



**Center for Advanced Multimodal Mobility  
Solutions and Education**

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**STUDYING THE IMPACT OF PANDEMIC OUTBREAKS ON MARITIME  
TRANSPORTATION AND PORT OPERATION**

**Final Report**

by

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## **EXECUTIVE SUMMARY**

Maritime transportation is the backbone of international trade and the global economy. According to the United Nations Conference on Trade and Development (UNCTAD), around 80% of global trade by volume and over 70% of global trade by value are transported by sea and commercial shipping. In December 2019, COVID-19 outbreak started and World Health Organization (WHO) upgraded the outbreak of COVID-19 to the status of a pandemic. The effects of the outbreak extended well beyond health and the threat to human lives since the novel coronavirus significantly impacted international trade. The COVID-19 pandemic was unraveling the economy nationally and globally as most of the world moved toward a lockdown that entails the closure of significant portions of both the service and manufacturing industries. International shipping was one of the majorly affected industries amidst this outbreak. The maritime transportation and industry was deeply affected as a result of the upheaval caused by the coronavirus and its impacts. Even countries with relatively few cases experienced a fall in container handling due to the interconnected nature of world trade. Due to the pandemic outbreak, ports saw many “blank sailings” - ships scheduled to arrive that never finished their journeys. Scheduled vessel calls in many ports were canceled by shipping lines. Ocean carriers worldwide scrubbed voyages due to dwindling demand by shippers for vessel space. Many ports saw sharp falls in activity.

This study investigates the impact of pandemic outbreaks on maritime transportation, especially on port operation. It is important to study how to mitigate the myriad of issues which arise in such events. Recommendations such as digitalization in the maritime industry, safe and effective maritime transportation communications by using modern information and communication technologies, operational adjustments in sanitary protocols and processes, finance, and working practices, and coordination and cooperation between regions and departments were proposed. The results may provide the authorities and stakeholders in ports and maritime transportation a better understanding of the vulnerability of the maritime domain to the future pandemic outbreaks and the external shocks to the system.



# Chapter 1. Introduction

## 1.1 Introduction

The outbreak of COVID-19 marks as an unanticipated epidemic all over the world, launched a huge impact on people's lives, families, and communities. So far, over 596 million people worldwide have been infected and over 6.4 million people died of the virus (WHO, Aug 25, 2022). The COVID-19 pandemic has unraveled the economies nationally and globally. During the pandemic, most of the world moved toward a lockdown entailing the closure of significant portions of both service and manufacturing industries.

Maritime transportation is the backbone of international trade and the global economy. According to the United Nations Conference on Trade and Development (UNCTAD), around 80% of global trade by volume and over 70% of global trade by value are transported by sea and commercial shipping. As a result, when disruptive factors such as pandemics occur, the sector works as a transmission channel that sends shockwaves across supply chains and regions. COVID-19 triggered a global health and economic crisis with wide-ranging implications for maritime transportation and trade. Restrictions introduced in response to the pandemic have caused disruptions affecting ports, shipping, and supply chains. Various industries faced challenges along their supply chain such as raw material shortages, lead time issues, ocean blank sailings, port closures, reduced working hours at ports, equipment and labor shortages, as well as truck/transportation capacity constraints. These obstacles undermine the smooth movement of trade flows and supply chain operations and can significantly erode the transportation services trade liberalization and trade facilitation gains achieved over the years. While the longer-term impact of the COVID-19 outbreak is yet to be fully understood, all indicators are pointing to significant immediate challenges for the sector. These differ depending on the maritime transportation segment (e.g., container, bulk, reefer, tanker) and whether the transportation operation is domestic or international. They also vary by region, level of development, and the state of prior preparedness to shocks and disruptions. Countries with a high share of forward and backward global value chain participation are more vulnerable to supply chain disruptions.

International shipping is one of the majorly affected industries amidst this outbreak. The maritime transportation and industry have been deeply affected as a result of the upheaval caused by the coronavirus and its impacts. COVID-19 caused almost 10% drop in worldwide maritime trade in 2020 (UNCTAD), with 350 million per week loss to the shipping industry (Trade Association International Chamber of Shipping, ICS). The port tracker report by NRF and Hackett Associates, which logs activity at major U.S. container ports, reveals that the port activities fell to the lowest level in five years after the pandemic broke out. Imports accounted for 1.61 million 20-foot-equivalent unit containers in April 2020, which was down 8% from the same time in 2019. Ports in California, as an example, have seen significant cargo volume decreases as COVID-19's impact on shipping. Ports of Los Angeles and Oakland loaded container volume decreased 29.8% and 12.7%, respectively, in May 2020 compared to the same month in 2019. Overall, the January-to-May cargo statistics show an 18.6% and 7.8% decrease, respectively, compared to the same time period in 2019. The economic effects of the pandemic

are expected to generate throughput and cargo declines along with financial stresses well in excess of what is expected under typical recessionary conditions (UNCTAD, 2021).

## **1.2 Objectives**

The COVID-19 pandemic has exposed the fragility of the global supply chains and showcased the vulnerability of maritime networks, port efficiency, and intermodal connectivity. There have been significant concerns regarding the current and long-term effects of the COVID-19 on international trade and the global economy. This research study investigates the impact of pandemic outbreaks on maritime transportation, especially on port operation. A series of recommendations are made to mitigate the negative impact of future pandemics, transnational risks, and multinational health crisis on maritime transportation, particularly on port operation.

## Chapter 2. Background

### 2.1 Introduction

For this research, a thorough review of the literature, guidelines, recommendations, and information related to COVID-19 pandemic and maritime transportation was conducted. Specific areas and sources were reviewed including international health regulations such as the ones set by the World Health Organization (WHO), guidelines and circulars issued by the International Maritime Organization (IMO) for seafarers, maritime workers and passengers to cope with the pandemic, guidelines provided by the Center for Disease Control and Prevention in the United States (CDC), and safety information provided to vessel owners and operators as precaution against the virus as well as procedures implemented by the United States Coast Guard (USCG) to conduct statutory and regulatory inspections on commercial vessels.

### 2.2 WHO Guidance

On March 25, 2020, the World Health Organization (WHO) published the *Interim Guidance entitled Operational Considerations for managing COVID-19 Cases and outbreak on Board* (WHO, 2020). This guidance was published timely in response to the global outbreak of the pandemic. The guidance was recommended to be used as WHO's handbook for management of public health events on board ships. As the pandemic moved to another stage, the interim guidance was set as "no longer authoritative" to cope with the complicated situation of pandemic. The target audience for this guidance was any authority involved in the public health response to a COVID-19 public health event on board a ship, including International Health Regulations (IHR) National Focal Points (NFPs), port health authorities, and local, provincial, and national health surveillance and response systems, as well as marine port and ship operators.

In the guidance, a management plan for outbreaks of COVID-19 was advised for passenger ships sailing on international voyages. Pre-boarding information of passengers and crew members were needed to be prepared in accordance with WHO's advice for international traffic. For the pre-disembarkation information collection, all passengers and crew members were recommended to complete their Passenger Locator Form (PLF), and the form were recommended to be kept on board for at least one month after the disembarkation. To ensure proper management by port health authorities, passenger ships on international voyages were advised to implement pre-boarding screenings, through questionnaires, to defer or reschedule the boarding of any traveler who had been identified as being a contact of someone with COVID-19.

