

Singapore's Maritime Transport between Market Demands and the Environmental Aspect

النقل البحري لسنغافورة بين متطلبات السوق والجانب البيئي

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Abstract:

While maritime transport is an essential sector for global trade, it also has a substantial environmental footprint e.g. greenhouse gas emissions, and ocean pollution. The maritime industry experiences pressure from growing demand for international trade to implement more sustainable measures.

This paper investigates approaches in the trade-off between trade expansion and environmental sustainability such as clean fuel adoption, technology innovations, and international regulation.

The study underlines the need for industry players to work together to foster a greener maritime industry without jeopardising the efficiency and cost-efficient nature of global trade.

Keywords: Maritime Transport; Environmental Impact; Global Trade; Cleaner Fuels; Singapore.

JEL Classification Codes: Q01, Q56, Q58.

ملخص:

في حين أن النقل البحري هو قطاع أساسي للتجارة العالمية، إلا أن له أيضا بصمة بيئية كبيرة مثل انبعاثات غازات الاحتباس الحراري وتلوث المحيطات. تتعرض الصناعة البحرية لضغوط من الطلب المتزايد على التجارة الدولية لتنفيذ تدابير أكثر استدامة. تبحث هذه الورقة في مناهج المفاضلة التي

تتبنها سنغافورة بين التوسع التجاري والاستدامة البيئية مثل اعتماد الوقود النظيف والابتكارات التكنولوجية والتنظيم الدولي. تؤكد الدراسة على الحاجة

إلى أن يعمل الفاعلون في الصناعة معا لتعزيز صناعة بحرية أكثر خضرة وتعرض الكفاءة والطبيعة الفعالة من حيث التكلفة التجارية العالمية للخطر

كلمات مفتاحية: النقل البحري؛ الأثر البيئي؛ التجارة العالمية؛ الوقود النظيف؛ سنغافورة.

تصنيفات JEL: Q01, Q56, Q58.

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INTRODUCTION:

International maritime transport (IMT) is the lifeline for global economy, it serves as a route for transportation of goods across oceans, linking the countries to each other and functioning on the backbone to support international trade network by providing significant quietback. It is one of cheapest ways to move huge bulk of goods for long distances, making up more than 90% of global trade. Further enhanced by shipping technologies advancements and containerization, maritime transport is still more effective than a standalone process that fuels the vast global supply chains as its backbone.

To be successful in practice the IMT needs its infrastructure backing such as sea freight, ports & multimodal transport system all linked and interlinked. To illustrate, mega ports like Singapore and Shanghai are major transit hubs that account for millions of TEUs channeled from one region to another. In addition, international maritime conventions will enforce the conduct of shipping operations in a safe, secure and environmentally-friendly way ensuring stability within global trade.

The importance of strategic location and infrastructure is brought out in microcosm by Singapore, the global maritime hub showcasing IMT as an industry is directed at. The Straits of Malacca, one of the busiest shipping lanes in the world and located right where western Arabian sea meets eastern ASEAN inundates Singapore in this role of fulcrum between East and West that promotes a lubricated trade. With its port infrastructure, extensive maritime services and promulgation of government policies, The nation is leading on an international scale as a leader of shipping. The importance of Singapore in global economy becomes profoundly evident when we realize that maritime sector contributes a large part of the GDP of the country, employment rate and interconnects its international trading network.

Research Question:

International regulatory frameworks such as those of the International Maritime Organization (IMO) have put in place measures to combat emissions and foster sustainable policies. Yet a significant investment, technology and international cooperation is necessary with the shift away from fossil fuels such as liquefied natural gas (LNG) and renewable fuels. So that we could ask the question from that matters related to the shipping sector: **How can shipping continue to meet its swelling trade demands without sacrificing the environment?**

To fully understand the main issue, we need to address the following sub-questions:

- ▷ What is the role of international maritime transport in global trade?
- ▷ How does Singapore's geographic and strategic position support its maritime leadership?
- ▷ What are the key environmental challenges associated with maritime transport?
- ▷ What international regulations govern environmental sustainability in shipping?
- ▷ How has Singapore responded to environmental pressures in its maritime sector?
- ▷ How does Singapore balance economic benefits from maritime trade with environmental sustainability goals?

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▷ How does Singapore compare globally in terms of environmental maritime performance?

To answer the main question, we propose the following hypothesis:

- ▶ H1: Singapore's investment in green port infrastructure significantly reduces its maritime CO₂ emissions without compromising trade volume.
- ▶ H2: The adoption of clean fuels and maritime digitalization in Singapore enhances operational efficiency and environmental performance simultaneously.

The significance of this study lies in its exploration of how Singapore, as one of the world's foremost maritime hubs, manages the increasing demands of global trade while addressing the urgent need for environmental sustainability. Maritime transport accounts for over 90% of global trade by volume, but it is also a major contributor to greenhouse gas emissions. The relevance of this research is grounded in the growing international focus on decarbonizing the shipping sector in line with frameworks such as the IMO 2020 Sulfur Cap and the Net-Zero 2050 goal.

Singapore provides an exemplary case due to its strategic location along the Strait of Malacca, its advanced port infrastructure, and its proactive environmental policies. Studying Singapore allows for the identification of best practices, challenges, and innovations in aligning economic and environmental goals. As such, the research contributes both theoretically and practically to discussions on sustainable maritime development, offering insights for policymakers, port authorities, and international organizations.

