I was a kid until now. This dissertation also dedicated to my “Guru” YM Datuk Hj Maideen bin Kadir Shah (PMW, BCM) who always gives advice and guidance to me so that I can succeed in whatever I am doing. Special thanks to my brothers and sisters Hilyati, Zunnasri, Hilyana, Hilayani, Zulhairi, Zulazri and also for all my beloved friends, thank you for your encouragement.

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ABSTRACT

Almost 90% of the world trade is carried by ship and estimated annually some 86,000 ships move around 9 billions ton of cargo globally. Ship is responsible for 18%-30% nitrogen oxide (NO_x) global pollution and 9% sulphur oxide (SO_x) of the world pollution. Ship is the least contributing on World annual CO_x emission pollution which is estimated 2%-5. In recognition of the ecological responsibility rested in the maritime industry, a few maritime companies, including market leader has initiated Green Vessel Technology with the primary objective of developing and demonstrating green technologies within shipping and shipbuilding. However, Ship-owner is the player in the market that determines the successful of the green vessel technology. The problem is how far the acceptance of this technology by the ship owner and what are the level of awareness and perception of the ship-owner toward Green Vessel Technology. The objective of this research is to study the green vessel technologies in the maritime industry and whether it is having good response from the ship-owner or not. Besides that, the objective of the research is to study the awareness and the perception of the ship-owner toward the Green Vessel Technology that already launce in the market. This research was used the questionnaire method, which was sent via email through ServeyMonkey webserver and there have twelve respondents which are among the Malaysian local Ship-owners that their business base is in Peninsular Malaysia. Unfortunately, only four companies were successful contacted and willing to cooperate with this research. As a result, for awareness level question, ship-owners managed to collect a score of 75% and with that it is proved that they are aware for the green issue, green technology and green legislation knowledge. For perception, researcher can conclude that ship-owners are believed that the Green Vessel Technology is effectively in reducing the gas emission and also will give them advantage in the business in term of cost operation reduction. Only the cost is the main barrier for them to implement the Technology. There have a few limitations that restrict the application of the research findings. The time allotted to complete this research is for a year. With limited time, it becomes a difficulty in obtaining more accurate data. Researcher had to use email to save time and using this method is less entertained by some respondents. However, this study has successfully completed and the research result can be applied to improve the level of development of Green Vessel Technology especially in Malaysia region.

