

A Resilient Shipping Industry in the Wave of the Digital Economy during the Post Pandemic Era: Based on Maersk's Approach

Xingge Li ^{1, †}, Meixuan Zhang ^{2, †}, Xinyi Zhang ^{3, †}, Gaoyuan Zhu ^{4, *, †}

¹ School of Business Administration, Zhongnan University of Economics and Law, Wuhan, 430073, China

² Fort Hays State University, Kansas, 67601, USA

³ School of Economics, Zhengzhou University of Aeronautics, Zhengzhou, 450046, China

⁴ Reading College, Nanjing University of Information Science & Technology, Nanjing, 210044, China

† These authors contributed equally.

* Corresponding author: 202183060014@nuist.edu.cn

Abstract. The purpose of this essay is to focus on how Maersk made choices about its career development and to analyze and explain it using a set of "addition and subtraction" principles. Two distinct aspects of e-commerce are highlighted: "simplification" and "supplementation". Faced with cyclical shipping demand, the impact of the COVID-19 pandemic, and inherent industry shortcomings, Maersk entered the shipping e-commerce market by developing a series of platform products for online booking services. This helped simplify and connect the supply chain through subtraction. In addition, Maersk built a terminal delivery network to support B2B and B2C electronic fulfillment with powerful and flexible e-commerce technology. This promotes the integration of technology and consumption modes, extends the supply chain through addition, and complies with the digital economy. In the pursuit of green development and decarbonization in the shipping industry, Maersk has made subtractions by controlling carbon emissions and making efforts in ship and fuel development and manufacturing. This essay also considers the future management implications and direction of Maersk and the shipping industry it represents.

Keywords: Shipping industry, E-commerce, platform, carbon neutral.

1. Introduction

In the post-epidemic era, the global Purchasing Managers' Index (PMI) generally indicates that the global economy remains robust, even though the pace of economic recovery has slowed down. The latest market trends in the industry are still strong in terms of freight demand [1]. For the shipping industry as a whole, the shortcomings of the traditional shipping model have been more clearly exposed during the epidemic. It has become a new trend to update the shipping model by following the footsteps of cutting-edge technology, with the proportion of artificial intelligence and new communications in shipping technology set to increase significantly. The negative effects of the new epidemic will be addressed in the recovery period, with a reasonable adjustment of the industry [2].

The boom in the digital economy has led to a high degree of online commerce. The "low-touch" nature of the epidemic has led to considerable vigilance and increased attention to online shipping services. Against this backdrop, liner companies need a more direct approach to address the industry's own issues, such as high fragmentation, low transparency and visibility, cumbersome manual processes, outdated customer interfaces, volatile fuel prices, demand uncertainty, environmental regulations, and intense competition and overselling of intra-industry and competitor shipping models [3]. The consequent low predictability needs to be addressed to achieve overall growth in business scale and market competitiveness. The logic of digitalization of shipping becomes clearer and more concrete as the Boston Consulting Group, which focuses on the container industry (2018), presents seven digital trends that will transform container shipping, led by electronic online booking platforms

[4]. On the other side of the spectrum, green supply chains and ship emissions reduction technologies are gaining increasing attention from the global maritime industry [5]. With the trend towards emissions reductions in shipping brought about by international schemes and private initiatives [6], the relationship between shipping and environmental protection will become even stronger. With a Boston Consulting Group survey [7] showing that 82% of European shipping customers are willing to pay a premium for zero-emission shipping services, customer demand is becoming an important driver for the shipping industry to move towards carbon neutrality. Decarbonization is increasingly seen as a competitive resource, with more shipping customers saying they would be more loyal to zero-emission shipping companies. There are several internal and external factors that have pushed shipping companies to embrace digital technology. It indicates that customer requirements regarding visibility, lower prices, lower carbon footprint of their freight transport, and increasing operational and cost efficiency are the chief drivers of digital technology in shipping (please see Figure 1).

