An analysis of available solutions for commercial vessels to comply with IMO strategy on low sulphur

Nguyen Manh Cuong and Phan Van Hung
Faculty of Navigation, Vietnam Maritime University, Hai Phong, Vietnam

ABSTRACT
The International Maritime Organization (IMO) strategy reduces ship emission to 2020 and zero in 2050, the ship-owners and ship operators are looking for economic solutions to meet the new emission requirements. The available solutions include using Liquefied Natural Gas (LNG) or sulphur-free-fuel, switching form high sulphur fuel oil (HSFO) to marine gas oil or distillate fuels, using very-low-sulphur fuel oil or compliant fuel blends and using scrubber/exhaust gas cleaning system on the ship, which allows operation on regular HSFO. The cost of changing and using fuel may be too high as a barrier for Vietnamese ship-owner. Therefore, advantages and disadvantages of available options need to analysis. In this article, the pros and cons of available options were analysed by using thematic PLEET analysis that considering political, legal, economic, environmental, technological and sociological aspects. The results show that using compliant blended fuel is a priority solution for the most Vietnamese commercial ship-owners as well as using LNG fuel will be a solution for building new ships. It is expected that this research would make any contribution to improving the efficiency of commercial ships to satisfy the IMO’s strategy.

Introduction
The maritime industry plays a vital role in the development of global economy, with the benefits of the volume and distance carried. With the world commercial fleet hit 94,171 vessels, combined tonnage of 1.92 billion DWT, maritime shipping has been mode of transport that was over 80% of global trade by volume (UNCTAD 2018). However, maritime activities also emit an increasing large amount of greenhouse gases and other toxic emissions (Li et al. 2020), causing negative impacts on the environment and global climate (Russo et al. 2018; Zhen et al. 2018). According to the Third IMO Greenhouse Gas Emissions Study, international shipping emitted 796 million tonnes of CO2 in 2012, accounting for 2.2% of total global greenhouse gas emissions, and that could increase from 50% to 250% by 2050 due to the growing global seaborne trade. In addition, maritime activity causes 12% of sulphur oxide (SOx) emissions and about 13% of nitrous oxide (NOx) emissions globally.

In order to response to the negative impacts caused by marine emissions, over the past decades, various measures to decrease chip emission have proposed by national and international organizations (Chang et al. 2018; Wan et al. 2019; Gritsenko and Regulating 2017). The IMO has made many efforts to develop a legal and technical framework for controlling and reducing emissions from the ship (IMO 2020; Perera and Mo 2016), following achievements: MEPC adopted the regulations on energy efficiency for ships in chapter 4 of MARPOL Annex VI, the regulation entered into force on 1 January 2013 and apply to all ships of 400 GT and above, considering NOx and SOx emission; MEPC 72 adopted resolution MEPC.304(72) on Initial IMO Strategy on reduction of GHG emissions from ships on 13 April 2018, with the scope of reducing the total annual GHG emissions by at least 50% by 2050 compared to 2008; IMO adopted ship and port emission regulations for the shipping industry, the ship-owner/ship operator’s incentives have become not only environment but also economic and efficient ship operation. This article will compare three options, including MGO or approved equivalent methods like high sulphur marine gas oil (MGO), low sulphur fuel oil (LSFO) and LNG or approved equivalent methods like high sulphur fuel oil (HSFO) combined scrubber. The

CONTACT Phan Van Hung  phanvanhung@vimaru.edu.vn  Faculty of Navigation, Vietnam Maritime University, Hai Phong, Vietnam

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Table 1. Vietnam’s seaports cargo throughput.