1- The Maritime Transport and Sustainable Transport Trends:

Maritime transport is the main artery of international trade, carrying over 80% of goods, but it has huge carbon footprint and is depleting marine resources. Across the industry sustainable solutions are taking hold, alternative fuels (hydrogen, ammonia) electrification as well as smart navigation technologies to address its sustainability challenges. Regulatory requirements, like the IMO 2020 sulfur cap and Net-Zero 2050 are putting pressure on decarbonization(IMO, Marine Environment, s.d.).

1-1- What Is International Maritime Transport ?

Moving goods and commodities from one side of the seas or oceans between countries and ports by means of ships. Maritime transport is one of the oldest forms of mass transportation, used to transport huge shipments over large distances at least cheaply in comparison to other transport means. International shipping carried about 11 billion tons of cargo in 2021.

1-1-1- Definitions of International Maritime Transport:

One of the earliest methods of transport that human beings used for intercontinental travel is maritime transport through the use of ships and vessels sailing on seas(Wan Z. & al., 2018, p. 430), oceans. Maritime transport plays a key role in international trade for any country it allows you to transport thousands of tons of both export and import cargo on one go. Over the years it has turned into an indispensable tool of commercial activity.

The word bank define it as "*The carriage of cargo and passengers via ocean-going vessels between countries, forming a critical component of global supply chains and economic development, particularly for landlocked and island nations*" (Bank, 2020).

Also, Maritime transport was defined by International Maritime Organization (IMO) as: "*the movement of goods and passengers by sea between nations, utilizing ships and vessels that operate across international waters. It is governed by global regulations to ensure safety, security, and environmental protection.*" (IMO, routing, Weather, 2024).

Stopford, M define itas: "*International maritime transport involves the use of seaborne vessels to transfer goods between ports in different countries, facilitated by global shipping companies, freight forwarders, and port authorities, while adhering to international maritime law.*" (Stopford, 2009, p. 50).

In summary, we can define shipping as an internationally governed business for the transnational shipping of goods and passengers by sea based upon ships, port infrastructure and common legal frameworks (e.g., Bills of Lading / Charterparties). It is the pulse of global trade and supply chains, allowing shipping bulk commodities like roughs, manufactured goods, energy assets from one country to another. Instituted under International Bodies such as the IMO, this mainly concerns safety, security and environmental friendly containing elements like carbon emission, marine pollution etc. A mode based in cooperation between shipping lines, governments and other stakeholders...for the economical development in balance with ecological responsibilities particularly relevant for land locked and island States depending to a very large extend on maritime connection.

1-1-2- Essential Elements of Maritime Transport Services:

Maritime transport services are basically the bundle form of services and it also includes some of the very important elements into global trade & logistics as below. Along with that is sea freight, which means shipping cargoes in containers or container ship wagons across oceans/seas and this by far now becomes the most common method of international trade because it can effectively move huge volumes at a cheaper price point-costly but suitable for containerized shipping represented > 60% of the seaborne trade globally.

This is intertwined closely with international shipping, defined as "the transport of ships between international ports" which serves as a means of transporting goods and people across national borders while at the same time complying with international trade laws, maritime safety regulations worldwide in effect a necessary role given that over 80% of global commerce by volume was still carried by sea as of 2020. Ports are important nodes of maritime trade, where goods and commodities are imported or exported Port major ports, like Container Ports of Shanghai and Singapore handles millions of TEUs (Twenty-foot Equivalent Units) annually while alone in 2022 Shanghai was able to perform 47 MM TEUs, which is the busiest sea port in the globe.

Furthermore, maritime transport which is one of the strands of global supply chains – are complex networked structures designed to move goods and services across international borders, with maritime transport taking nearly 90 % of the physical transport of goods around

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the globe. Also, mixed transport which takes more than one mode of transport—if this could be arranged in a multimodal way (sea, road, rail and air as one instance of mixed logistics in global trade)—increases the efficiency of logistics in international trade by guaranteeing smooth connectivity from origin to destination. Finally, international maritime conventions provide a set of globally recognised regulations and standards for seafaring in effect to provide for maritally safety, but also security and environmental protection. An example of this is SOLAS (International Convention for the Safety of Life at Sea) which serves as a keystone to the safety and indeed security of maritime trade. These are the foundations of the maritime transport industry, without which goods and services would not glide around the world so seamlessly.

1-2- Sustainable Transport:

The current state of the transport sector has become a source of negative impact on both environmental and social levels. It is now one of the obstacles to sustainable development. Therefore, it has become necessary to adapt transportation systems in a way that ensures environmental preservation and guarantees the rights of future generations, which is known as sustainable transport (Lim, 2024, p. 14).

1-2-1- Definition of Sustainable Transport:

The notion of "sustainable transport" originates from the concept of sustainable development and has been used to describe transport mode, planning systems and infrastructure that are in-line with broader sustainability goals. Definitions of sustainable transport and related concepts like sustainable mobility are quite many and varied. According to the European Union Council of Transport Ministers, one such definition is as follows.

Transport that is sustainable enables people and companies develop, companies are able to do business safely in ways that are beneficial human health and the environment while ensuring fair treatment and meaningful involvement of all from one generation to the next. It will have to be cost-effective, fair and efficient in the provision of transport modes, fair economic competition, balanced regional development imperil emissions and waste within the carrying capacity of the planet. Another another thing it should be built upon is through renewable resources at least turning over economically or slower than their natural replenishment and non-renewable at technologically equal to or slower than development of renewable alternatives. It should also have reduced land use and annoyance exterior to it. (Wan Z. & al., 2018, p. 430).