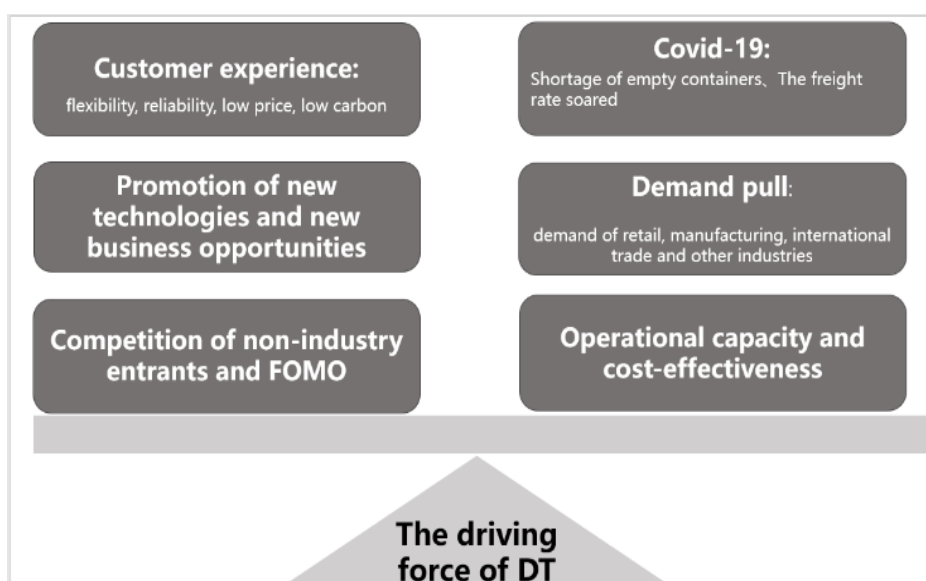


Figure 1. The driving force of DT
 Photo credit: Original

Maersk, the world's largest integrated supplier of containerized carrier transport, with four core businesses in shipping, logistics and transportation, terminals and tugs, and container manufacturing, operates on a large scale, including an independently operated energy segment, and has a rich history and corporate heritage in the industry. Using Maersk as a case study, this paper will summarize a set of additions and subtractions from their actions regarding their e-commerce platform, global end-to-end and decarbonization practices that fit with the global situation. The paper also intends to distill the progress of the entire shipping industry in the post-epidemic era of digitally featured e-commerce and decarbonization processes in Maersk, and thus beyond its own superior performance. The paper will also illustrate the ideas and inspiration it brings to the shipping industry to innovate in the industry's operations to reduce trade frictions and facilitate more global trade.

2. Case presentation

The ancient Roman statesman Cicero said, "Whoever controls the sea controls the world." This statement still seems to hold the same significance today. As we all know, shipping is responsible for 90% of the world's international trade and is the central vehicle for global trade and distribution. Over the past few years, the shipping and logistics industry has experienced a 'perfect storm' of inevitable crew infections, labor shortages, port congestion, inefficiencies, and delays due to the recurring Newcastle epidemic. As a direct result of these factors, demand for ocean freight exceeded available ocean liner capacity, and container freight rates soared to record levels. Furthermore, disruptions to the ocean shipping schedule led to global delivery delays, severely disrupting production and creating

supply shortages. Such a dire situation has inspired the industry to always be prepared to manage uncertainty in the maritime industry.

Secondly, the cyclical nature of shipping should also be taken into account. In traditional shipping theory, freight rates are usually considered to be determined by a combination of transport demand and supply [8] [9], especially in a bulk carrier market (perfectly competitive market) environment. When transport demand is high, freight prices rise, and as transport earnings increase, supply increases, and the increased supply in turn pulls down freight prices. Conversely, low demand causes freight rates to fall and then rise again when the market absorbs the excess supply [10]. When container slots are ordered in advance of a fixed period (e.g., 1 year), demand shows prominent seasonality. Generally, the low demand season occurs in the first half of the year, while the high demand season occurs in the second half of the year. However, in the real container shipping business, shippers usually complete the shipping process by comparing the freight rates of several liner companies, buying slots from several companies at the same time, and then comparing and canceling the bookings one by one. Due to slot cancellations, many overbookings of reserved container slots occur, resulting in lower utilization of vessel capacity. In addition, the cancellation of slot bookings, especially during peak demand seasons, also leads significantly to loss of revenue for the liner companies, who have to oversell capacity in response, which undoubtedly results in some shippers having their cargo rejected, even though they ordered slots in advance. Although shippers are compensated by the liner companies for their payments, the unfinished contracts will lead to a lack of trust in the liner companies, which can be an obstacle to their long-term growth.