| Year | Container (TEU) | Liquid cargo (t) | Dry cargo (t) | Transit cargo (t) | Ships call ports | Cargo throughput (t) |
|------|----------------|-----------------|--------------|------------------|-----------------|---------------------|
| 2007 | 4,489,165      | 35,271,834      | 79,444,184   | 17,113,949       | 88,619          | 181,116,296         |
| 2008 | 5,023,312      | 35,682,346      | 87,759,214   | 17,677,994       | 98,593          | 196,519,572         |
| 2009 | 5,539,247      | 42,517,556      | 68,321,773   | 20,075,633       | 108,016         | 251,218,000         |
| 2010 | 6,521,004      | 51,608,624      | 105,109,355  | 29,489,660       | 119,744         | 259,144,580         |
| 2011 | 7,210,180      | 51,009,414      | 109,679,459  | 43,762,372       | 130,002         | 286,091,675         |
| 2012 | 6,668,996      | 49,565,877      | 112,853,439  | 41,062,413       | 98,901          | 294,540,952         |
| 2013 | 8,609,970      | 49,887,162      | 136,372,021  | 40,860,293       | 85,802          | 237,864,676         |
| 2014 | 10,398,240     | 52,078,713      | 154,582,311  | 47,971,488       | 92,905          | 373,027,220         |
| 2015 | 11,646,029     | 58,328,159      | 173,132,188  | 53,728,067       | 99,378          | 427,390,175         |
| 2016 | 12,988,000     | 62,559,000      | 205,797,000  | 43,459,000       | 103,112         | 459,833,000         |
| 2017 | 14,357,000     | 62,632,000      | 213,166,000  | 77,778,000       | 112,701         | 519,297,000         |
| 2018 | 18,062,000     | 73,015,000      | 274,818,000  | 77,312,000       | 530,145,000     |

Source: Vietnam Maritime Administration (2019).

result of this study would help ship-owner/ship operator for future decision making.

Vietnamese shipping fleet comprises 1,863 ships totalling about 8.176 million DWTs as of December 2018, reaching about 1.98 per cent of world total DWT. In terms of ship tonnage, the shipping fleet of Vietnam ranked number four within 10 ASEAN countries, behind Singapore, Indonesia and Malaysia.

A widely used indicator providing insights into ability of seaport is volumes handled by port, including all cargo types such as container, liquid cargo and dry cargo, can serve as a leading economic indicator. Table 1 provides a list of Vietnamese seaports cargo throughput, increased by 328% to 14,733,000 TEUs in 2018, compared with 4,489,165 TEUs in 2007 rising throughput, increased by 328% to 14,733,000 TEUs in 2018, compared with 4,489,165 TEUs in 2007 rising. Clearly, Vietnam’s seaports cargo throughput.

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Using LNG or sulphur-free fuel (NH3, LH2)

This option is a best solution for shipping industry’s environmental problems. LNG is expected as a marine fuel in the future for complying with the strategy reducing sulphur emission from ships because of sulphur content less than 0.1% as the cleanest form of fuel. LNG is present a technically proven measure, bunkering infrastructure is developing rapidly at all major ports around the world (Lee, Yoo, and Huh 2020). Beside, LNG price is cheaper form of fuel almost...
Switching from high sulphur fuel oil to marine gas oil or distillate fuels

When switching to distillate fuels, it will be a significant increase in the cost of fuel and may also require upgrading to a fuel treatment plant due to the significantly lower viscosity of the distillate fuels. In order to avoid contamination and non-compliance problems, the requirement of all fuel tanks previously used for HSFO must be carefully cleaned before bunkering MGO or distillate fuels.

Using very-low-sulphur fuel oil or compliant fuel blends (0.50% sulphur)

LSFO – compliant fuel as blended fuels are anticipated to be available in the fuel market through various products. New blended fuels may go experience stability, compatibility problems, low viscosity, flash point, etc., which will make fuel handling very important for potential safe and operational issues. The quality control of new blended fuels when bunkering is very important because of specific fuel is received must be satisfy requirement of IMO 2020. The ISO (2019) Fuel Standards working group already published a Publicly Available Specification (PAS) in 2019, entitled “Considerations for fuel suppliers and users regarding marine fuel quality in view of the implementation of maximum 0.50% S in 2020”. It provides the guidance for both fuel suppliers and users as ship owners. Besides, the IMO has also published a “Guidance on Best Practice for Fuel Oil Purchasers/Users for assuring the quality of fuel oil used on board ships”.