Sustainable transportation is also a low impact of concern to the environment and the concept of transportation besides non-motorized transport (walking, cycling) as well as any other green vehicles. This is having to do with constructing / preserving efficient urban transport systems that use fuel economically both in term of spaces and nourish to a healthy way of life.

1-2-2- Characteristics of Sustainable Transport:

Among the qualities of sustainable transportation are (UN. 2022, p 34):

- a) A System of Engineered Industrial Prosperity and Diversification: integrating this into a well-developed infrastructure and integrated management system will thus serve as a major engine for industrial progress, a competitive benefit which channels industries & businesses for development. It contributes to:
 - ✓ Increase transport sector share in GDP.
 - ✓ Lessening the volume of overall economic costs from traffic congestion.
 - ✓ Decrease overall economic injuries due to damages.
- b) Environmentally Sustainable System: Sustainable transport stands as a backbone of global environmental leadership in terms of carbon emissions and pollution from economic and social system acting as a multiplier to this reduction (through economic activity). With systems that minimize environmental impact (for example – mode of transport corresponded autofree regarding carbon emissions is everything from maritime, air and land transport).
- c) A System that supports Social Welfare: Safe Efficient and inclusive transport It is focused on the needs of all residents and visitors with a focus on services that are convenient, efficient and safe and affordable. The objectives are:
 - ✓ Decreasing accidents and fatalities in all modes of transport.
 - ✓ Increasing public transport rideship.
 - ✓ Enhancing quality and increasing the fraction of public transport.
 - ✓ Fewer consumer complaints.

2- International Maritime Transport:

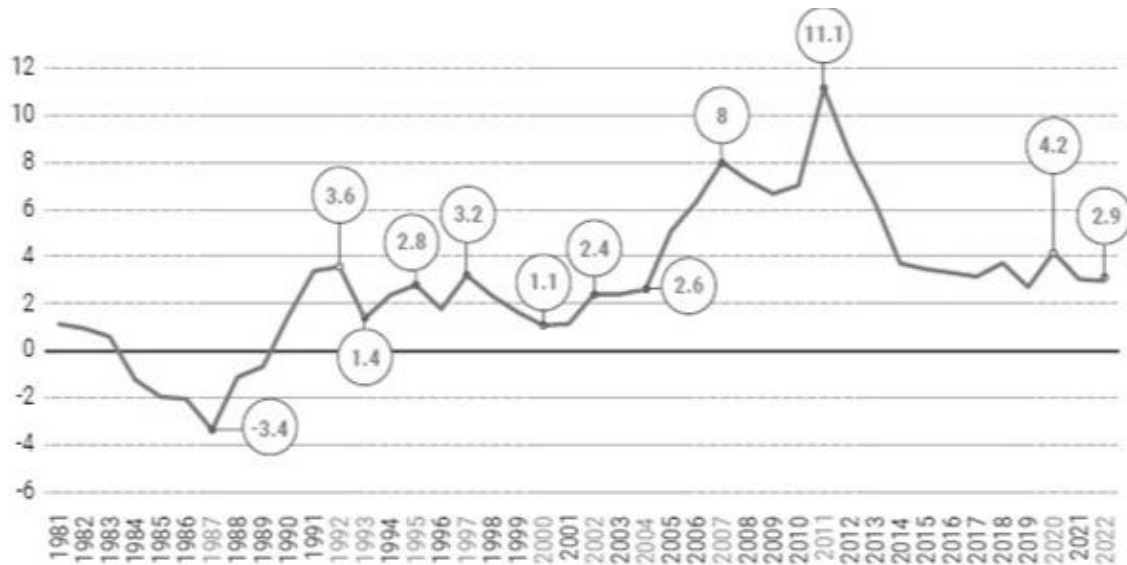
A key component of international trade that facilitates the exchange of commodities and goods between countries worldwide is international maritime transit. More than 90% of the world's goods are moved by water, making it a vital component of the connections economies need or the driving factors behind globalization. Given how effective and economical it is, its significance in the global economic system cannot be overstated.

2-1- The Role of International Maritime Transport in Global Trade:

International maritime transportation facilitates the easy movement of goods from producers to consumers worldwide and connects remote regions of the planet. Important shipping lanes, such as the Panama Canal and the Suez Canal, are vital routes that result in less expensive and quicker transit times between far-flung locations. Oceans teeming with marine routes transport manufactured goods and the majority of other items, as well as raw commodities like oil, natural gas, iron ore, and agricultural products, all over the world.