On August 25, 2020, the World Health Organization published the interim guidance entitled *Promoting Public Health Measures in Response to COVID-19 on Cargo Ships and Fishing Vessels* to provide necessary instructions and advice for shipowners, seafarers, unions and associations and competent authorities. This guidance was going to prevent new COVID-19 cases that might occur among this population. In the beginning of the pandemic, no medical doctors were generally on board of vessels, and medical supplies and equipment were not

available at the same level. Specific plans for virus prevention and care were not in place and generic guidance for respiratory diseases were not sufficient for managing COVID-19. Meanwhile, seafarers might not have access to personal protective measures or equipment or might not be trained to use them. Seafarers were required to clean and disinfect on-board facilities, but protocols and guidance for environmental measures were not available for COVID-19. There was no uniform guidance for the prevention of COVID-19 around the world; and public health policies, such as the requirements for preventing transmission of the virus, varied on ships and ports of call around the world. Shipowners were encouraged to develop written contingency plans to cover surveillance and report cases, manage cases, cleaning and disinfection, communication, and training.

WHO set the prevention measures into three stages: pre-boarding, onboard, and leaving the ship. In the pre-boarding stage, everyone were suggested to have a pre-board screening. If any symptoms were identified, then the person should not travel and instead seek medical care. This surveillance could be conducted through self- reporting, visual observation and/or temperature measurement with non-touch thermometers. When on board the ship, risk analyses were suggested to be conducted first to determine which type of personal protective equipment should be used. Protective measures, including general measures, hand hygiene and respiratory etiquette, physical distancing, and use of masks were stipulated in the guidance. Environmental measures were taken into the account with minimum possible contamination through the environment. WHO also gave advice on how to manage suspected COVID-19 cases and their contacts, information about how to access to medical facilities, and instructions on ship owners obligations and responsibilities. During the leaving the ship phase, WHO also provided guidance on the public health measures for shoreside visits, and public health measures throughout the journey. Furthermore, communications, digital tools and mobile applications, crew member training, mental health and psychosocial support were also addressed in the publication.

WHO also published the *Rational Use of Personal Protective Equipment for COVID-19*. This document summarizes WHO's recommendations for appropriate use of personal protective equipment (PPE) in health care / community settings, including handling cargo.

## **2.3 IMO Guidelines and Circulars**

On March 22, 2022, International Marine Organization (IMO) issued the circular letter No.4204/Add.35/Rev.11 to all IMO member states, United Nations and specialized agencies, intergovernmental organizations, and non-governmental organizations in consultative status with IMO with the subject of "Coronavirus (COVID-19) – Designation of seafarers as key workers". The circular letter made provisions in three resolutions: Resolution 1, Resolution 2, and Resolution3.

Resolution 1 includes actions recommended to facilitate ship crew change, access to medical care and seafarer travel during the COVID-19 pandemic. This resolution was adopted by the Maritime Safety Committee (MSC) on September 21, 2020. Resolution 2 is an international cooperation to address challenges faced by seafarers as a result of the COVID-19 pandemic to support global supply chains. This resolution was adopted by the United Nation General Assembly on December 1, 2020. Resolution 3 is about maritime labor issues and the COVID-19

pandemic, which was adopted by the Governing Body of the International Labor Office on December 8, 2020.

## 2.4 CDC Guidance

In 2020, the Center for Disease Control and Prevention in the United State (CDC) issued the *Interim Guidance for Ships on Managing Suspected or Confirmed Cases of Coronavirus Disease 2019* (CDC, 2020). This guidance was designed for ships originated from or destined for the United States to help prevent, detect, report, and medically manage suspected or confirmed COVID-19 cases. The guidance was to prevent the spread of COVID-19 during and after a voyage, and it includes personal protective measures, management of sick or exposed persons on board, reporting suspected or confirmed cases, and cleaning and disinfection recommendations for common areas on the ship and areas previously occupied by individuals with suspected or confirmed COVID-19. CDC issued plans to mitigate COVID-19 on board ships, such as training all crew on COVID-19 prevention and mitigation; on-board monitoring of crew and non-crew for signs and symptoms of COVID-19; onboard or onshore COVID-19 testing; on-board isolation, quarantine, and physical distancing; etc. The guidance also stipulated detailed preventive measures for ship operators and persons on board the ships.

## 2.5 Coast Guard MSIB

Marine safety is one of the missions, and in fact the largest mission, performed by the United States Coast Guard. The Coast Guard publishes Marine Safety Information Bulletins (MSIB) to warn mariners of different potential and increased risks exposed to maritime domain. With respect to COVID-19, the Coast Guard has published a series of MSIBs since 2020. Table 2 lists the Coast Guard MSIB publications on COVID-19.

**Table 1. Coast Guard MSIB Publication about COVID-19**

| <b>Number</b>                   | <b>Subject</b>  | <b>Date</b> |
|---------------------------------|---|-------------|
| <u>14/20</u>                    | COVID-19: Ballast Water Management (BWM) Extensions   | 04/09/2020  |
| <u>13/20</u><br><u>Change 3</u> | COVID 19 - Transportation Worker Identification Credential (TWIC®) Operations, Change 3         | 04/21/2020  |
| <u>12/20</u>                    | COVID-19 - Vessel and Facility Response Plans   | 04/02/2020  |
| <u>10/20</u>                    | COVID-19 - Guidance for Maritime Operators on Compliance with Federal Drug Testing Requirements | 03/27/2020  |
| <u>09/20</u>                    | COVID-19 - Vessel Inspections, Exams, and Documentation   | 03/26/2020  |
| <u>08/20</u><br><u>Change 5</u> | COVID-19 - Mariner Credentials, Change 5  | 12/22/2020  |
| <u>07/20</u><br><u>Change 2</u> | COVID-19 - Port and Facility Operations, Change 2   | 05/07/2020  |
| <u>06/20</u>                    | COVID-19 - Vessel Reporting Requirements for Illness or Death                                   | 03/13/2020  |
| <u>02/20</u><br><u>Change 7</u> | COVID-19, Change 7  | 05/07/2021  |

| Number        | Subject   | Date       |
|---------------|---|------------|
| 07/21         | COVID-19: Spotlight on the Mental Health of Mariners                            | 05/20/2021 |
| 04/21         | COVID-19 Crew Change Issues   | 03/17/2021 |
| 02/21,<br>CH5 | COVID-19 Safety Requirements in the Maritime Transportation System:<br>Change-5 | 04/19/2022 |

## 2.6 UNCTAD Publication

In 2020, when the COVID-19 pandemic broke out, various maritime stakeholders faced challenges such as lead time issues, ocean black sailings, port closures, reduced working hours at ports, equipment and labor shortage, and transportation capacity constraints. At that time, the long-term impact of the COVID-19 was not yet fully understood. United Nations Conference on Trade and Development (UNCTAD) published its first report in coping with COVID-19. The report mainly analyzed the impacts of the COVID-19 on the maritime supply chain and challenges faced. It also reviewed the challenged faced by relevant stakeholders and proposed response measures. In 2021, UNCTAD carried out its second assessment on COVID-19 disruption and impacts on maritime supply chain and trade. The assessment focused on the impacts of the COVID-19 on the maritime trade flows, ship calls, and liner shipping connectivity in the first half of 2020.

Based on the industry stakeholders' opinions, the UNCTAD regional webinars on *COVID-19 and Maritime Transport* held in 2020 and 2021, and the feedback received by a global UNCTAD survey questionnaire, UNCTAD published another report titled *COVID-19 and Maritime: Transport Navigating the Crisis and Lessons Learned*. The report provided a global view of how the COVID-19 pandemic and related restrictions affected shipping across different segments. Challenges arising from the disruption across ports and hinterland connections were highlighted and response and mitigation measures implemented by various stakeholders were presented in the report.



# Chapter 3. Impacts of COVID-19 on Maritime Transportation

## 3.1 Introduction

The trade contraction caused by COVID-19 is deeper than the one observed during the financial crisis of 2008- 2009. This chapter of the report summarizes the brief impact of COVID-19 to maritime transportation through the study of global trade changes, impact on ocean freight rate, blank sailings, and demurrage and detention.