Using scrubbers/EGCS on ship, which allows operation on regular HSFO

Obviously, HSFO will still be a significant option after 1 January 2020. However, in order to comply with the requirement of IMO 2020, the exhaust gas cleaning system (EGCS) or SOx scrubbers will be installed. It is note that the installation of scrubber could be complex, nothing to changes to operate the main engine, controlling fuel treatment system, especially for retrofits. The capital expenditure-CAPEX and operating expenditure-OPEX of EGCS or scrubber are still high, relating to the increase of power consumption, chemical consumables and residence storage handling for hybrid or closed-loop scrubbers.

In Vietnam, it is well-known the national plan “The development plan of Vietnamese shipping industry for 2020 and towards 2030” acknowledged by the Decree No. 1517/QD-TTG of the Prime Minister on 26 August 2014, considering six target categories: Ship types and sizes; Shipping fleets; Seaport system; Shipbuilding industry; Supporting services and maritime transport logistics; and Human resources in maritime transport. There are a few general studies related to emission reduction strategies in Vietnam, such as the Status of ship pollution and the proposed mitigation solution (Du and Pham 2014), mitigation of ship emissions (My Van 2015), lacking of academic research related to the potential effects of the IMO 2020 Sulphur Cap on the Vietnamese maritime economy. This research should be considered as a pioneer study in discussing the potential changes on Vietnamese maritime patterns.

Research methodology

The PESTLE analysis method as a technique for “Scanning the Business Environment” that was developed by Aguilar (1976) who discusses four factors: economic, Technical, Political, and Social. After that, several authors, such as Porter (1985), (Fahey and Narayanan 1986; Morrison and Mecca 1989; Jurevicius 2013; Rastogi and Trivedi 2016), and (Abdul Rahman et al. 2016) improved to this method, including various classification such as PEST, STEEPLE, STEP, SPEPE. PESTLE method is useful tool to identify important factors that impact maritime business industries (Helmold 2019; Pulaj and Kume 2013; Syazwan Ab Talib et al. 2014; Vintilă et al. 2017). This method gives a panoramic view of specific issue that was checked on a plan. The most research sectors have been published by using PESTLE method such as automobile industry (Li, Mao, and Qi 2009; Tan et al. 2012), logistics industry (Činčalová 2017; Von der Gracht and Darkow 2010), construction industry (Pulaj and Kume 2013; Vintilă et al. 2017), and maritime field (Abdul Rahman, Saharuddin, and Rasdi 2014; Kolios and Read 2013; Sridhar et al. 2016) PESTLE method finds the answers of 6 key questions regarding Political, Economic, Socio-culture, Technology, Legal and Environment.

The implications in the opening the Northern Sea Route of Malaysia was studied by using PESTLE/PESTLES methods (Abdul Rahman et al. 2016, 2014). However, these studies do not consider important elements such as novel seaport system, maritime security and safety, supporting services, maritime transport logistics and human resources in maritime transport.
Therefore, in order to enhancing PESTLE method in this article, new arrangement of element and various sub-elements will be considered. For instance, new sub-element in “Environment” element is “National strategy to control air and water pollution”. The “Political” element considering Stability of Government, Tax policies, Social policies, Entry mode regulation, National plan of Shipping industry, and National energy Security policies. These elements and sub-elements has been identified, analysed, and reported pattern with data by using thematic analysis. Thematic analysis allows for flexibility and detailed and complex description of data. It may develop a deeper appreciation for the situation or group of study (Braun and Clarke 2006).

In this study, in order to comprehensive analysis of the option responding IMO Strategy on Vietnamese maritime industry, the standard six elements were analysed by using thematic Political, Legal Economic, Environmental, Technological and Sociological (PLEETS) method (see Figure 1), finding the answers of seven key questions of experts from main agencies including Vietnam Maritime Administration, Vietnam Register, Ministry of Transportation, Vietnam Oil and Gas Group, Port operator, Port Authority, Shipping Company, Logistic Company and Freight Forwarders.