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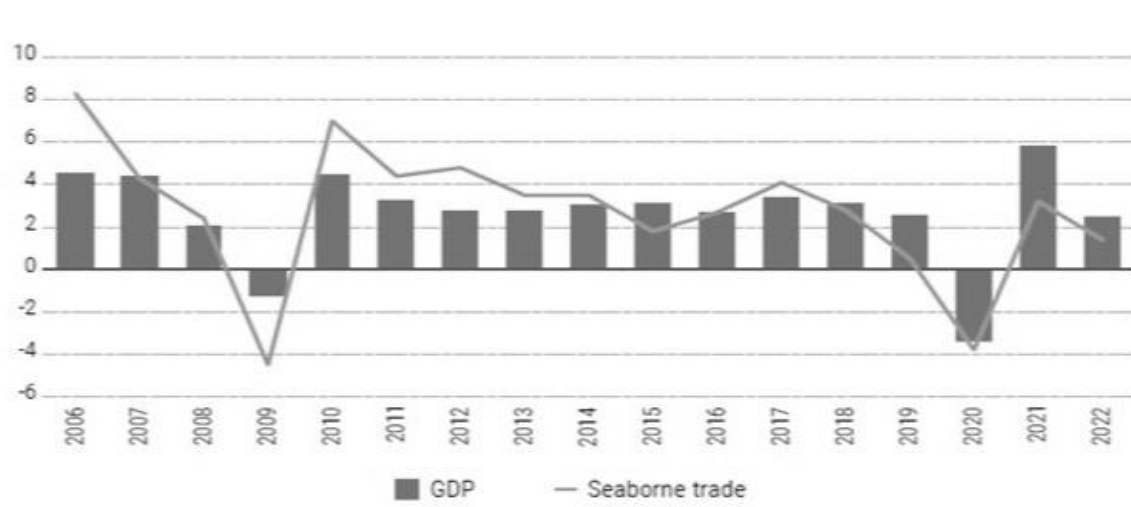
Graph (1): Annual growth of commercial feet, 1981–2022 (percentage of the dwt)



Source : (Rodriguez, 2022, p. 09)

The global commercial fleet saw growth slow to under 3% this year 2021, one of the weakest rates since 2005. Liquefied gas carriers experienced the fastest growth, buoyed by a higher long term Trendlyne global demand for gas going forward (Parker, Shaw, Rojon, & Smith, 2021, p. 31), in tandem with containership and bulk carrier growth. Last decade slump in the global fleet age. Average ship age: 21,9 and average carrying capacity age is at 11.5 years Note: ship is the current type of vessel, which is the youngest now is bulk carriers with an average age of 11.1 years, followed by container ships at 13.7 years and the oldest being oil tankers aged 19.7 years

Graph (2): International maritime trade and world GDP (percentage annual change)



Source : (Rodriguez, 2022, p. 34)

International maritime transport has large economic impacts globally. Shipping is the least-cost method to bulk move goods over long distances. The low cost of shipping allows sea freight to be less expensive, advantageous to both citizens and to the companies. A simple illustration: shipping a car from Asia to Europe by sea is far cheaper in terms of cost than air freight, making it available for international markets.

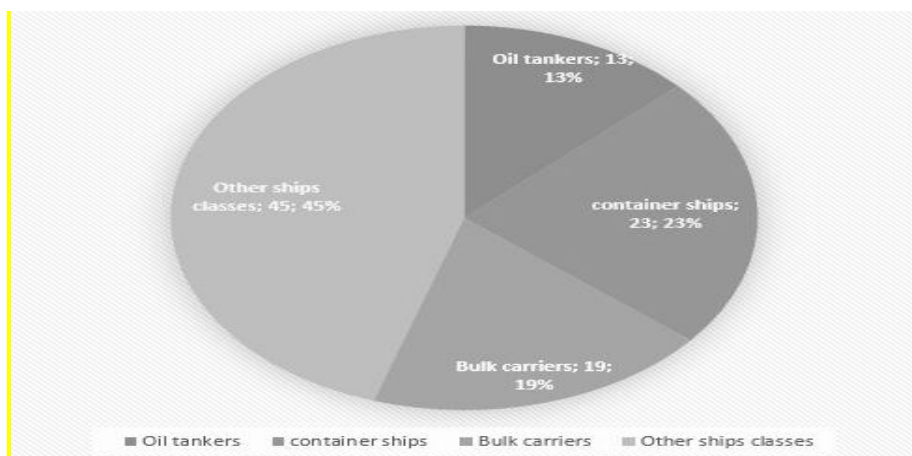
International maritime trade increased 3.2% to a record 11 billion tons in 2021 after plunging 3.8% in 2020. Nevertheless, this was 18 months lower than the pre-COVID-19 classic rate, which was brought on by the pandemic's waves, the world's shipping congestion, and the supply chain's capacity shortage. Most notably, while crude oil loading decreased, containerized trade, gas, and dry bulk cargo were the main drivers of expansion. UNCTAD estimates that marine trade growth will slow down to 1.4 percent in 2022 and an annual average of 2.1% between 2023 and 2027 from the previous three decades average of 3.3% Post-trade has not yet been completed.

Containers, that were until now the fastest-growing share are now forecasted to expand by 1.2% 2022 and 1.9% in 2023 against macroeconomic woes as well a reduced demand weakening Chinese economic stimulus (Parker S, 2021:17). Another bumpy 2022 maritime scene: Inflation, supply chain snarls due to China's zero-COVID policy and the war in Ukraine (which has denied key Black Sea ports). Rising inflation coupled with labor strikes in ports of various countries and global extreme weather events exacerbate the situation of maritime transport worldwide.

2-3-Environmental Impact and Sustainability Challenges:

Between 2013 and 2015, the greenhouse gas (GHG) emissions from oil tankers, bulk carriers, and cargo ships accounted for 55% of all emissions from international maritime transportation. There are four (4), including testing operations as required by the International Maritime Organization (IMO), exhaust emissions, refrigerant leaks, and other transport-related incidents. At least 2.9% of the world's CO₂ emissions in 2019 came from global shipping, with container ships alone accounting for roughly 240 million metric tons of that total ("Parker S2021, p 18")

Graph (3): Share of CO₂ Emitted by Ship Class Between 2015-2020



Source : (Shi & Gullett , 2018, p. 138)

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In response to this the IMO, back in 2023 introduced new rules hoping on a 40% carbon intensity reduction by 2030. A 50% overall reduction in GHG emissions by 2050 is set to achieve with low carbon technologies and sustainable fuels(Parker, Shaw, Rojon, & Smith, 2021, p. 18).