ABSTRAK

Hampir 90% daripada perdagangan dunia adalah menggunakan pengangkutan kapal dan dianggarkan setiap tahun sebanyak 86,000 kapal bergerak secara global iaitu sembilan billion tan kargo. Kapal adalah bertanggungjawab untuk 18% -30% pencemaran nitrogen oksida (NOx) dunia dan 9% pencemaran sulfur oksida (SOx). Tetapi kapal adalah yang paling kurang menyumbang kepada pencemaran karbon dioksida (COx) dunia iaitu pelepasan yang dianggarkan adalah 2% -5%. Sebagai mengiktiraf tanggungjawab ekologi dalam industri maritim, beberapa syarikat maritim, termasuk syarikat utama dalam pasaran telah memulakan Teknologi Kapal Hijau dengan objektif utama adalah untuk membangunkan dan memperkenalkan teknologi hijau dalam perkapalan dan pembinaan kapal. Walau bagaimanapun, pemilik kapal adalah pemain di pasaran yang menentukan kejayaan teknologi kapal hijau. Permasalahannya ialah sejauh mana penerimaan teknologi ini oleh pemilik kapal dan apakah tahap kesedaran dan persepsi pemilik kapal terhadap teknologi hijau ini. Objektif kajian ini adalah untuk mengkaji teknologi kapal hijau dalam industri maritim dan sama ada ia mempunyai sambutan yang baik daripada pemilik kapal atau tidak. Selain itu, objektif kajian ini juga adalah untuk mengkaji kesedaran dan persepsi pemilik kapal terhadap Teknologi Kapal Hijau yang sudah berada di pasaran. Kajian ini menggunakan kaedah soal selidik yang dihantar melalui e-mel melalui pelayan sesawang “SurveyMonkey” dan terdapat dua belas responden yang merupakan pemilik kapal tempatan (Malaysia) yang mana perniagaan mereka adalah berpusat di Semenanjung Malaysia. Malangnya, hanya empat syarikat sahaja telah berjaya dihubungi dan bersedia untuk bekerjasama dengan kajian ini. Hasil daripada kajian ini, untuk soalan tahap Kesedaran, pemilik kapal berjaya mengutip markah sebanyak 75% dan dengan itu ia membuktikan bahawa mereka adalah sedar untuk isu hijau, teknologi kapal hijau dan pengetahuan undang-undang hijau. Bagi soalan Persepsi, penyelidik boleh membuat kesimpulan bahawa pemilik kapal percaya bahawa Teknologi Kapal Hijau adalah berkesan didalam mengurangkan pelepasan gas dan juga akan memberikan mereka kelebihan didalam perniagaan dari segi pengurangan kos operasi. Hanya kos adalah halangan utama bagi mereka untuk melaksanakan Teknologi ini. Terdapat beberapa halangan didalam menyelesaikan kajian ini. Masa yang diberikan untuk menyiapkan kajian ini ialah selama setahun. Dengan masa yang terhad, ia menjadi satu kesukaran untuk mendapatkan data dengan lebih tepat. Penyelidik telah menggunakan e-mel untuk menjimatkan masa dan menggunakan kaedah ini adalah kurang dilayan oleh beberapa responden. Walau bagaimanapun, kajian ini telah berjaya disiapkan dan hasil kajian ini boleh digunakan untuk meningkatkan tahap pembangunan Kapal Teknologi Hijau terutamanya di rantau Malaysia.

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GLOSSARY OF TERMS

NO _x	-	Nitrogen Oxides
SO _x	-	Sulphur Oxide
CO _x	-	Carbon Oxide
GWP	-	Global Warming Potential
ODP	-	Ocean Depletion Potential
MARPOL	-	Marine Pollution
IMO	-	International Maritime Organization
USCG	-	United States Coast Guard
ECA	-	Emission Control Area
MASA	-	Malaysia Shipowners' Association

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CHAPTER 1

INTRODUCTION

Sea transportation is the primary conduit of the world trade activities. Almost 90% of the world trade is carried by the ship. It is the key element of the economic development, and a reason why the world enjoys ready access of the low-cost products in the market. Sea transportation is the most efficient mode of transport for goods. A single large container can carry over 200,000 containers in a year. That will be a comparatively low cost for the transportation operation. From refrigerated freighters and container ships to car carriers and super tankers, the world's shipping industry has played an incredibly key role in transporting 90% of the world's food, products and energy while helping to transform the global economy along the way. Each year, some 86,000 ships move more than 9 billion tons of cargo, more than a ton for each person on the planet that across our seas each year (Lori Ann LaRocco, 2012). Besides that, sea transportation is the greener mode in term of carbon emission compare to other mode. Because of its inherent advantages, including much greater payloads per trip than land or air transportation, the industry emits far less carbon dioxide (CO₂) per ton/mile of cargo than any transportation mode. Therefore, sea transportation become more popular and the demand increase from year to year. Many are predicting, that development of the world economy has grown rapidly, line with growing demand of the worldwide trade will create more demand for sea transportation and continue to increase year to year.