## 3.2 Global Trade

The COVID-19 pandemic outbreak had a significant impact on the global trade. The year 2020 was marked by some of the largest reductions in trade and output volumes since World War II. The declines in both world industrial production and goods trade in the first half of 2020 were of similar depth to those at the trough of the Global Financial Crisis (GFC). Nevertheless, they materialized and disappeared more quickly, facilitating a V-shaped recovery in 2020. Trade continued to grow strongly in 2021 and has compensated some, but not all of the accumulated losses from the steep declines seen earlier. The volume of global trade has recovered to the pre-pandemic level at an extraordinarily fast pace from around mid-2020.

According to Figure 1, the value of global trade reached a record level of about US\$ 28.5 trillion in 2021, an increase of about 25 per cent relative to 2020 and an increase of about 13 per cent relative to the pre-pandemic level of 2019. Trade growth was not only limited to goods. Trade in services also grew substantially through 2021, to finally reach pre-pandemic levels during the fourth quarter of 2021.

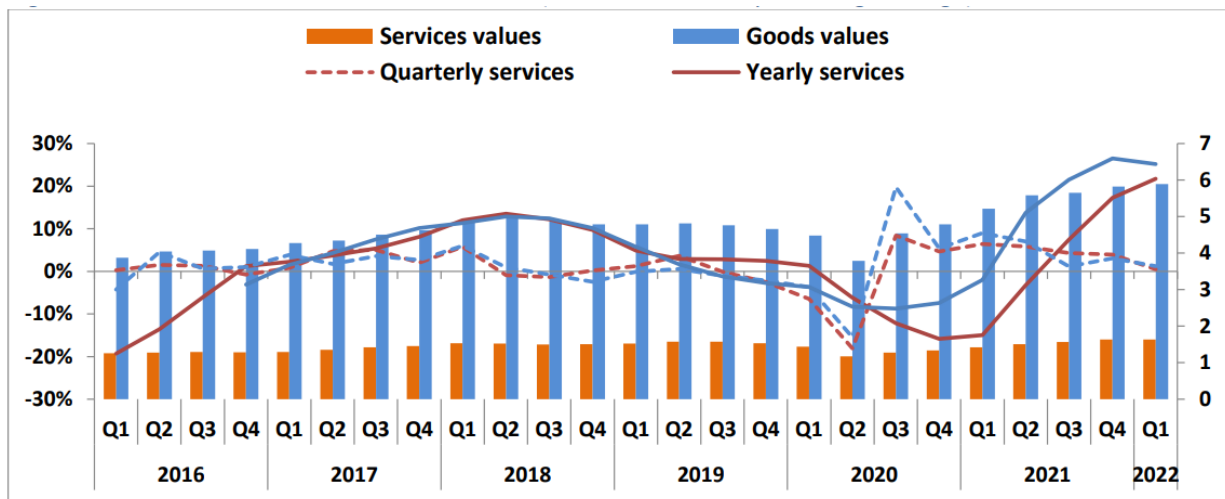
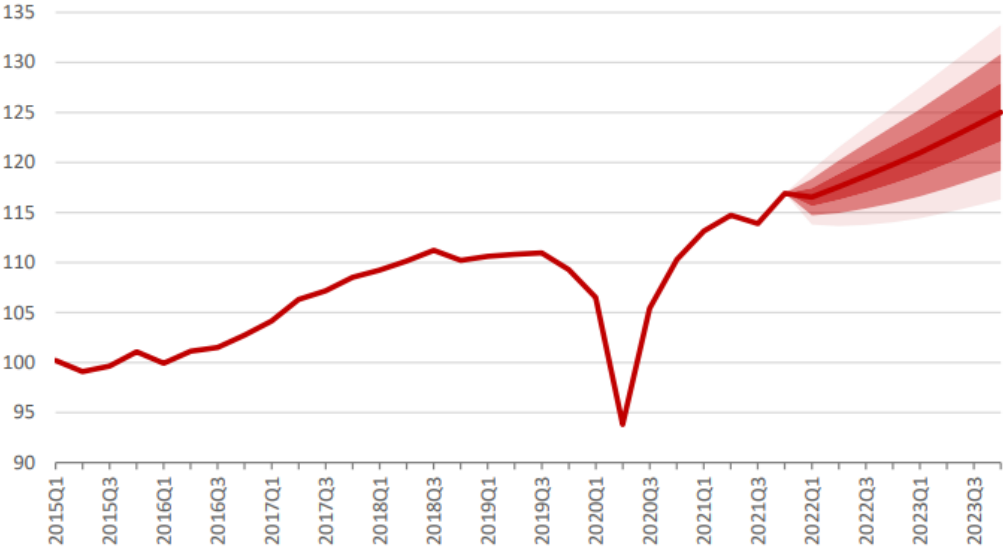


Figure 1. Global Trade 2016-2021 (Adopted from UNCTAD, 2022)

Trade in goods and trade in services followed similar patterns during 2021, with stronger increases during the first half of the year. Trade growth continued to be positive for both goods and services in the third quarter and particularly in the fourth quarter of 2021. During the fourth quarter of 2021, trade in goods increased by almost US\$ 200 billion to reach about US\$ 5.8 trillion, which hit a new record. During the same period, trade in services rose by about US\$ 50 billion to reach about US\$ 1.6 trillion, a value just above pre-pandemic levels. The positive trend for international trade in 2021 was largely the result of increases in commodity prices, subsiding pandemic restrictions and a strong recovery in demand due to economic stimulus packages.

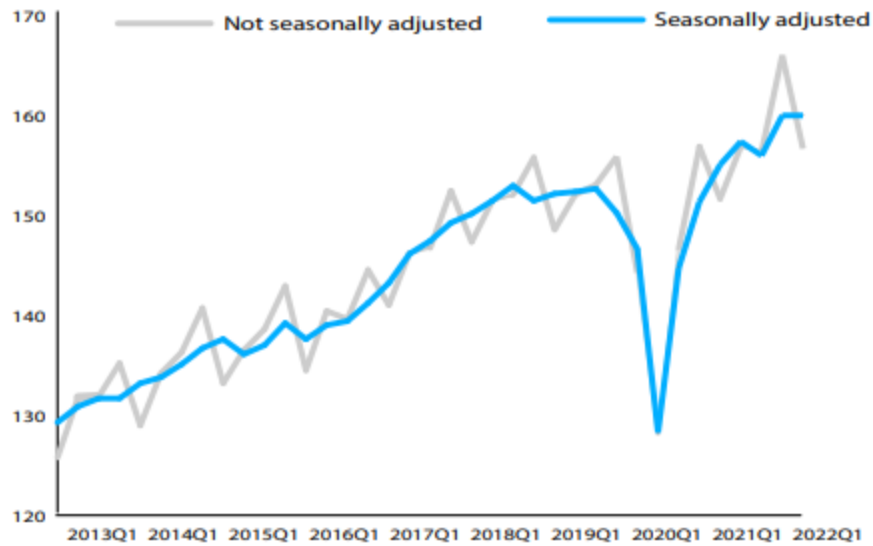
Figure 2 shows quarterly world merchandise trade volume estimates through the end of 2023, including error bands indicating confidence intervals associated with the forecast. Given current GDP assumptions, merchandise trade volume growth in 2022 could be as low as 0.5% or as high as 5.5%. These projections will be updated in October 2022, but an earlier revision could be issued if incoming data warrant it. The forecast takes into account higher frequency data for selected economies, including monthly statistics on container throughput of U.S. and Chinese ports in order to capture port congestion in these countries.



**Figure 2. Volume of World Merchandise Trade (Adopted from WTO and UNCTAD)**

According to the WTO-UNCTAD statistics, world merchandise trade volume1 growth was flat in the first quarter of 2022 over the previous quarter, in seasonally adjusted terms.