As a result, Maersk, which is seen as a barometer of global trade, chose to develop shipping e-commerce to overcome the manual, paper-based exchange of information, and a series of advanced real-time shipping visualization platforms were put on the agenda. Specifically, Maersk has streamlined the complex offline booking process steps to five simple steps through its own developed online platform (Maersk Spot). Secondly, Maersk is giving more thought to its wider customer base with its e-commerce digital products such as Twill, an end-to-end logistics platform for small and medium-sized enterprises, as well as Maersk flow, a supply chain collaboration platform, Tradelens, a digital platform for shipping logistics that has been withdrawn in October 2022, and "Cabin Treasure," an order trading platform that breaks the traditional booking rules, launched in conjunction with Alibaba.

On the other hand, in 2016, Maersk proposed a strategic transformation and upgrade, aiming to become a company specializing in end-to-end container logistics services, with e-commerce logistics as a strategic focus for growth. The supply chain determines the success or failure of an e-commerce business, and the three key words of reliability, speed, and performance excellence are particularly important to the supply chain. Omnichannel fulfillment and resilient adaptability are reflected in the ability to deliver from manufacturing to the last mile. Such challenging end-to-end dispatch capabilities are integral to meeting customer expectations, but often, supply chains serving bulk orders struggle to keep up with the surge in e-commerce demand. This is something Maersk needs to overcome.

Rather than building its own asset-heavy end-delivery network from scratch to avoid direct competition with end-delivery companies, Maersk has now opted for a low-capital expenditure, fast-moving approach by acquiring existing businesses to plug the gaps in its own operations.

Today, the international community is beginning to pay increasing attention to the growing environmental problems. Global warming and carbon neutrality are relevant to today's environment and are having a profound impact on the shipping industry. Some may be more pessimistic about Maersk's prospects due to recent criticism of maritime pollution, but the company says it will adapt its environmental, social, and governance efforts to cover both its marine and land-based operations. The company has committed to decarbonizing its fleet and other delivered vessels, and says 90 of its 200 largest customers have made similar ESG commitments. In terms of solutions to ESG, Maersk Line has set a decarbonization target for 2030. Maersk has also established a non-profit organization, the Zero Carbon Shipping Centre, through which it will outline a decarbonization pathway to

accelerate the development of selected decarbonized fuels and power technologies that will significantly reduce pollution of the marine environment. The goal of achieving net-zero emissions from all operations by 2050 has been brought forward to 2040. In addition, Maersk will offer a range of green products in 2030, accelerating the introduction of new container vessels, including an order for 12 methanol-fueled container vessels. This is expected to save 150 tonnes of CO₂ per year, representing 4.5% of Maersk's fleet emissions.

As the ultimate goal of decarbonization in shipping is the transition to green fuel technology, Maersk will be sourcing green methanol in order to promote industry collaboration and international cooperation in the use of new green fuels for ships. It is establishing strategic partnerships with CIMC America Holdings Ltd, Euro Energy, Swiss energy company Proman, Danish Renewable Energy, and US-based Low Carbon Fuels, respectively. The move will not only help Maersk secure the green methanol needed for well over 12 new containers but also increase annual global green methanol production capacity. A new report from the Maersk Zero Carbon Shipping Centre explores the role of onboard carbon capture (OCC) in decarbonizing the maritime industry through a series of case studies that compare and contrast carbon capture with larger tankers. Based on Prometheus Fuels' 'direct air capture' technology for the production of e-fuels and Waste Fuel's technology for converting waste into renewable fuels, investment in them will undoubtedly go a long way towards helping Maersk meet its decarbonization targets and address the current global climate crisis.

Maersk has achieved priority berthing rights for ships at the Port of Jebel Ali through a strategic partnership with DP World. This partnership is driving the implementation of new processes to speed up port turnaround times and reduce fuel consumption, which will further support Maersk's customers. Additionally, the visualization tool also provides customers with real-time information on DP World and opens up the supply chain. Maersk is actively engaged in providing Lenovo with eco-friendly transport solutions, further contributing to carbon reduction up and down the supply chain and reducing its carbon footprint. In this way, Maersk is confident that by signing long-term purchase contracts, companies up and down the supply chain will be able to invest in green fuel production.

3. Case Studies

3.1. Exploration in E-commerce in Shipping: Simplifying the Supply Chain and Subtracting

For the shipping industry as a whole, the traditional development mindset and organizational culture of using fleet size and number as a competitive advantage through shipping power is no longer suitable for the development of modern logistics businesses. Standardization achieved through digitalization is particularly important for shipping punctuality and efficiency. Recent studies [11-13] show that digitalization in maritime logistics is driven by changing customer needs and expectations, cost reduction, the digital shift in customer industries (e.g., manufacturing), legislation, and changes in the competitive landscape. Maersk has taken the lead in making these reductions. To remain an attractive modern transport option in an increasingly digital economy, the maritime logistics industry must create a new digital infrastructure based on data sharing between participants that promotes visibility, predictability, and ultimately better decision-making for the players involved [14].