However, ship is still become the contributor to the air pollution. Diesel engine that power the majority of the world ship are responsible for carbon dioxide

(CO_x), sulphuric and nitrous oxides (SO_x/NO_x), smoke, and particulate emissions, noise, and sensible heat leaving the stack (Green Vessel Design, 2008). Maritime industry was estimated produces 2.7% of the world's CO₂ emission (World Shipping Council, 2009). In recent year, the industry has been increasingly the demand, and it is expected to increase from year to year. There will be more carbon emission produce by the shipping industry for the future. If this continues to happen, then the ship's reputation as the Greener of transportation mode would be affected. "As ships get bigger, the pollution is getting worse. The most staggering statistic of all is that just 16 of the world's largest ships can produce as much lung-clogging sulphur pollution as all the world's cars", (Pearce, 2009). Based on this statement, we can claim that the biggest sulphur pollutant is coming from shipping industry. Regarding to Professor James Corbett from University of Delaware, he estimates that the death toll globally could be as much as 64,000 annually, with 27,000 in Europe alone (Pearce, 2009).

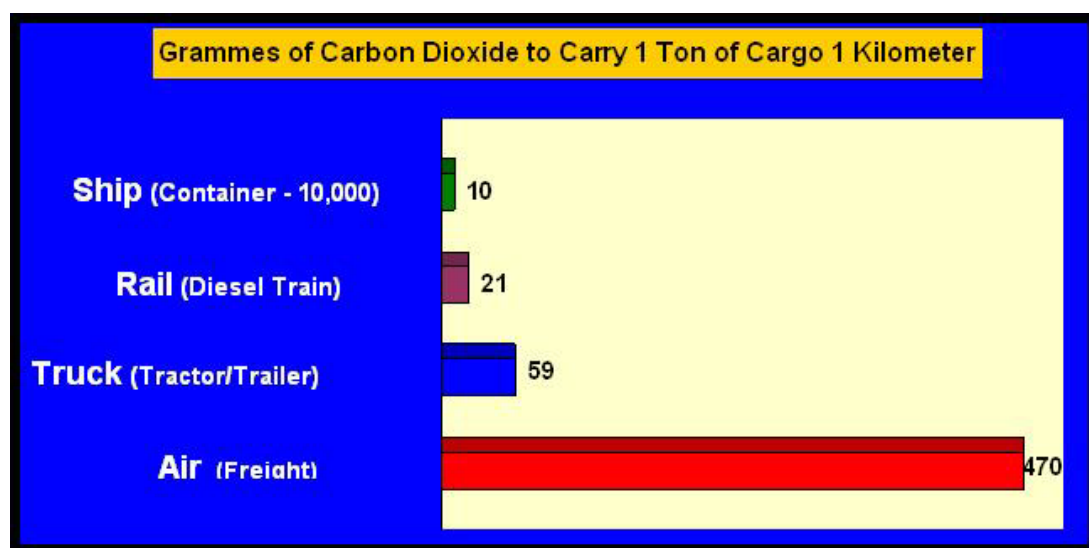


Figure 1-1 Carbon Dioxide (Gramm) to carry 1 ton of Cargo 1 Kilometre (World Shipping Council, 2009)

As illustrated by the graph above, ocean shipping is by far the most carbon-efficient mode of transportation. Because of its inherent advantages, including much greater payloads per trip than ground or air, the industry emits far less carbon dioxide

(CO₂) per ton/mile of cargo than any other transportation mode. According to the figures in this graph, transporting the 2008 volume of 1.3 billion metric tons of cargo via containership generated approximately 13 billion grams of CO₂ per kilometre. If that same volume had been transported by airfreight instead, carbon dioxide emissions would have increased by 4,700% to some 611 billion grams of CO₂ per kilometre (World Shipping Council, 2009). Government, industries, and consumers around the world are responding to concerns about the effect of carbon dioxide (CO₂) emission on climate change by determining how to design more efficient energy and environmental practices.