### Indices, 2005=100



**Figure 3. Merchandise Trade Volume (Adopted from WTO-UNCTAD)**

Figure 4 illustrates the Quarter-on-quarter growth in percentage, seasonally adjusted world trade volume.










|                         | Exports |        |        |        | Imports |        |        |        |
|-------------------------|---------|--------|--------|--------|---------|--------|--------|--------|
|                         | 2021Q2  | 2021Q3 | 2021Q4 | 2022Q1 | 2021Q2  | 2021Q3 | 2021Q4 | 2022Q1 |
| <b>World</b>            | 0.8     | -1.0   | 2.6    | -0.6   | 2.1     | -0.7   | 2.6    | 0.6    |
| North America           | 0.3     | -1.9   | 4.4    | -1.5   | 1.0     | 0.2    | 3.5    | 3.9    |
| South & Central America | 4.7     | -2.0   | -0.6   | -0.1   | 6.2     | 0.5    | 3.4    | -0.2   |
| Europe                  | 1.7     | -0.6   | 2.7    | -1.0   | 2.9     | -0.4   | 4.2    | 1.5    |
| Asia                    | -0.9    | -0.9   | 3.1    | 2.2    | 1.3     | -1.5   | 1.0    | 0.1    |
| Other <sup>1</sup>      | 3.5     | -0.9   | -1.4   | -7.8   | 1.9     | -1.5   | -0.3   | -8.4   |

Color Key

1. Includes the Caribbean










**Figure 4. Quarter-on-Quarter Growth of Regions (Adopted from WTO-UNCTAD)**

World merchandise exports decreased by 0.6% in the first quarter of 2022. At the same time, other regions saw the largest decrease (-7.8%). Asia was the only region which had positive growth of exports (2.2%) in the first quarter 2022. On the import side, world merchandise imports increased by 0.6% in the first quarter of 2022.

| SERVICES   | Q3 2021 RELATIVE TO 2019 AVERAGE |         | Q3 2021 RELATIVE TO Q2 2021 |         |
|--|----------------------------------|---------|-----------------------------|---------|
|  | IMPORTS                          | EXPORTS | IMPORTS                     | EXPORTS |
|  Brazil             | ↓ 26%                            | ↑ 1%    | ↑ 2%                        | ↑ 3%    |
|  China              | ↓ 10%                            | ↑ 46%   | ↑ 6%                        | ↑ 14%   |
|  India              | ↑ 3%                             | ↑ 7%    | ↑ 18%                       | ↑ 17%   |
|  Japan              | ↓ 6%                             | ↓ 19%   | ↓ 4%                        | 0%      |
|  Republic of Korea  | ↓ 5%                             | ↑ 24%   | 0%                          | ↑ 12%   |
|  Russian Federation | ↓ 21%                            | ↓ 10%   | ↑ 13%                       | ↑ 6%    |
|  South Africa       | ↓ 12%                            | ↓ 30%   | ↑ 5%                        | ↑ 8%    |
|  United States      | ↓ 8%                             | ↓ 11%   | ↑ 5%                        | ↑ 3%    |
|  European Union     | ↓ 4%                             | ↓ 1%    | ↑ 4%                        | ↑ 2%    |

*Source:* UNCTAD calculations based on national statistics.  
*Note:* Growth rates are relative to year averages for 2019 and of previous quarter. Data is seasonally adjusted. Statistics for the EU exclude intra-EU trade.

| GOODS  | Q4 2021 RELATIVE TO 2019 AVERAGE |         | Q4 2021 RELATIVE TO Q3 2021 |         |
|--|----------------------------------|---------|-----------------------------|---------|
|  | IMPORTS                          | EXPORTS | IMPORTS                     | EXPORTS |
|  Brazil              | ↑ 33%                            | ↑ 23%   | ↑ 11%                       | ↓ 7%    |
|  China              | ↑ 32%                            | ↑ 43%   | ↑ 2%                        | ↑ 6%    |
|  India              | ↑ 32%                            | ↑ 25%   | ↑ 4%                        | ↓ 1%    |
|  Japan              | ↑ 13%                            | ↑ 6%    | ↑ 2%                        | ↓ 2%    |
|  Republic of Korea  | ↑ 34%                            | ↑ 26%   | ↑ 6%                        | ↑ 3%    |
|  Russian Federation | ↑ 24%                            | ↑ 33%   | ↑ 2%                        | ↑ 3%    |
|  South Africa       | ↑ 9%                             | ↑ 35%   | 0%                          | ↓ 2%    |
|  United States      | ↑ 20%                            | ↑ 12%   | ↑ 5%                        | ↑ 4%    |
|  European Union     | ↑ 27%                            | ↑ 10%   | ↑ 9%                        | ↑ 1%    |

**Figure 5. Imports and Exports of Major Trading Economies**

In the fourth quarter of 2021, trade in goods increased more strongly for developing countries compared to the developed countries. In the fourth quarter of 2021, developing countries exported about 30 percent higher compared to the fourth quarter of 2020. In comparison, this increase was about 15 percent for the developed countries. Moreover, trade growth between developing countries (South to South) outpaced the global trade during the fourth quarter of 2021, with an increase of about 32 percent compared to the fourth quarter of 2020 (and with an increase of about 38 percent when excluding East Asian economies). Similar patterns are found when comparing the fourth quarter of 2021 with the pre-pandemic levels.

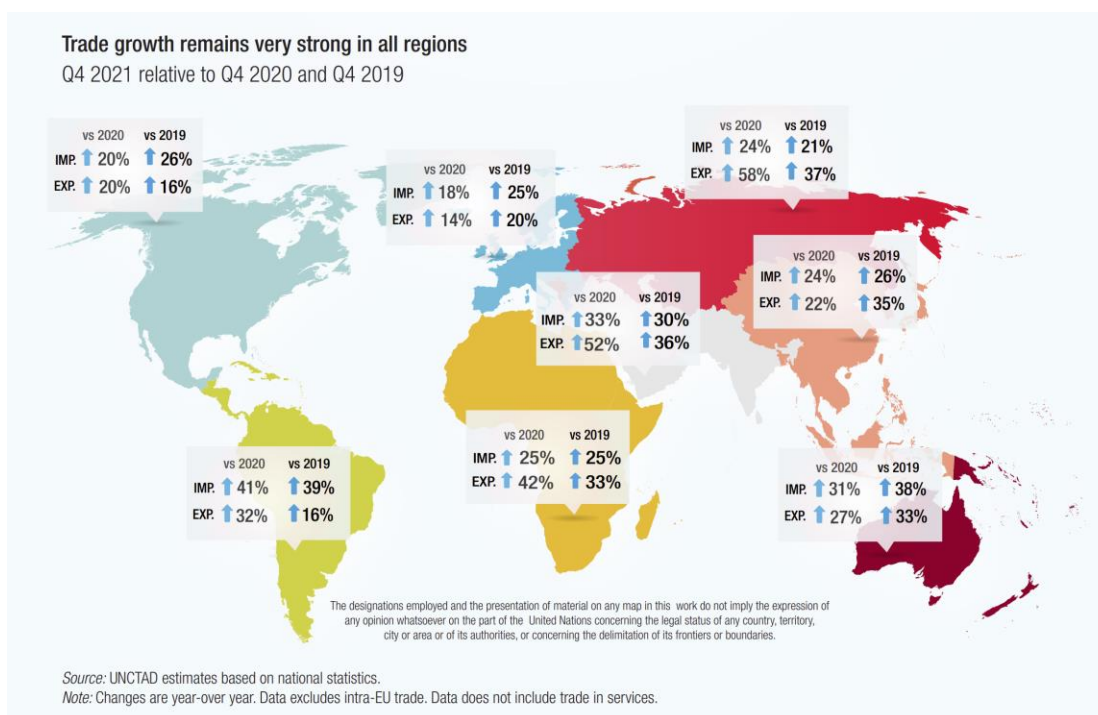
Figure 6 also illustrates that the trade growth in developing countries was stronger in the fourth quarter of 2021 compared to each of the 2020 and 2019 fourth quarters.

|  | vs 2020 |        | vs 2019 |        |
|--|---------|--------|---------|--------|
|  | IMPORT  | EXPORT | IMPORT  | EXPORT |
| Developed countries                        | ↑ 19%   | ↑ 15%  | ↑ 25%   | ↑ 19%  |
| Developing countries                       | ↑ 26%   | ↑ 30%  | ↑ 28%   | ↑ 35%  |
| South-South Trade                          | ↑ 32%   |        | ↑ 33%   |        |
| Developing countries (excluding East Asia) | ↑ 31%   | ↑ 41%  | ↑ 29%   | ↑ 29%  |
| South-South trade (excluding East Asia)    | ↑ 38%   |        | ↑ 38%   |        |

*Source:* UNCTAD estimates based on national statistics.  
*Note:* Changes are year-over year. Data excludes intra-EU trade. Data does not include trade in services.