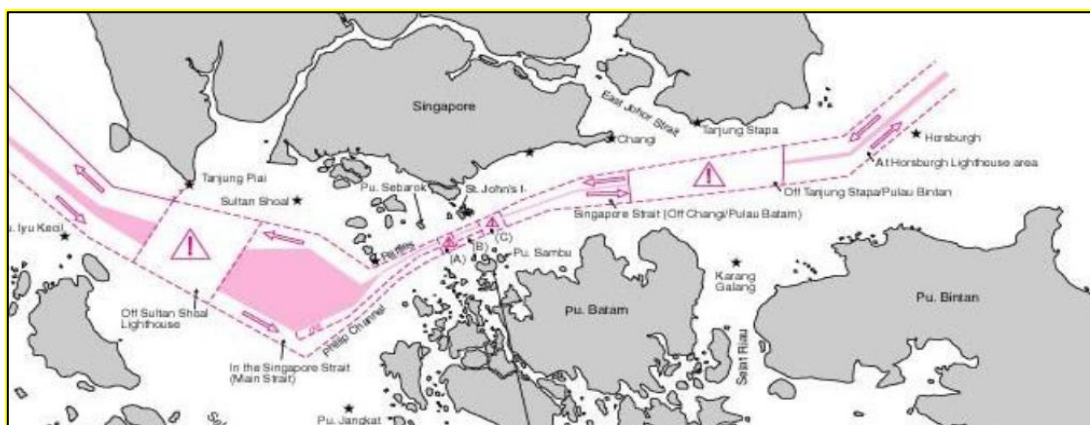
3- International Maritime Transport of Singapore:

Singapore is one of the most important international maritime hubs in the world, due to its strategic location at the crossroads between east and west. Singapore International maritime transport is a vital factor in the Singapore economy as ports and maritime logistics services help increase global trade and thus the wealth of nation.

3-1- Strategic Location of Singapore:

Straddling the busy Strait of Malacca (one of the world's most important waterways), Singapore links the Indian Ocean to the South China Sea. Singapore, a strategic locale between Asian, European and American markets.

Fig (1): Location of Singapore on the Maritime Road



Source:(IMO, 2024)

Over 80 % of global trade by sea passes through Singapore as the final leg or transit, a lot of which all have originated elsewhere undoubtedly. Malaysia is especially important in energy, with about a third of seaborne crude passing through the Strait of Malacca for trade.

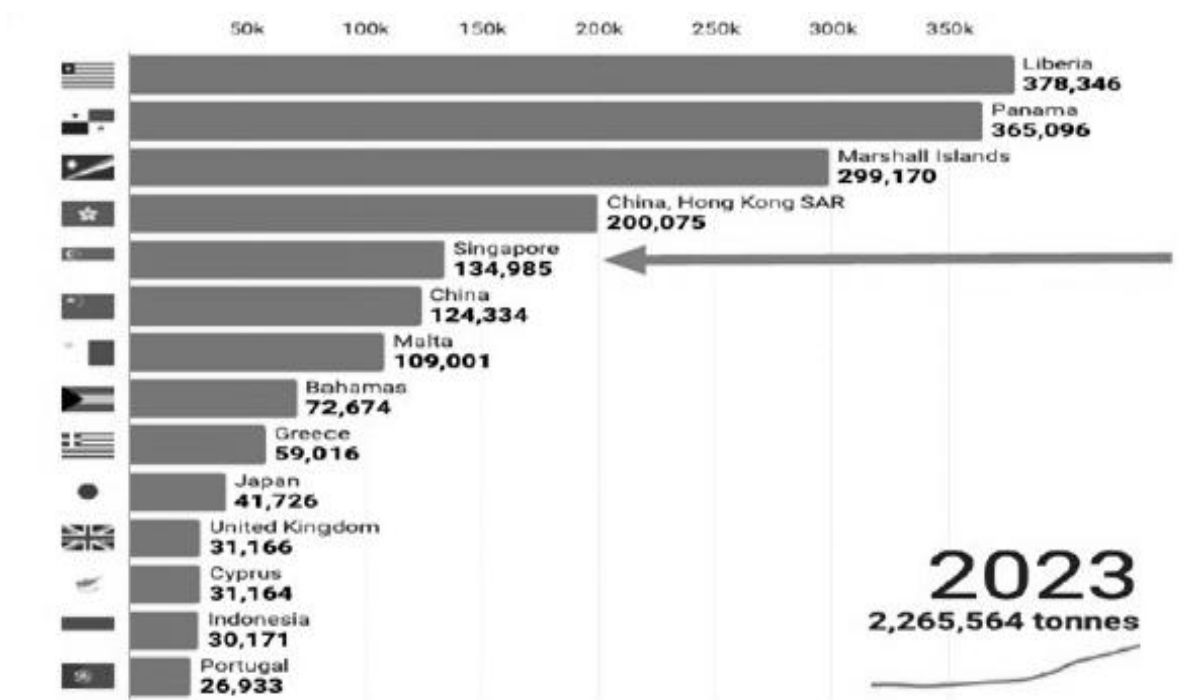
3-2- Logistic and Maritime Services of Singapore:

Combines the entire spectrum of maritime and logistics services, including shipping, warehousing, and distribution; it also offers legal services for marine insurance that assist international trade from Singapore. Additionally, the nation serves as a major port of call for ship repair, bunkering, and other maritime support services. These services further solidify Singapore's position as the world's marine superport by attracting international shipping giants.