1.2 Green Transportation

In recent year, environment issue especially about pollution, Global Warming (GWP), Ocean Depletion (ODP) has become an issue of highness priority. These issue becoming major influence in public policy, regulation and enforcement. This is particularly relevant to the maritime community when it consider that roughly 70 per cent of the earth's covered by water. Almost 90 per cent of the world trade is carried by ship and for the vast majority of world trade activity transport is by ship. From of concerning the environmental issue, there was came a word which is green transportation. The word green is signifies the green cover of the earth which is mean to reduce the impact to the environment as a result of the increase of human intervention in environmental activities. Maritime industry is one of the greatest contributors of the greenhouse effect, a phenomenon that has drastically affected the earth's natural ecosystem. Thus, as an effort to reduce carbon emissions coming from the maritime industry and also to support the world movement towards eradicating the greenhouse effect, many shipyards around the world have started inculcating special methods and equipment in their ships. It is not only helps in minimizing the carbon foot prints but also in increasing the ships efficiency. These environmentally-friendly ships are known as "Green Vessel" or "Green Ship".

1.3 Green Vessel Technology

The increasing pressure of environmental issue is forcing the shipping companies and ship manufacturer around the world to make their ships "eco-friendly" in nature. Anyone following this trend must have come across the term "green ships". Regarding to MARPOL (Prevention of Pollution from Ship), which is international convention that developed by International Maritime Organization (IMO), there have six technical annexes covering marine pollution. The six annexes is regarding to the particular from ship that will create pollution to environment (Maritime and Coastguard Agency, 2012). The six annexes are:

1. Oil
2. Noxious substances carried by bulk
3. Harmful substances carried in packaged form
4. Sewage from ships
5. Garbage from ships
6. Air pollution from ships

Under Maritime and Coastguard Agency with their Green Vessel Design Article in 2008, they have list out seven guiding principles as a practices toward green vessel for environmentally responsible design. The seven principles are:

1. Minimize use of hazardous materials and environmental contaminates,
2. Maximize use of recycled and recyclable material,
3. Minimize waste and scrap,
4. Maximize use of rapidly renewable and regional materials,
5. Minimize air emissions,
6. Minimize energy use, and
7. Minimize discharges to water.

All these principle are interdependent and not for economic performance purpose. Many efforts have started in developed a ships that have environmentally friendly features. Vessel will still be dependent on fossil fuels (Lene Espersen, 2010). The green technology that was start released in the market was many in engine efficiency

technology which is to give fuel efficient to minimize the carbon emission from ship and also will reduce the operation cost of the vessel.

There are two types of common diesel engines used to power large ship which is propulsion and auxiliary. Propulsion engine are bigger than auxiliary. Typically, propulsion engine can be as large as three stories tall and be as long as two to three school buses (J. Katsioloudis, 2012). This type of engine usually produces a large of sulphur and carbon dioxides and use a large quantity of fuel as well. The solution to reduce the gas emission from the engine is with lower ship speed within certifications. The engine is design for certain power output corresponding to ship speed. As the propulsion power demand decreases, changes to engine components and adjustments are beneficial for the improvement of fuel oil consumption, lowering of CO₂ emission and for improvement of the overall performance of the engine (Danish Shipowners' Association, 2010). This new technology engine also includes the system of cutting out the turbocharger on the engine and it using the low-load mode on electrically controlled engine. The method of cutting the turbocharger that automatically control by electronic by switching to low-load mode will causes the engine run efficiently and possible to reduce the CO₂, NO_x, and SO_x. This project was managed by the company of A.P. Mller-Mearsk and MAN Diesel.