**Political – What political aspects are likely to impact the maritime activities?**

**Legal – What legislation will impact the maritime activities?**

**Economic – What economic elements will impact the maritime activities?**

**Environmental – What environmental problem may impact the business?**

**Technological – What technological trend may impact the maritime industry?**

**Social culture – What socio-cultural aspects are likely to impact the business?**

### IMO 2020 and changing maritime activities

#### Identifying the issue

The IMO’s lower sulphur limit for marine fuels effects good or bad for the shipping industries, countries and other groups. Advantages of IMO 2020 are making strongest benefits of public health and encourage development of green power generation. However, it also brings about adverse effects: Large majority of commercial fleet in the world will switch from high sulphur fuel oil (HSFO) to marine gas oil (MGO) or distillates, resulting in high pressure to refiner to increase crude oil to maximize distillate, increasing distillate prices. It is expected that the potential cost of compliant fuel for IMO 2020 will be a big difference from cost of HSFO, creating ship-owners to install scrubbers on board or using alternative fuel like blended fuels or switch to LNG. Therefore, the estimating implications of one option decision for the IMO 2020 on changing the maritime activities will be discussed by using thematic analysis combined with PLEETS analysis through different aspects (Figure 1).

#### Possible implications

Firstly, the changes in the geographical aspect after implement of the Kra Canal, which are new maritime routes can be developed. They are for instance:

- Northern region (Hai Phong port) – Hon Khoai – Kra – Middle East/Europe; Central region (Van Phong port) – Hon Khoai – Kra – Middle East/Europe; Southern region (Ba Ria – Vung Tau) – Hon Khoai – Kra – Middle East/ Europe. Vietnam has a priority strategy for developing international gateway port for vessels of larger than

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Figure 1. Thematic PLEETS analysis template
100,000 DWT in Hai Phong, Ba Ria – Vung Tau and Khanh Hoa, developing comprehensive navigation facilities in all channel systems. Interestingly, Hon Khoai Project was approved by Vietnam’s Prime Minister that it would build a deep-water seaport, named Hon Khoai Port, on the Southeast of Hon Khoai Island 15 km off the coast of Ca Mau province. According to the opinions of various experts, Hon Khoai Port will be invested to become the largest seaport in Vietnam, making the main link, opening new gateway connection portal of global goods and services in Vietnam, especially coal, petroleum and container. The “Investment report on Hon Khoai general seaport project”, prepared by VIP, determined the total estimated investment of US$ 5 billion, of which US$ 3.5 billion for the “super port” and US$ 1.5 billion for the logistics. It is expected that the Hon Khoai Port will have the capacity to transport 800 million tons of cargo each year.

Secondly, after developing the Kra Canal, the geographical advantage of the Hon Khoai Port, it is predicted that the Hon Khoai Port will be one of the target destinations that will go significant benefits from the increase foreign ships calls as global logistics hub for the handling of import and export cargo of Mekong Delta River as well as transshipment cargo.

Currently, Vietnam is enhancing on waterway between Ho Chi Minh City and Ca Mau to facilitate the operations of barges of more than 2,000 tons, upgrading Xa No Canal and the Dai Ngai-Bac Lieu-Gia Rai sea route, modernizing large river ports for containerized goods including Binh Long, An Phuoc, Long Binh and Cai Lay Ports, upgrading project to dredge and expand Cho Gao Canal to 80 meters, etc.

The Hon Khoai Port becomes the new shipping hub as a special trade zone; it attracts investment of various production companies and providing opportunities to business as well as development of regional economy.

### Pros and cons implications of option for the IMO 2020

Obviously, four options above also have pros and cons when considering political, legal, economic, environmental, technological and sociological aspect. In this section shows the results of option using LNG and option using blended fuel oil as potential trend of Vietnamese ship-owners.

According to plan for development of the gas industry of Vietnam by 2025 with vision to 2035 (Prime Minister Decision No 60/QD-TTg 2017), research, find markets and accelerate the construction of port infrastructure facilities to be ready to receive and import LNG with the reaching 1–4 billion cubic meter per year in the period of 2021–2015 and reaching 6–10 billion cubic meter per year in the period 2026–2035. Using LNG or sulphur-free fuel for Vietnamese commercial fleet will have both pros and cons implications of new energy. Through a data collection process or direct interviews with experts, the information is showed on the Table 2 as below. It is note that using LNG as alternative fuel oil will be potential development of new ship building which encourage for Vietnam shipping.