For example, Maersk Spot, the spot rate trading platform, is leading the way in digital innovation for shipping companies, with the vision of streamlining and connecting the customer's supply chain to provide a seamless customer experience. This includes one "all in" price from quote to final booking. The platform has a fixed route, fixed volume, irregular release, fluctuating prices based on supply and demand, and a non-membership tier system. The product features of the post-paid model and the ability for customers to compare spot FAK rates on SPOT with their long-term contract rates allow customers to make the most advantageous choice with the industry guidance of FAK rates, solving the vicious cycle of overbooking and improving bookings' transparency, certainty, and immediacy. With Maersk Spot, customers can search online 24/7 and get competitive rates in a timely manner. The launch of the Maersk Spot booking platform benefits small and medium-sized forwarders to bypass headline forwarders who agree on superior rates.

In comparison, COSCO Shipping, also a leading shipping enterprise, has joined the camp of shipping e-commerce participants with its development of SynCon Hub, a vertical e-commerce platform for shipowners. The platform focuses on providing end-to-end services from one-click booking to online settlement through a digital platform. This enables customers to quickly understand the changes in the supply chain and logistics status, with a slogan of the entire process being timely, transparent, and controllable. COSCO Shipping also actively carries out whole online transactions and contactless visualization services, allowing customers to enjoy one-stop online services such as online booking and electronic processing of the entire process. Subsequently, Mediterranean Shipping launched its e-commerce platform, myMSC, and Hamburg Süd and Evergreen also launched two online platforms, Instant and Green X, respectively. Shipping e-commerce is gradually becoming normalized.

Turning its attention to the Chinese market and in order to more robustly overcome the shortcomings of the current industry pricing and booking model, Maersk and Alibaba jointly launched the "Cabin Treasure" logistics partner, which focuses on the needs of small and medium-sized enterprises during the end of the shipping season and achieves a triple guarantee - orders go directly to the shipowner and are protected by locking in positions and prices in advance. In addition to the usual two basic models of e-commerce and third-party trading platforms developed by shipping companies, Maersk has chosen a third path with the launch of Cabin Treasure, which is a partnership between shipping companies and third-party platforms. Specifically, Maersk is using Alibaba's One Touch foreign trade platform as the backbone, mainly piloting a new model of maritime e-commerce operation to solve the problems of difficult booking for SMEs during the peak season, the tendency to dump containers, and the high cancellation rate of shipping companies' slots.

In addition, within the Maersk digital family, there are Twill, a digital logistics platform that provides supply chain solutions for small and medium-sized enterprises; Maersk Flow, a collaboration platform that reduces manual workload and increases fault tolerance, thereby improving supply chain control stability; and TradeLens, a shipping blockchain platform built in partnership with IBM (which was withdrawn in October 2022). Based on a bold vision of the viability of an open and neutral industry platform, TradeLens aims to modernize manual and paper documents by replacing them with blockchain-enabled digital solutions. It enables the transparent and secure exchange of global trade information, facilitating cost reduction and safer global trade. Maersk also offers digital products that are operational in China, such as Smart Customer Service "Small Motor," which ensures smooth supply chain operations around the clock.

Interestingly, during the epidemic, Maersk conducted its first live shipping e-commerce trial, with the main aim of promoting booking coupons and implementing online booking. This was in line with the new trend of selling products 'live'. Despite being rooted in such a long-established and traditional industry, Maersk chose to be proactive and move with the times.

In 2021, Maersk's major platform offerings generated \$38 billion in revenue, driving 2/3 of Maersk's global revenue, up almost 90% from 2019 and 15% from 2020, with a 52% increase in searches for Maersk's maritime products and more than 15 times the number of bookings processed on the mobile app. This demonstrates a dramatic shift in the way customers prefer to engage with shipping, particularly with the maintenance of social distance in contemporary relationships and the popularity of remote working. Approximately 70% of Maersk's transactions offer instant booking confirmation, which is an industry first, contributing to a seamless and smooth transaction. The core strategy of digital transformation practiced by Maersk is to capture more lucrative profits for its end-to-end business and keep its growth competitive for the long term.