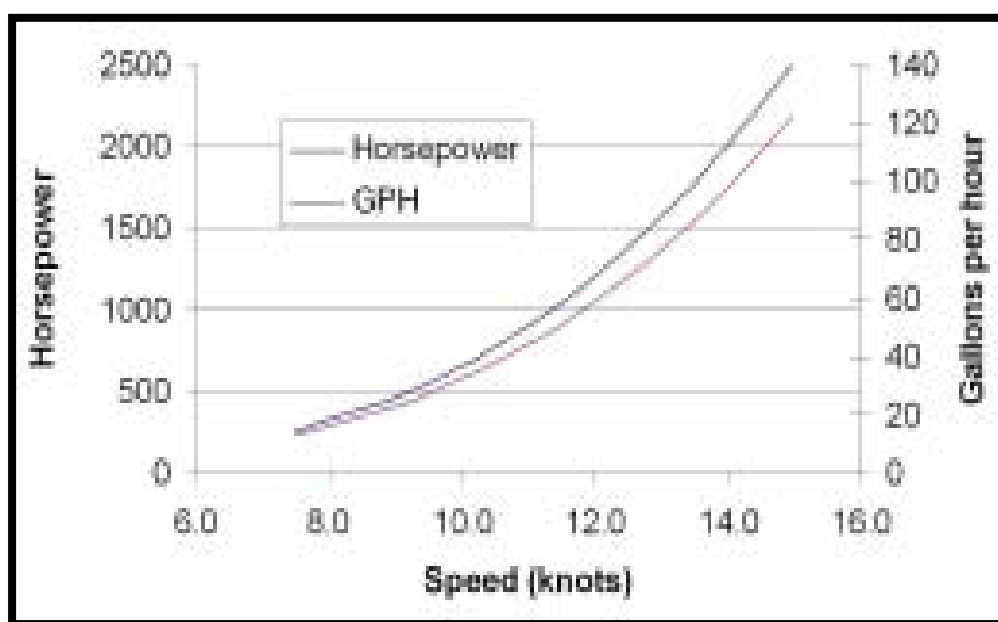


Figure 1-2 Optimum speed will reduce the use of fuel per hour (USCG, 2008)

The other technology to reduce NO_x and SO_x from the ship is the exhaust gas recirculation system (EGR). This system developed by Companies which is A.P. Moller-Maersk, Aalborg Industries, Man Diesel, and Odense Steel Shipyard. The system will reduce harmful SO_x by directing part of the exhaust gas back into the scavenge air of the engine. This reduces the oxygen content of the air in the combustion chamber, thereby reducing the combustion temperature and with that it will reduce the NO_x gas emission. The result from the study, this technology will reduce NO_x in 80% and SO_x 19%.



Figure 1-3 Emission reduction using exhaust gas recirculation (EGR)

The heat from the gas exhaust also can be used as the energy to produce a power for another engine. The heat can be used to supplying the steam to a steam turbine. The steam turbine is connected to a generator, and thereby the waste of heat is recovered as electrical energy to support the ship operation. This technology was developed by the group of companies Aalborg Industries A/S, AP Moller Maersk, Man Diesel, and Odense Steel Ship Yard. This system named Waste Heat Recovery (WHR) and it can reduce CO₂, NO_x, and SO_x which is 7 – 14 per cent. **Table 1-1** below are the list of other green vessel technology that is developed by a few company under Green Vessel of the Future group.

Table 1-1 Green Vessel Technology

System Name	Function	Manufacturer	Gas reduce
1. Exhaust gas scrubbers	Used for washing the exhaust gas from the main engine to lowering the sulphur content	- Aalborg Industries - A/S MAN Diesel - DFDS	- CO ₂ : 3% - SO _x : 98%
2. Performance monitoring and trim optimization	To demonstrate the fuel reduction when ship is trimmed correctly. With right trim, will minimum the water resistance.	- Clipper Group - Force Technology	- CO ₂ : 3% - NO _x : 3% - SO _x : 3%
3. A floating cooling lab	Lowering the use of electric energy by using the variable speed pumps of engine cooling system	- A.P. Moller-Maersk - Odense Stell Shipyard	- CO ₂ - NO _x - SO _x
4. Engine tuning	With auto-tuning the margin can be harvested by continuously and automatically tuning engine for best performance so that the engine will maintain efficiently.	- A.P. Moller-Maersk - MAN Diesel	- CO ₂ : 1-3% - NO _x : 1-3% - SO _x : 1-3%
5. New silicone antifouling	Use copper and biocide free paint for fouling release coating system. This anti fouling use for vessel hull that can avoid fouling at ship hull and it can reduce the water resistance.	- Force Technology - Hempel	- CO ₂ : 3-8% - NO _x : 3-8% - SO _x : 3-8%