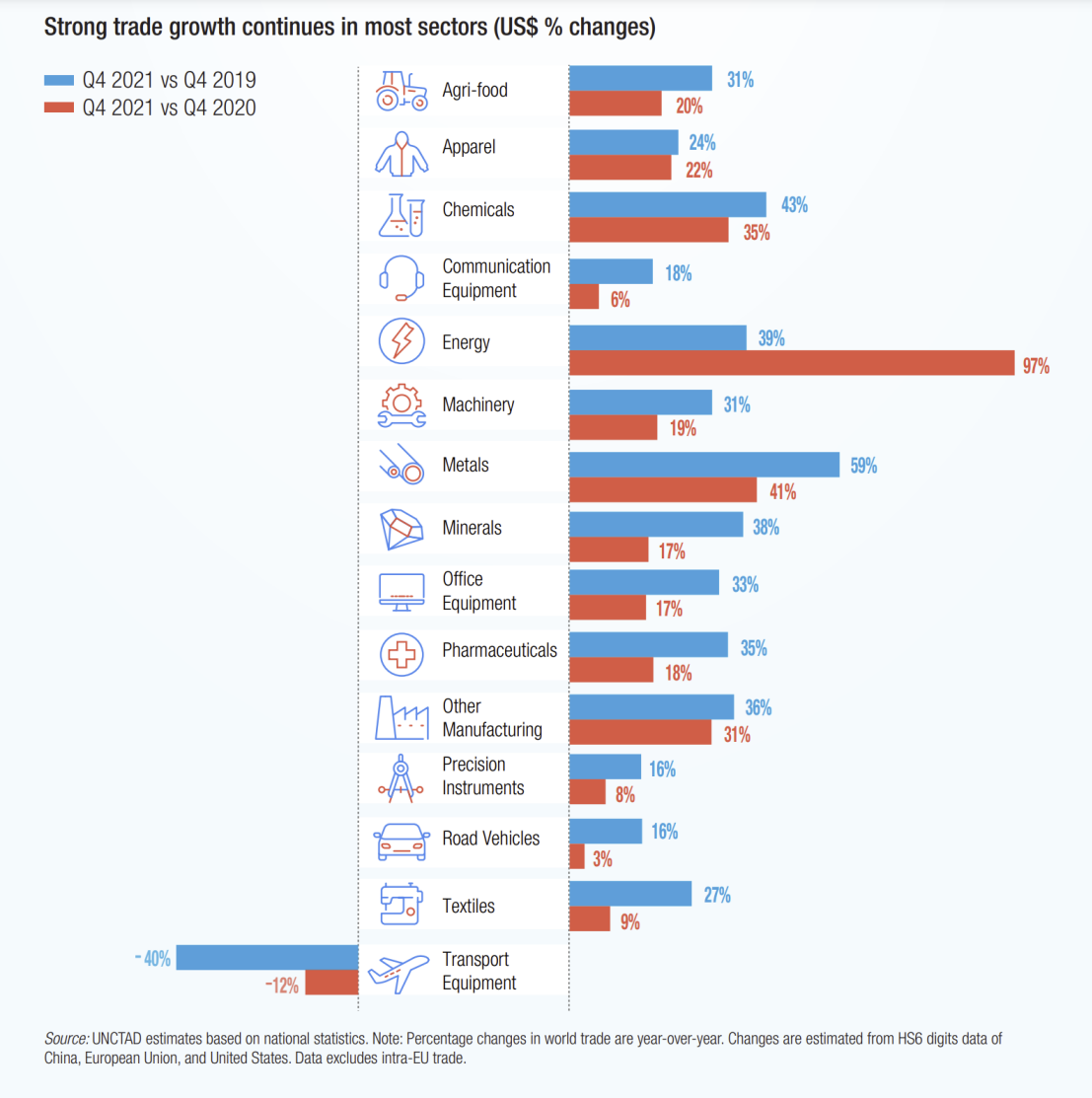
**Figure 6. Imports and Exports of Developed and Developing Countries**  
 (Adopted from [https://unctad.org/system/files/official-document/ditcinf2021d4\\_en.pdf](https://unctad.org/system/files/official-document/ditcinf2021d4_en.pdf))

Trade growth rates in the fourth quarter of 2021 remained very strong across all geographic regions, although lower in Europe, North America and East Asia. Export growth has been generally stronger in commodity-exporting regions, as commodity prices have increased. Trade growth remains very strong in all regions in the fourth quarter of 2021 compared to each of the 2019 and 2020 fourth quarters.



**Figure 7. Imports and Exports by Regions**  
 (Adopted from Source: [https://unctad.org/system/files/official-document/ditcinf2021d4\\_en.pdf](https://unctad.org/system/files/official-document/ditcinf2021d4_en.pdf))

With the exception for transportation equipment, all economic sectors saw a substantial year-over-year increase in the value of their trade in the fourth quarter of 2021. High fuel prices are behind the strong increase in the value of trade of the energy sector. Trade growth was also above average for metals and chemicals. As a result of the global shortage of semiconductors, trade growth in communication equipment, road vehicles and precision instruments were subdued during the fourth quarter 2021.

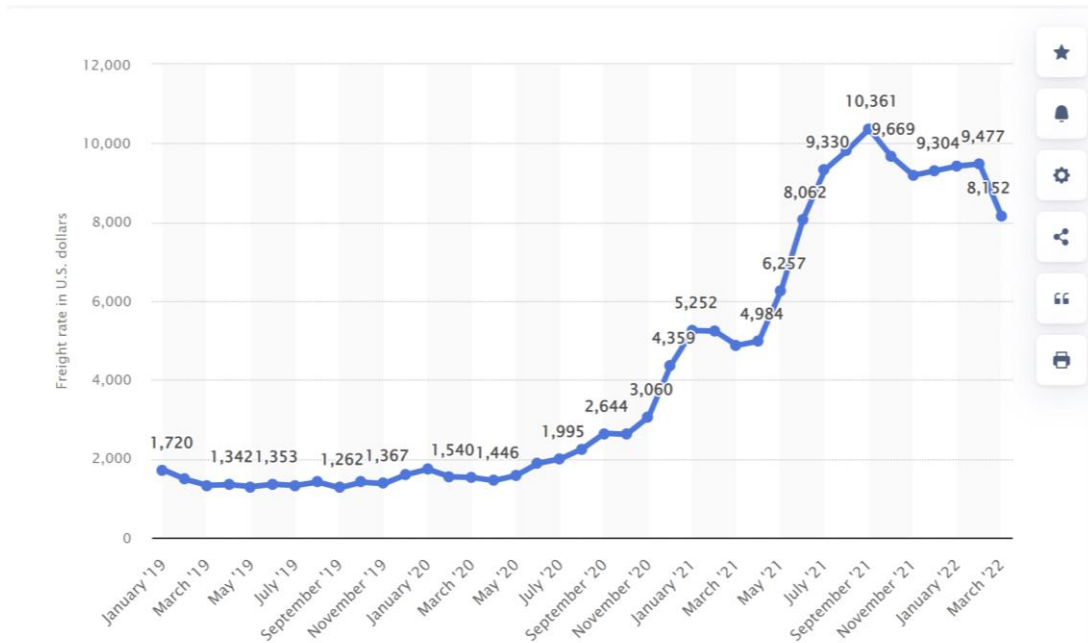


**Figure 8. Imports and Exports by Sectors**

### 3.3 Ocean Freight Rate

The COVID-19 pandemic outbreak had a major impact on the ocean freight rate, and the rates has changed significantly since the beginning of the pandemic. Figure 9 shows the global container freight rate index from January 2019 to March 2022 (in U.S. dollars). Prices for

container transportation have surged, from 1,500 dollars to over 10,000 (for 40' container) bogs down recovery.