3.2. E-commerce logistics "ashore" - layout of the consumer side to do the addition

The e-commerce logistics landscape is constantly evolving and changing, with retailers around the world becoming increasingly resilient and rapidly adopting an omnichannel, direct-to-consumer (D2C) model to reach their customers. At the same time, they are looking to reduce the cost, effort, and complexity of their B2C supply chains and prioritize integrated logistics solution providers to

help them connect with the best local delivery providers in each destination and enable a full 'factory to sofa' online sales process. Through eCommerce logistics, Maersk aims to help brands and retailers achieve a direct-to-consumer delivery model that seamlessly integrates with their existing B2B supply chains. To do this, they offer E-Delivery and E-Fulfillment products that help customers save time, avoid high costs, and increase sales regardless of the season.

It is also impossible to ignore the fact that e-commerce companies and digital shippers such as Amazon and Alibaba are now present in the shipping and transportation services market, creating a platform for online procurement for customers of cross-border logistics services. Among them, as the world's largest B2B cross-border e-commerce platform, Alibaba's international station logistics network has covered many countries and regions around the world. The entry of e-commerce companies into the maritime industry is an important innovative development towards the B-side. In order to respond to these changes and diversify marketing channels, and with the driving force of changing customer needs and their own business transformation, Maersk has chosen to "go ashore" in the face of e-commerce companies "going to sea" to expand its e-commerce footprint.

Throughout its series of acquisitions, Maersk has incorporated e-commerce capabilities into the company's business model, responding to the trend towards online commerce and the integration of technology and consumer models, with a focus on creating an asset-light global business with strong and flexible e-commerce technology to support B2C and B2B e-fulfilment and SCM. This enables Maersk's customers to fully leverage its e-commerce logistics network to achieve fast delivery within 24 hours to 75% of US consumers and two-day delivery to 95% of the US territory. With Maersk's acquisition of B2C Europe, a major player in Europe, Maersk provides its customers with full supply chain control, competitive costs, and shipment visibility. The transaction has an enterprise value multiple of 13 and reflects strong growth prospects and synergies. Maersk also acquired LF Logistics in a transaction valued at US\$3.6 billion, a premium omni-channel fulfilment service provider in the Asia Pacific region with a strong presence in e-commerce and inland transportation. Going forward, LF Logistics will use the Maersk brand.

Maersk's expansion into e-commerce is complementing its existing supply chain and meeting the integrator vision and the needs of its existing customers in the B2C supply chain business. Vincent Clerc, CEO of Maersk's Marine & Logistics business, said, "Maersk has the capability to start building strong e-commerce logistics to extend and strengthen our existing supply chain offering and create growth opportunities." In 2020, Maersk acquired Performance Team, a leading North American warehousing and distribution logistics company, for \$545 million. Performance Team is best known for its B2B and B2C distribution solutions in the retail, wholesale, and e-commerce sectors, which complements Maersk's service supply chain for warehousing and distribution to North American customers.

Maersk is aggressively penetrating downstream to unlock the full chain of logistics from production to consumption. By acquiring leading players in the e-commerce logistics industry, Maersk is moving closer to the C-suite and taking the "last mile." The transition from the industrial supply chain to the consumer supply chain is a startup for Maersk and an extension of its existing supply chain. These operations by Maersk, known as a "multi-hyphenate," are designed for the three global e-commerce regions, including Europe, North America, and Asia.

3.3. GreenShipping -Controlling Carbon Footprint by Subtraction

The current environmental pollution undoubtedly requires shipping companies to "reduce" emissions rather than "do subtraction". In terms of the structure of cargo sources [15], the global economy and industry will undergo a green transformation, and the demand for fossil fuels such as coal and oil will peak or even decrease. In the future, the shipping industry needs to take measures to reduce carbon emissions and even achieve carbon neutrality, and find alternative energy sources for commercial use. Questions like how to establish an emission reduction mechanism - market-based or administrative, how to break through core technology - is carbon capture, carbon sequestration, or other methods effective, and how to establish a global unified carbon emission certification

mechanism, require in-depth cooperation between shipping and its customers, upstream and downstream industries, and research teams to balance carbon emission targets and sustainable shipping development.