Singapore Port — One of the busiest container ports in the world and always making a return to top three list. the port managed about 37.5 million twenty-foot equivalent units

(TEUs) in 2023 asserting the top of the world with first transshipment alone. They can process a lot of the biggest ships with their cutting edge infrastructure, which will shorten loading and unloading times. Singapore is speeding up the digital side of infrastructure as well. The country has already released the Next Generation Port 2030 which is a smart technology-enabled roadmap to significantly improve port operations for rapid build and ship waiting times, as well make port management sustainable.

Graph (4): Singapore as a Major Flag State



Source : (UNCTAD, 2023)

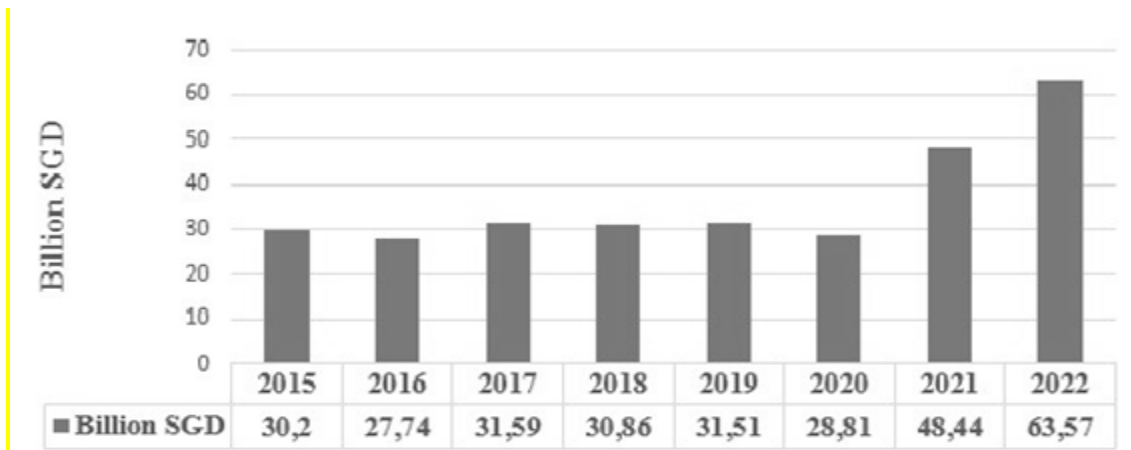
According to the Singapore Maritime Report prepared by the Singapore Shipping Association in 2022, Singapore has over 5,000 ships registered under its flag and plays a major role in world maritime transport. The country is a major hub for global shipping; it receives over 140,000 vessel calls each year, while also being the busiest port in Western Europe on its own merit.

3-3-The Impact of International Maritime Transport on Singapore's Economy:

Shipping has long been the bedrock of Singapore's economy, located as it is at the nexus of major global shipping lanes key maritime nation to over time the world. Singapore contributes around 7% of its GDP (SGD 47 Billion in 2023) to this sector. That contribution illuminates how critical maritime activities are to the beating heart of this city-state.

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Graph (5): GDP of Singapore Maritime Transport Industry

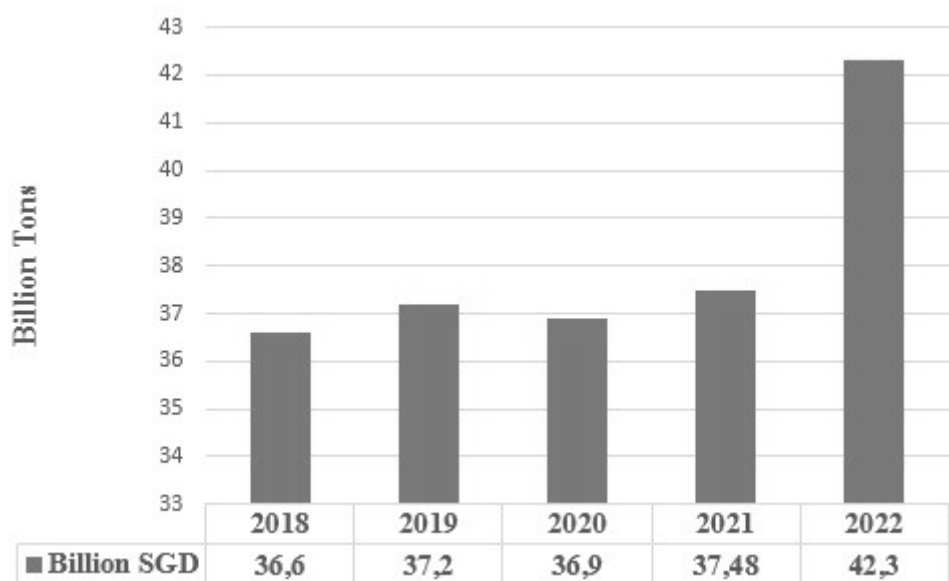


Source:(DSS, 2024)

By generating many jobs, the shipping industry not only adds to financial prosperity but also, in many ways, saves humanity. About 170,000 people work there in a variety of jobs, including port operations and logistics, engineering shipbuilding, and maritime services. The fact that there are more than 5,000 maritime enterprises highlights how the industry is expanding throughout the economy for those jobs.