**Figure 9. Container Freight Rate Index Worldwide 2019-2022**

Container freight rates increased dramatically between January 2019 and March 2022. The year 2021 saw an especially steep increase in global freight rates, reaching a record price of nearly 10,400 U.S. dollars in September 2021. In March 2022, the global freight rate index stood at about 8,200 U.S. dollars (Placek, 2022). The index represents a market rate for freight for any given shipping lane for a 40' container.

### 3.4 Blank Sailings

Marine ports and terminals were among the main components of the maritime industry that have been experiencing severe disruption since the beginning of the pandemic. As these facilities are keys to the global shipping industry, which handles over 80% of all internationally traded goods, congestion and delays there have wide ripple effects.

A blank sailing refers to a sailing that has been canceled by the carrier. A blank sailing could mean a vessel is skipping one port, or that the entire string is canceled. Blank sailings happen when demand for space on vessels is low, so that carriers canceled some sailings. As a result, the vessels can be full during the rest of the sailings and its rates can stay up. By this operation, shipping company could reduce operational supply and achieve better capacity utilization, and thus rationalize terminal networks and increase the bargaining power of carriers regarding terminals.

Most blank sailings do not cause major disruptions. During holiday periods, for example, cargo demand is lower than usual, and hence services can be rescheduled or cancelled with only limited cargo rolling. For example, during the Chinese New Year, offices and manufacturing plants shut down across China. Migrant workers in the coastal regions return to their rural homes, leaving logistic centers understaffed and contributing to a reduction in transportation service capacity. This causes global trade volumes to diminish, and ship operators respond by issuing blank sailings. These kinds of disruptions are foreseeable.

Since the outbreak of the COVID-19, shipping companies across all major alliances have announced a large number of blank sailings. Empty and near-empty sailings due to lack of demand caused ocean carriers to pull vessels out of rotation to avoid substantial operational losses. In February and March 2020 alone, nearly 350 sailings were cancelled globally. Data show that carriers blanked 990 sailings globally throughout the first half of 2020. In fact, blank sailings were widely considered as a way of managing capacity during the COVID-19 crisis.

Blank sailing affected delivery time for goods and created issues in receiving important containerized supplies in ports, and even created difficulty for many shippers to return containers on time. The latter has resulted in unfair coronavirus-related detention fees. Some of the early blank sailings were due to port or terminal shutdowns due to the fear of spreading the novel coronavirus. However, most blank sailings have been about greatly reducing capacity to keep freight rates up during the significant drop in demand. For example, Maersk's first quarter profit, as well as the fact that freight rates have been higher in 2020 as compared to the same period in 2019, shows the blank sailing strategy has been effective.

### **3.5 Demurrage and Detention**

Demurrage charges are raised when the full container is not moved out of the port/terminal for unpacking within the allowed free days offered by the shipping line. The charge is levied by the shipping line to the importer. If the importer has picked up the container for unpacking, but the empty container has not returned to the nominated depot within the agreed free-time, detention charges occur.

During COVID-19 outbreak, there has been a strong continuation of blanking sailings, which leads to a more complicated equipment logistic puzzle at global origin or destination locations. Some retailers and manufacturers failed to pick their cargo up at marine terminals and abandon their cargo in those locations. Ocean carriers and marine terminal operators thus charged demurrage and detention fees; and these charges accumulated to considerable amounts in a relatively short time. Maersk, the world's largest container ship and supply vessel operator, developed a variety of solutions to minimize substantial demurrage and detention costs. Contingency solutions of the current storage and forward storage were also considered and offered for the same purpose.

As COVID-19 affected normal maritime movements, the Federal Maritime Commission (FMC) announced its adoption of a final interpretive rule to provide the maritime community guidance on the "reasonableness" of detention and demurrage charges in May 2020. The new interpretive rule addresses shipper complaints of excessive and unwarranted charges by



stipulating that charges may well be found unreasonable unless they further the prompt movement of cargo (“freight fluidity”), thus the burden of delay that is beyond the control of either party are shifted away from the shipper towards the carrier.

Meanwhile, a European association for forwarding, transport, logistic and Customs Services (CLECAT), called for fair and equal demurrage and detention charging during the COVID-19 pandemic. In April 2020, CLECAT issued a paper that provided recommendations for a more transparent process regarding the determination of detention and demurrage practices in container shipping. All the measures are implemented to ensure that freight keeps moving and containers reach their destination.

## **Chapter 4. Recommendations**

### **4.1 Introduction**

Based on the findings from the literature review, a survey questionnaire was developed to collect the information on “the measures used to mitigate port congestion and delays due to the pandemic”, “digitalization application in maritime domain during pandemic”, “new collaboration and coordination among maritime stakeholders since the pandemic”, and “multi-dimensional adjustments to mitigate the COVID-19 impacts”. The survey questionnaire is in Appendix of the report. This chapter of the report includes recommendations proposed based on the literature review and also the results of the survey. The recommendations were made in the areas of digitalization, communications, operation, and coordination. The recommendations are going to help mitigate the negative impacts of future pandemics, transnational risks, and multinational health crisis on maritime transportation, particularly on port operation.

### **4.2 Digitalization**

Digitalization refers to the implementation of digital technologies or process automation to enhance business productivity and sustainability. Digitalization in the maritime transportation sector refers to the implementation of a variety of technologies, which may provide enhanced productivity, efficiency, sustainability, as well as transparency (Agati's & Kolanovi's, 2020; Helig et al., 2017; Zerbino et al., 2018). Digitalization escalates information-sharing with fewer manual interactions and enables quicker responses and frequent adjustments to changing conditions. Digitalization could increase competitiveness and enhance the operational efficiency of maritime transportation. It provides a competitive advantage by connecting all the stakeholders involved in the value chain (Feibert et al., 2017). Furthermore, it could be implemented to spur maritime transportation to decarbonization in order to realize zero emission. Digitalization could also be implemented to secure efficient and sustainable operation; and strengthen short-term and long-term competitiveness. Embracing digitalization in maritime industry will lead to better economics, safety and greener sea transportation (Bhalodi, 2019).

Before the pandemic, only a small number of industry players in the maritime transportation sector realized that digitalization could change their business significantly. A survey from shipping companies showed the level of importance of digitalization for the maritime transportation (Quitau et al., 2018). The results revealed that 15% of participants considered it a radical industry change to be unavoidable, while 69% felt that it would make significant changes but no revolution in the industry. The rest of participants (16%) considered the topic to be overrated (Quitau et al., 2018). The PwC Norway survey which included 28 decision-makers active in ocean shipping found that digitalization was set to play a key role in shipping. The maritime industry is now anticipating extensive digitalization processes with a great degree of certainty (PwC Norway, 2017).

The COVID-19 pandemic forced the global community to seek and quickly implement meetings and transactions that would otherwise require physical presence (Piñeiro et al., 2021). The pandemic also accelerated the process of digitalization in the maritime industry. Since the

pandemic, ships, seaports, and offshore facilities have become increasingly dependent on information and communication technologies (Heering, 2020). For other sectors, paper-based processes were replaced by technologies that could optimize resources, share information, and enable remote working and conclusion of processes.