| Factors      | Positive implication                                                                 | Negative implications                                                                 |
|--------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Political    | Vietnam will has more economic cooperation with other countries to import LNG and reduce GHG emission (IGF Code) | It is the movement of foreign investment to develop the LNG ports or LNG vessel, LNG Bunkering chain. |
|              | It will enhance the safety, environment and sustainable development                   | Education and training for crew, expert in LNG supply and users chain                   |
| Legal        | Development of legal framework of LNG for shipping, seaport and logistic services activities. | Creating a stable legal, conducive system that supports the developing and operation of the shipping like administrative reform. |
| Economic     | LNG will be one of the important marine fuel therefore more supply and users will call at the Vietnamese ports. | Building cost of an LNG ship is much higher and complex than other cargo ships.          |
|              | LNG is much cheaper form of fuel almost half the cost of crude oil and one third the cost of diesel oil. | Space required for LNG fuel is four-times space required to store other fuel, decreasing cargo capacity of ship. |
|              | More ship call and cargo handled by the ports lead to increasing income of logistics and supply chains. | It is need to huge finance to invest LNG supply chain/infrastructure.                   |
|              | Major ports will be potentially developed to supply bunker LNG for vessels.           | Cost for search and rescue activities at Vietnam waters increases.                      |
|              | Overall, there is increase in maritime economy that makes important distribution to the Vietnam economy. | Methane emission from using LNG needs to be investigated because it can cause environmental pollution. |
| Environmental| LNG is cleanest form of fuel with sulphur content less than 0.1%, reducing GHG emission | LNG engines, LNG storages and LNG ship building require complex designed.                |
|              | Enhancing development of green port, and supporting national strategy to reduce GHG emission. | Cost for LNG system are and will continue to be higher than expenditures associated with using a scrubber system with HSFO. |
| Technology   | It is enhancement of developing LNG building technology, designed LNG storage tanks    | HSFO supply income is expected to show a downward trend.                                |
|              | LNG bunkering infrastructure for ships is improving quite rapidly in the world such as Singapore, Japan, Korea, China, etc. |                                                                                       |
| Sociological | It improves public health                                                               |                                                                                        |
|              | It creates jobs and income for local community around ports area because of the developing LNG logistics and supply chains. |                                                                                       |
In term of Vietnamese ship-owners, the option of using very-low-sulphur fuel oil or compliant fuel blends (0.50% sulphur) is choosing priority because of its positive and negative implications that was showed on the Table 3.

Vietnam need to find a way to benefit from the scenario of IMO 2020 is going to be realised. First and foremost, the Vietnamese Government and related Ministries need to confirm the availability of compliant fuel which encourage LNG/LSFO for Vietnam shipping and Vietnamese ports from 1 January 2020. Secondly, it is ensuring accuracy on quantity of fuel delivered through adopted technical reference for bunker mass flower metering, specification of management quality of bunker supply chain. Thirdly, according to the Regulation 17 of MARPOL Annex VI, Vietnam parties to MARPOL that are required to provide reception facilities for the collection of scrubber residue. Finally, policy to encourage all economic sectors to invest in the Vietnamese maritime industry, including the development of new compliance fuels supply and logistic services should be studied and implemented that is key factor in the shipping industry.

### Conclusion

The IMO strategy reduces ship emission to 2020 and zero in 2050 is warm welcome by most of people because of real benefits that it brings to human health. Ship-owners, ship-operators, maritime authorities and oil industry have to find the solutions to meet the new emission requirements. In this study, advantages and disadvantages of available options compliant with IMO 2020 to political, legal, economic, environmental and sociological aspects showed that encourage LNG/LSFO for Vietnam shipping is an imperative need. The inherent strengths of the geographical country need to take advantage to propose plan for maritime business that boost and reshape the Vietnam’s maritime economy, for instance: developing policies to enhance the control and supervision of the compliance fuels (LNG/LSFO) supply chain and logistic services; promulgating legal policy to encourage all economic sectors to invest new ship using LNG fuel and LNG barge suppliers; building long-term plan to develop main bunker fuel supply or energy source for vessels.

### Disclosure statement

No potential conflict of interest was reported by the authors.

### ORCID

Phan Van Hung [http://orcid.org/0000-0002-4114-5295](http://orcid.org/0000-0002-4114-5295)

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