The maritime industry is important both domestically and internationally. With 600 ports spread over 120 nations, Singapore has the greatest maritime network in the world, making it a sort of hub for international trade and transport. Therefore, it is not unexpected that Singaporean enterprises' USD 4.8 billion in total maritime commercial spending results in ongoing expansion and foreign investment.

Graph (6): Total container throughput in Singapore



Source : (DSS, 2024)

Cnters translated in excellent shipping/ firms coming to the country but it also served as a catalyst for maritime tech innovations and sustainable shipping developments. In the green shipping arena, Singapore has taken top dog position leading initiatives seeking to lower emissions and push for cleaner fuels. This rapidly arms Singapore with even more initiatives which fortify its place as an innovative and eco-friendly maritime hub.

3-4- Singapore's Role in Global Trade:

International trade, Especially in Asia Singapore and its maritime transport system becomes the new underline. Through being the gatekeeper to Southeast Asia, it connects emerging markets to existing economies and allows trade flows through out the region. According to the World Bank's 2022 report, Singapore's port is the second most effective in the world at dealing with container movements which describes Singapore as an international trade facilitator very well.

Singapore, which handles some 90% of global trade by sea — ensures goods keep on the move and supply chains are steady even in crises, like the COVID-19 pandemic for that matter. Not only has the ability to sustain high level of operations during these periods reduced any global supply chain disruptions assisted by the port.

4- Shifting towards clean shipping in Singapore:

Though successful, Singapore also has to make certain it keeps its status as world leader. Although the sand imports ports in China (Shanghai, Hong Kong), and geopolitical risks from Asia-Pacific is one of risk-upside. And global moves towards sustainable shipping as well increasing costs of decarbonization will create a host of both challenges and opportunities for Singapore maritime sector.

Table (1): Singapore's environmental performance index performance

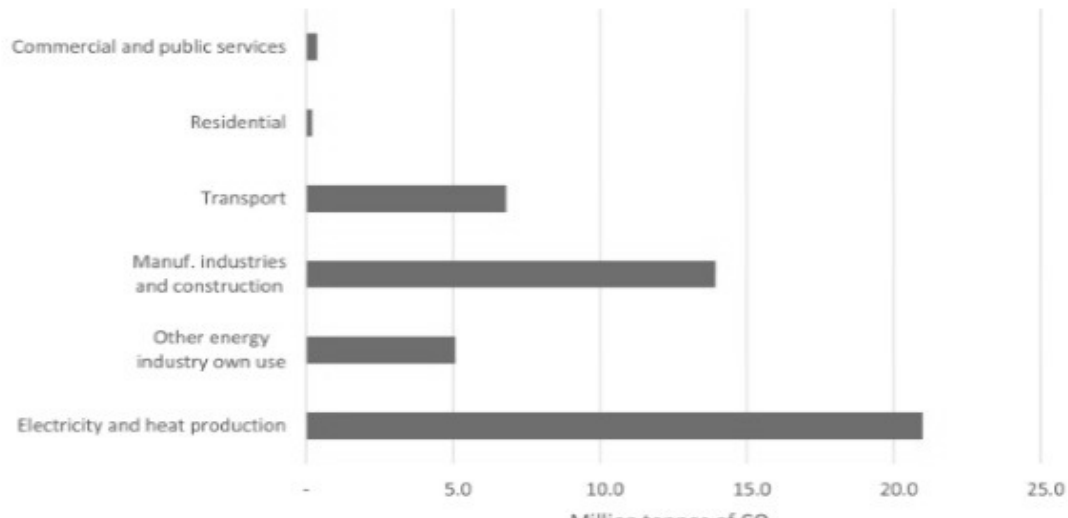
Year	EPI Global Ranking	EPI ASEAN Ranking
2014	4	1
2016	14	1
2018	49	1
2020	39	1
2022	44	1

Source :(QUAH, 22, p. 09)

Singapore has new port projects underway to tackle these challenges, the latest of which being Tuas Mega Port (target 2040) which is meant to be the world's largest automated terminal upon completion. This initiative will also support Singapore and enable the port to cope with higher shipping volumes, this in turn means that Singapore strengthens its global shipping position and also decrease the harmful gas emission solely relying on electrical power.

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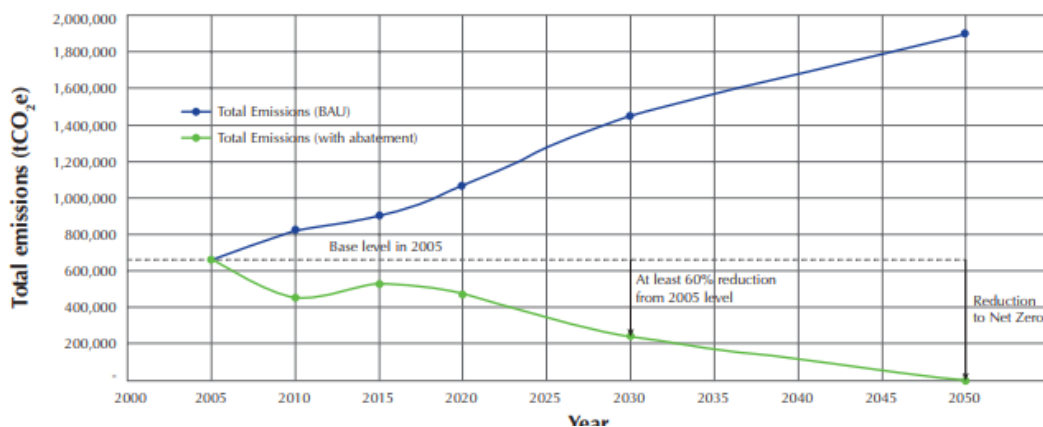
Graph (7): Singapore's CO₂ emissions from fuel combustion by sector in 2019