The move from a physical to a virtual business environment brought on through cross-border ship-shore electronic exchange of information, electronic bills of lading, and the general expansion of the distributed ledger technology (World Economic Forum, 2019-2020). While information and communication systems and technologies have been used as a way to increase the efficiency of operations (UNCTAD), the COVID-19 pandemic has also made apparent that digitization and automation are no longer mere luxuries but rather necessities and the most viable options to keep maritime operations going (Piñeiro et al., 2021).

Digitalization allows carriers to issue authorizations and extensions for ships, conclude employment agreements involving seafarers, issue and validate certificates, and grant authorizations to implement remote inspections. Carriers could register vehicles and enter to remove the load and import cargo through digital systems, which avoids the presenting of printed documents. Meanwhile, with digitalization, all import and export services, booking processes, invoicing, and obtaining shifts for the withdrawal or delivery of empty containers could be billed online.

Digitalization is also proved useful for improved planning of tug and pilotage services in a way that helped increase the reliability of vessel departure or arrival times. In some cases, accelerated digitalization included setting up online platforms for key stakeholders to meet and discuss issues related not only to port operations but also to corridor transportation and trade facilitation (i.e. real-time updates on what was happening at each transit or transportation node along the corridor, sharing experiences and exchanging views about challenges and opportunities arising with the pandemic) (Northern Corridor and the East African Community, 2020).

It is important to mention that digitization not only provides opportunities, but also it brings risks and threats (such as cyberattacks) to the system. The maritime industry is particularly vulnerable, and any attack to the system will have obvious implications on global trade. The close interconnection between ships, ports, cargo owners, and dozens of other stakeholders in the maritime industry also calls for prompt assessment of cyber risks and development of rapid and concrete solutions to cope with the challenges posed by the accelerated shift to digitized systems due to the COVID-19 pandemic.

### **4.3 Effective Communications**

COVID-19 calls for the safety and efficiency of maritime transportation communications. Modern information and communication technologies are proven to be extremely necessary in collecting, storing, processing, presenting, and distributing relevant data and information to the participants in maritime domain. To avoid the spread of virus, personal contact is not suggested during the pandemic, the overall port operation services are enhanced to move to a paperless environment and providing a valuable and relevant solution that completely restructures the manual process of documents exchange among port community members. For example, some ports reduced the vessel and cargo turnaround time to make available the necessary real-time

data for yard operations and perform all statistical and data analysis for decision makers, thus the port management processes could be optimized.

According to the Interim guidance *An Implementation Guide for the Management of COVID-19 on Board Cargo Ships and Fishing Vessels* issued by WHO on December 23, 2021, communication must be enabled between the ship or fishing vessels and the competent authorities at port, the flag state and the shipowner (e.g. direct from the master or skipper to the doctor via telephone, video conference or through the maritime telemedical assistance service). Then, procedures must be in place to collect information and contact details from all persons who are boarding the ship to facilitate communication with them if needed during the 14 days after they disembark. WHO also suggests communication protocols be established for shoreside operations to advise officers if any shore personnel develop any signs or symptoms within 14 days of having boarded.

Effective and timely communication plans and practices are vital. In the *COVID-19 and Maritime Transport: Navigating and Crisis and Lessons Learned* published by UNCTAD, timely communication of the adopted measures was suggested to be maintained in operation. Constant access to clear, accurate and correct information keeps stakeholders and the local community informed and aware of measures. This is a multilayer effort that also includes reinforced communication with the community in partnership with public authorities.

#### **4.4 Operational Adjustment**

Working and operational adjustment measures that can help the maritime industry adapt to the changes of COVID-19 are transformational for maritime stakeholders. Meanwhile, digitalization of processes and the use of technology have triggered the need to revisit operations and upgrade knowledge and skills. In addition to the advancement of digitalization and communication strategies, port authorities have strived to mitigate the risks and challenges generated by the COVID-19 crisis by a substantial reorganization of operations after the pandemic broke out. These adjustments include operational adjustments, prioritization of essential services, reorganization of sanitary protocols and processes, financial adjustment, and adjustments to working practices and organizational aspects. As a result, many ports managed to avoid significant disruptions to cargo operations. This was facilitated by the reduced number of vessel port calls and the reduced maritime trade flows.

Sanitary protocols and related measures are proven to be especially important throughout COVID-19. When implementing the protocols, the capacity to coordinate with national and/or local authorities and communicate with other steps along the chain is critical. The capacity to put in place the necessary protocols when treating (suspected) COVID-19 cases is also important.

For fully privatized ports, the financial implications of the crisis are manifold and more pronounced. The port may find it difficult to continue their financing, or port providers with limited financial capacities may be constrained by lockdowns and suppressed demand. In the circumstances, the capacity of ports to adopt urgent and compensatory measures can contribute to mitigating the negative effects of the crisis. Those measure include but not limited to taking advantage of cash flows for early payment of providers, or delay of payments by some of their users.

Multidimensional adjustments of working practices can be used to limit personnel shortages. Ports were able to diffuse several risks when they allowed for telecommuting, implemented sanitary protocols including social distancing, limited meetings and traveling, taking advantage of relevant social policies, and making greater use of technology. Similar adjustments were identified for the case of shipping lines. Responses to the crisis and the “back to work practices” vary in scope and type. Nonetheless, the capacity for active and prompt interventions has proved to be crucial. To adjust the working practices and organizational aspects, it is important to develop instructions to ensure a safe interface between ship and shore-based personnel. The instructions may include guidelines on splitting working teams, having longer shifting breaks (for example changing the length of watch from 4 days on, 4 days off to 7 days on and 7 days off). This could take place both at the local and at the international level and with support from relevant industry associations and international organizations.

There are other operational adjustments to port operations that are also recommended. Those operational adjustments include measures to revise vessel and terminal access processes, optimizing online gate process options and gate hours, measures to increase use of off-site storage for both inbound operations (including peeling) and outbound (storage of empty containers), measures that prioritize the U.S. Customs and Border Protection (CBP) inspections and 24-hour rule, market-based actions taken to encourage shippers to pick up their cargo (e.g. increasing demurrage rates, reducing free days, and other fees), measures to improve performance tracking and reporting to monitor and share movement of essential goods and services in/out of ports, and measures focusing on avoiding yard capacity overutilization that would undermine efficient operations.

## **4.5 Coordination and Cooperation**

COVID-19 became not only a huge health crisis, but also a crisis to globalization and global governance. Most obviously, it raised the question of how the world should coordinate and cooperate against the threat of pandemics. It also has implications for how globalization is perceived and what that perception means for the future of international cooperation.

In the early days of COVID-19, many countries individually closed borders and restricted access without coordination with neighboring countries. Additionally, confusions arose over different quarantine procedures in marine ports, creating congestion or sending ships wondering over high seas. A unified, standardized process at the global and/or regional level, should have been established, which could be applied in situations such as COVID-19. It would help to prevent unnecessary delays of vessels carrying essential goods, supporting international trade and to bring a social safety net for transportation workers (especially crew), who continue to be directly affected by the crisis. Cooperation and support from the international community are essential for rapid recovery. It was the reason that the United Nation rapid response project, titled *Transport and trade connectivity in the age of pandemics: Contactless, seamless and collaborative UN solution*, brought together six UN regional commissions to help governments and businesses keep transportation networks and borders operational and facilitate the flow of goods and services, while containing the spread of the coronavirus.