1.4 Problem Statement

Nowadays, the environmental issue is seriously debated globally, especially in the maritime field. Starting from that, the efforts to develop green vessel technology in achieving reduction of ship pollution at the rate set by the IMO has begun. However, it is very important to study and understand situation faced by the ship-owner which is the awareness and perception about green technology. This is because awareness and perception of the ship-owner is determinant of their response to the green product produced. Their response to green vessel technology can be affected a variety of things such as, awareness, perception or uncertainty of their economy situation. Therefore, this study is very necessary to clearly know the situation and condition of the ship-owner because the ship-owners are the player in the market that determine to successful of the green technologies. Besides that from survey did over the internet, there is no research on awareness and perception of ship-owner toward the green vessel.

1.5 Research Question

The research question focus on whether the ship-owners are concern about the green issue and the Green Vessel Technologies that already exist in the market. The reason is simple, the ship-owner are the player in the market that determine to successful of the green technologies that solving the global green issues. By knowing the awareness and the perception of the ship-owner toward green issues and technologies, its help the authorities and the manufacturing in term of decision making or in any implementation that they do in getting the solution of the green issues.

1.6 Research Objective

The objective of this research is to study the green vessel technologies in the maritime industry and whether it is having good response from the ship-owner or not. Besides that, the objective of the research is to study the awareness and the

perception of the ship-owner toward the Green Vessel Technology that already launce in the market.

1.7 Research Scope

1. The study will focus in the green vessel technologies that reducing the emission from vessel.
2. The study will focus the level of awareness of the ship-owner toward green vessel technology.
3. The study will focus the perception of the ship-owner toward green vessel technologies that held in the market.
4. The study will cover the player among Malaysian local ship-owner that have a five or more vessel in their operation and their operations based is in Peninsular Malaysia.
5. The study will use the questionnaire and will be answer by the operation manager or any in charge person in the operation of the shipping company.

1.7 Research Assumption

Throughout this research, the data collection from the shipping company will get from the Operation Manager which is representing the ship-owner. Researcher assumes that the Operation Manager is the person that has clear view of the overall operation and influences the decision making of the ship-owner. If the operation manager doesn't have good understanding about green issue, researcher assumes that the ship-owner also doesn't understand.

1.8 Limitation of the study

In this study, there are some limitations that have been identified. This study only determines the awareness and the perception of the ship-owner toward green issue and not sustainable issue that has different definition. The study will cover the local ship-owner that registered in Peninsular Malaysia and only for the company that have 5 or more ships in their operation. The Company is subject to the Section 11(1) of the Merchant Shipping Ordinance 1952, not include the ship-owner company from overseas that located their hub in Malaysia.

1.9 Significance of the research

Based on the survey from the internet, there is no research to get better understanding to ship-owner whether they are have clear understanding or aware about the green issue and the technologies or not. With my study, the authority and the manufacturers can used my result for get close and get clear understanding to the ship-owner and to know what their actually want and what are the problem that their face toward green vessel technology implementation. With that, from the good understanding between Authorities, Manufacturer and Ship-owner, any action or decision that will make from them will be more in win-win situation to the all parties involved and with that it will make the green vessel can be successful implement in the industry and then can solve the environmental issue for saving the future.

1.10 Structure of the report

The report will be organized into six chapters:

- **Chapter 1** provides introduction of the shipping industry, environmental issue and the green vessel technologies. This chapter also highlights the issues of the study, problem statements, research objectives, as well as scope, significance and limitations of research,

- **Chapter 2** is the Literature Review which contains the review of maritime green issue and green vessel design. Besides that, this chapter will try to answer all the questions that appear, in order to achieve the Research Objectives and this chapter also will include the previous awareness and perception study.
- **Chapter 3** will discuss on the research methodology, which explains how this study will be conducted,
- **Chapter 4** will present data collected from the questionnaire answered by ship-owner, explained the result and finding of the study; and
- **Chapter 5** will discuss the conclusion and suggestions from the study.

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