The use of green fuels has become the dominant choice in today's society. According to a study by the International Maritime Organization (IMO), as global trade activity continues to recover and grow, environmental pollution worsens each year. The IMO calls on all parties to accelerate the development of the shipping industry, reduce emissions, and develop green shipping. Firstly, the shipping industry is the most polluting industry to the world's environment, and its rapid development is negatively impacting people's living environment. More and more people are getting sick and even dying from respiratory problems, and "this mega-transportation burns a lot of fuel and produces a lot of air pollution [15]." Many marine organisms are also dying due to the pollution of the marine environment. Secondly, due to the industrial revolution, the earth's non-renewable energy sources are being used in large quantities, leading to a global shortage of resources and the need to find and develop new sources of energy to replace disappearing ones. Methanol was chosen by Maersk Shipping as the fuel for the new energy vessels because it is easy to produce, low cost, and a renewable and clean energy source. "According to the Methanex website, methanol is a safe, cost-effective, and globally available marine fuel. With the growing demand for cleaner marine fuels, methanol is an alternative fuel for ships that could help the shipping industry meet increasingly stringent emissions regulations [16]." Finally, new green energy reduces the cost of use, "It's good to use less energy. Using less energy not only reduces greenhouse gas emissions, it also saves organizations money [17]."

As mentioned earlier, Maersk has ordered and signed green fuel agreements with several countries. Such measures reduce the container shipping industry's dependence on oil and LNG and significantly decrease the use of non-renewable resources. Maersk Shipping is understood to have ordered 19 carriers with dual-fuel engines capable of running on green methanol, which are expected to be delivered by 2025. Currently, Maersk is looking for partners worldwide. As part of its supply chain decarbonization strategy [18], Maersk states that around half of its 200 largest customers have become or are setting ambitious scientific or zero-carbon targets for their supply chains, and this number is rising. Maersk has also partnered with SunGas Renewables, the US leader in providing technology and equipment systems for the mass production of renewable fuels (December 15, 2022), and signed a letter of intent for green methanol with SunGas Renewables, Inc. (December 15, 2022). Additionally, Maersk offers a carbon visibility product to help customers better understand and control their carbon footprint.

While technology continued to evolve and innovate, there were still some drawbacks to developing green shipping, such as the high upfront investment in inventions and the tendency for them to fail. Moreover, since LNG is transported in liquid form, it must be transported in containers with high-pressure carrying capacity and low internal temperatures [19]. This may slightly increase costs, but green transport is more cost-effective and environmentally friendly for the planet than traditional shipping methods. Delving deeper into Maersk's proactive emissions reduction goals has not only attracted more environmentally conscious customers to the company but has also given it a say in how the maritime carbon tax is collected in the future. Maersk has achieved emissions reductions while simultaneously gaining profitable performance. Whether it is contracting companies to manufacture methane or investing heavily in the development of new carriers, this is an exciting result for Maersk.

4. Conclusion

In conclusion, Maersk's experience demonstrates that the trend towards digitization is inevitable, even in an old and traditional industry like shipping. E-commerce can supplement the business model and logistics, and avoid harm.

It is worth mentioning that the shipping community believes that the main function of an e-commerce platform for shipping should be to integrate resources while also creating demand. Currently, low trust index, high transaction costs, and poor customer experience are common problems between shipping companies and cargo owners, especially for small and medium-sized direct customers. Both sides fail to establish a win-win relationship, resulting in a common loss. Although shipping and logistics platforms, like Maersk Spot, have emerged in various markets, they can only provide certain or multiple links of services. Almost no e-commerce platform can provide a complete online service or a relatively perfect service to build a cloud ecosystem, not to mention achieving the same level of integration as travel, aviation, and car rental platforms. To improve the customer experience, the shipping industry needs to pay attention, make efforts, and experiment with new solutions.

Regarding competition between shipping e-commerce platforms, trust and price should be focal points of future competition. It is challenging to quantify and standardize the logistics services purchased by shippers, which inevitably becomes an obstacle to promotion. Shipping e-commerce platforms lack real customer evaluation, and many customers complain that some platforms in the market are overpriced. Shipping e-commerce participants can reduce total costs by rationalizing the links and utilizing scale effects, without resorting to malicious market competition. However, a "price war" does not always have a negative connotation and can lead to another period of prosperous development of shipping e-commerce. Additionally, if shipping e-commerce platforms intervene in the customer's supply chain in advance, improve the forecast accuracy, and warehouse utilization rate, they can effectively reduce costs. For the industry, focusing not only on short-term benefits but also on long-term planning for shipping and sustainable development can create more exciting opportunities. This may be the way forward for Maersk.