Source : (QUAH, 22, p. 07)

Though Singapore is strong in maritime transport its economy contributing \$47 billion, maritime has turned out to be a major contributor of air pollutants. As per official statistics, approximately 7.3 million tonnes of greenhouse gases are emitted annually by the marine transportation sector. In light of the environmental issues cited and in order for Singapore to continue ranking in top in green environmental practices, the Government pursued by the Maritime and Port Authority of Singapore (MPA) (QUAH, 22, p. 10), TASAP launched a wide range of strategy. The general concept of this plan is to transition gradually from fossil fuels to a clean energy path it associate with outstanding electric engines instead of diesel engines. The move is part of wider plans by Singapore to fulfil global environmental obligations, lower carbon emissions and prove itself the new king of sustainable maritime operations. The approach is also to provide some incentives for ship operated companies to invest in newer technologies as well as fuels like liquefied natural gas (LNG) or biofuels for reducing their environmental footprint.

Graph (8): Port Terminals: Total Emissions (BAU vs with abatement)



Source : (MPAS, 2022, p. 05)

Climate change is a global problem that demands international cooperation. Innovative or not, Singapore being less than 0.11% of the global emissions and bound by bounds when it comes to alternative energy resources remain focused on solving this problem. In 2020, Singapore submitted an improved NDC that keeps capping emissions of nationwide level with around 65 MtCO₂e by about 2030 concurrently Singapore has also developed a Long-Term Low Emissions Development Strategy (LEDS) aiming to halve emissions, deriving 33 MtCO₂e by 2050 and towards achieving net zero emissions whenever feasible by the second half century (MPAS, 2022, p. 09).

Maritime transport at the international level continues to be the backbone of Singapore's economic foundation in global trade. As a strategically positioned, well-developed port, wide-ranging maritime services provider and visionary government enablers Singapore is to date a pivotal node in global supply chain. The country will have to keep adapting in order to maintain its status as maritime industry leader face the new challenges that come its way. With an emphasis on innovation, sustainability and collaboration Singapore is well placed to continue to lead the future of global maritime transport.

CONCLUSION:

As the world economy rapidly advances, there is an overlaying importance placed on how international maritime transport is applied as a means to an end respect of environmental sustainability. Maritime transport is a crucial transport for world trade, accounting for about 90% of world maritime's trade volume and as well as contributes to the economic development. Nevertheless, this industry itself harms the environment as well by polluting 7.3 million tons CO₂ per annum. Both of these layers creating a double hit to trade but also mitigate environmental ruin make it more important than ever for the comprehensive strategies.

Singapore with its 0.11% share of global emissions is a shining example of puppeteering the response to these environmental issues. In 2020, the emissions peak target was set at around 65 MtCO₂e by Singapore aiming to halve these emissions to 33 MtCO₂e by 2050. The country's Long-term Low Emissions Development (LEDS) Strategy aims for net-zero emissions of all sectors by the end of the century. Singapore has shown this through its recent proclamations and legislation, for example the Maritime Green Initiative to encourage the use of cleaner fuels and advanced technology in fleets.

Singapore also serves as a best-practice in maritime hub, which is operating more than 4400 ships, and handling nearly 37.5 million TEUs in 2023 further emphasizing that sustainability needs to be part of maritime operation. Reducing Environmental Footprint of Maritime Transport A critical part of Asia CleanEnergy Strategy, already underway is turning toward cleaner sources of clean energy — like battery-electric engines and sustainable fuels such as Liquefied natural gas (LNG). Together, the global maritime sector must innovate AND innovate collaboratively to address this one of central importance: climate change; whilst also maintaining efficient and low cost trade practices. Singapore is a very good

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example of balance between the economic expansion and environmental protectivism showing that sustainable projects can work with internationally extending value chains. With the times moving on, advancements solving other part like the international cooperation is necessary in order to construct towards positive evolution of a sustainable maritime future and tackling climate change as well.

The Study results:

1. **Clean Energy Production:** Maritime transport as one of the greatest sources of greenhouse gas emissions produces around 7.3 million tons CO₂ a year alone. It represents the environmental problem in sector despite playing an important role of global trade
2. **Emissions Reduction in Singapore:** At UNCTAD, we are asking Singapore to reduce its emissions, and ask what are their targets; peak at 65 MtCO₂e albeit based on the year 2030, and reduce this by half to reach 33 MtCO₂e by end 2050. Leading to its environmentally friendly approach, the country also has ambition to be carbon neutral from half of the century.
3. **Technological Development:** Maritime Green Initiatives in Singapore illustrate that it implemented cleaner technology and fuel options (electric engines, LNG) as a predominantly powerful strategy for reducing emissions and a model of sustainability for maritime transport.
4. **Economic and environmental alignment:** Singapore oversees a large number of maritime fleet with port and associated operations trading not just development economics but also within the constraints of environmental sustainability. This is a demonstration of how sustainability could coexist with trade efficiency.
5. **Broad Context and Future Directions:** As stressed in the study, international collaboration and innovation in maritime transport are global issues. Singapore is following a route providing an example that growth could be both ecologically present and world wide

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