References

- [1] Maersk. asia-pacific-market-update-June [EB/OL]. (2022-06-24) [2023.02.19]. <https://www.maersk.com.cn/news/articles/2022/06/24/asia-pacific-market-update-june>.
- [2] Feng Jiawei. With the development of remote communication technology, big data and artificial intelligence, 'smart ships' will definitely become the future development trend of the shipping industry. [J]. China Ocean Shipping, 2020, (05): 47.
- [3] Raza Z, Woxenius J, Vural C A, et al. Digital transformation of maritime logistics: Exploring trends in the liner shipping segment [J]. Computers in Industry, 2023, 145: 103811.
- [4] Sun H, Lam J S L, Zeng Q. The dual-channel sales strategy of liner slots considering shipping e-commerce platforms [J]. Computers & Industrial Engineering, 2021, 159: 107516.
- [5] BCG. Shipping Industry [EB/OL]. [2023-2-19]. <https://www.bcg.com/zh-cn/industries/transportation-logistics/shipping-industry>.
- [6] Qu Baozhi, Yang Yi, Tian Yu. Current status and development trend of ship abatement technology. [J]. China Water Transport, 2022, No.720 (03): 18 - 22.DOI: 10. 13646/j.cnki.42 - 1395/u.2022.03.006.
- [7] Peter Jameson, Laurids Schack, Camille Egloff, Ulrik Sanders, Mikkel Krogsgaard, Wade Barnes, Sanjaya Mohottala, Anders Madsen, and Dustin Burke. customers-willingness-to-pay-to-decarbonize-shipping [EB/OL]. (2022-12-13) [2023-2-19]. <https://www.bcg.com/zh-cn/publications>
- [8] Stopford M. Maritime economics (3rd edition) [M]. USA: Routledge, 2009.
- [9] Varnavides L, Karakitsos E. Maritime economics: amacroeconomic approach [M]. UK: Palgrave.
- [10] Wang Jiaying, Kou Ying, Zhao Yifei. A study of the cyclicity and smoothness of shipping system tariff fluctuations [J]. Logistics Technology, 2017, 36 (09): 62 - 67+104.
- [11] Kuo H M, Chen T L, Yang C S. The effects of institutional pressures on shipping digital transformation in Taiwan [J]. Maritime Business Review, 2022, 7 (2): 175 - 191.
- [12] Sullivan B P, Desai S, Sole J, et al. Maritime 4.0—opportunities in digitalization and advanced manufacturing for vessel development [J]. Procedia manufacturing, 2020, 42: 246 - 253.

- [13] Tijan E, Jović M, Aksentijević S, et al. Digital transformation in the maritime transport sector [J]. *Technological Forecasting and Social Change*, 2021, 170: 120879.
- [14] Lind M, Ward R, Bergmann M, et al. Maritime informatics for increased collaboration[M]//*Maritime informatics*. Cham: Springer International Publishing, 2020: 113 - 136.
- [15] Xu Lirong. The "three variables" driving global shipping in the post-epidemic era [J]. *China Water Transport*, 2021, No. 699 (08): 8 - 9. DOI: 10.13646/j.cnki.42 - 1395/u.2021.08.002.
- [16] Mitch Jacoby. The shipping industry looks for green fuels [EB/OL]. (2022-2-17) [2023-2-21]. <https://cen.acs.org/environment/greenhouse-gases/shipping-industry-looks-green-fuels/100/i8>.
- [17] Methanex Corporation. Methanol as a Marine Fuel | Methanex Corporation. (n.d.). [EB/OL]. (2023-2-8) [2023-2-21]. <https://www.methanex.com/about-methanol/methanol-marine-fuel#:~:text=Methanol%20is%20a%20safe%2C%20cost%20effective%2C%20globally%20available%20marine,the%20shipping%20industry%20meet%20increasingly%20strict%20emissions%20regulations>.
- [18] Greg Zimmerman. Green New Deal aims to reduce energy use and costs [EB/OL]. (2019-03-29) [2023-02-21]. <https://www.facilitiesnet.com/green/tip/Green-New-Deal-Aims-To-Reduce-Energy-Use-and-Costs--43578>.
- [19] A. P. Moller. Maersk and sungas renewables sign strategic green methanol partnership [EB/OL]. (2022-12-15) [2023-2.19] <https://www.maersk.com>.