Responding to the COVID-19 challenges also requires collaboration and coordination among all stakeholders, including port authority officials, terminal operators, longshore unions,

and other supply chain stakeholders. When established, collective actions will be more effective in combating risks and improving resilience. Adjustments to governance and communication strategies of parties involved are equally instrumental. When collaborating and coordinating, contingency plans could facilitate quick responses to the crisis. Ports that lack such plans have to take ad hoc responses or develop plans in a short period of time during the crisis.

Meanwhile, as many international organizations and research institutions are analyzing the economic and social impacts of COVID-19, coordination and cooperation are important keys for coherent and solid analysis of the shipping and port responses to COVID-19 and their effectiveness.

## **Chapter 5. Conclusion**

COVID-19 has a disruptive power across all industries, particularly in the maritime and international shipping section in the long term. As international trade and global production networks heavily depend on the smooth operation of maritime transportation, world trade fell sharply in the first half of 2020. However, rapid government responses have been always helpful to temper the contraction. More flexible regulations are applicable to ensure the continuity of the smooth run of the shipping sector.

For the post-epidemic era and future pandemics, recommendations were proposed to mitigate the impact of the catastrophes. For cargo owners and risk managers, it is necessary to monitor the situation closely before and during a pandemic and take timely and possible measures to address the issues arisen from the pandemic outbreak. Meanwhile, effective measures should be implemented by marine ports to prevent the spread of the virus and avoid causing severe disruption within the industry. Short/medium/long term plans should be established to enhance sustainability and resilience of ports and maritime transportation. Furthermore, possible elements of port strategic plans focusing on competitiveness, cargo fluidity, and other connecting transportation modes should be set up to make sure the maritime operation stays as smooth as possible.

In the future, governments are suggested to continue to pursue extensive monetary saving programs in the hope of alleviating any potential economic disasters. Meanwhile, investments are encouraged to go to freight technology companies to help the existing industry to connect shippers, brokers, and carriers in the maritime basis to optimize operations. The pandemic preparedness for the future should be strengthened if the world is faced with an unprecedented threat. Stronger health systems, quicker response, and improved global collaboration should be established. Lessons are learned from this pandemic to make the world a safer place.

## References

- Agatić, A. & Kolanović, I. (2020). Improving the seaport service quality by implementing digital technologies. *Sci. J. Marit. Res.* 34, 93–101.
- Bhalodi, A. (2019). Digitalization in maritime Industry. *Academia.* 1-24
- Feibert, D. C., Hansen, M.S. & Jacobsen, P. (2017). An Integrated Process and Digitalization Perspective on the Shipping Supply Chain—A Literature Review. In Proceedings of the International Conference on Industrial Engineering and Engineering Management IEEM, Singapore, 10–13 December 2017.
- Heering, D. (2020). Ensuring Cybersecurity in Shipping: Reference to Estonian Shipowners. *Int. J. Mar. Navig. Saf. Sea Transp.*, 14, 271–278.
- Heilig, L., Lalla-Ruiz, E. & Voß, S. (2017). Digital transformation in maritime ports: Analysis and a game theoretic framework. *NETNOMICS Econ. Res. Electron. Netw.* 18, 227–254.
- International Marine Organization. (2022). Coronavirus (COVID-19) – Designation of seafarers as key workers
- Lademan, D. (2021, January 6). Fewer blank sailings in early 2021 on year amid strong containerized trade demand: eeSea. *S&P Global*.  
<https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/shipping/010621-fewer-blank-sailings-in-early-2021-on-year-amid-strong-containerized-trade-demand-eeSea>
- Northern Corridor and the East African Community. (September 2020). *Covid-19: How the East African Community's convoluted response has exposed the slow integration process*.  
<https://africanleadershipcentre.org/index.php/covid-19-research/659-covid-19-how-the-east-african-community-convoluted-response-has-exposed-the-slow-integration-process>
- Northern Corridor and the East Africa Community. (2020). *The Northern Digest Corridor*. No. 4. June 2020.
- Piñeiro, L. C., Mejia, M. Q. & Ballini, F. (2021). Beyond COVID-19: the future of maritime transport. *WMU Journal of Maritime Affairs.* 20, 127–133.
- Placek, M. (2022). Monthly container freight rate index worldwide 2019-2022.  
<https://www.statista.com/statistics/1250636/global-container-freight-index/>
- PwC Norway. (2017). *The digital transformation of shipping: Opportunities and challenges for Norwegian and Greek companies*. Retrieved from: [https://www.pwc.no/no/publikasjoner/shipping/The-Digital-Transformation-of-Shipping\\_HE-NO.pdf](https://www.pwc.no/no/publikasjoner/shipping/The-Digital-Transformation-of-Shipping_HE-NO.pdf).
- Quitau, J., et al. (2018). Shipping in an era of digital transformation, Strategy 2030 - Capital and Life in the Next Generation, No. 25e, Berenberg Bank und Hamburgisches WeltWirtschaftsinstitut (HWWI). Hamburg. Retrieved from. <https://www.econstor.eu/bitstream/10419/177894/1/1017815119.pdf>.



- Trade Association International Chamber of Shipping. (November 2020). *Coronavirus (COVID-19): Guidance for Ship Operators for the Protection of the Health of Seafarers (Third Edition)*. <https://www.ics-shipping.org/publication/coronavirus-covid-19-guidance-for-ship-operators-for-the-protection-of-the-health-of-seafarers-v3/>
- UNCTAD. (2022). *COVID-19 and maritime transport: Navigating the crisis and lessons learned*. [https://unctad.org/system/files/official-document/tcsdtlinf2022d1\\_en.pdf](https://unctad.org/system/files/official-document/tcsdtlinf2022d1_en.pdf)
- UNCTAD. (2021). *COVID-19 and maritime transport: Impact and responses*. [https://unctad.org/system/files/official-document/dtltlb2021d1\\_en.pdf](https://unctad.org/system/files/official-document/dtltlb2021d1_en.pdf)
- UNCTAD. (2020). *COVID-19 and maritime transport: Impact and responses*.
- WHO. (2020). *Operational Considerations for managing COVID-19 Cases and outbreak on Board Ships*
- WHO. (2020). *Promoting Public Health Measures in Response to COVID-19 on Cargo Ships and Fishing Vessels*
- World Economic Forum. (2020). Available online: <https://www.weforum.org/agenda/2020/05/how-to-build-a-bluer-ocean-economy-after-covid-19>
- Zerbino, P., Aloini, D., Dulmin, R. & Mininno, V. (2018). Process-mining-enabled audit of information systems: Methodology and an application. *Expert Syst Appl.* 110, 80–92.

## **Appendix: Survey Questionnaire**

### **COVID-19: Impacts on Maritime Transportation and Port Operation**

We, in the Department of Transportation Studies at Texas Southern University, are conducting a research study to investigate the impact of the COVID-19 outbreak on maritime transportation and port operation. This questionnaire includes four (4) questions. Your contribution and response is extremely important to us. We do understand that your answers will be based on your personal views; and they may not necessarily reflect your employer's/agency's opinion. We wish to assure you that all answers provided will be aggregated prior to reporting. Any open-text responses cannot be attributed, and the research will not link the answers to your identity. The results of the research will be used to alleviate further impacts of the pandemic and cope with future catastrophes. Thank you in advance for your participation. Your time is greatly appreciated!

#### **Questions**

1. What measures do you know that have been used or can be used to mitigate port congestion and delays due to the pandemic? Please explain briefly.
2. "Digitalization" refers to enabling or improving processes by leveraging digital technologies and digitized data. The pandemic has had the potential to expedite digitalization and create new digital opportunity structures. Are you aware of any case(s) in maritime domain in which digitalization has been used since the pandemic outbreak? Please mention.
3. Responding to COVID-19 challenges requires collaboration and coordination among all stakeholders and public and private entities. Do you know of any real-world example of new collaboration/coordination in the field since the pandemic outbreak? Please explain briefly.
4. In response to the COVID-19 pandemic, the ports around the world have been adopted multi-dimensional adjustments to mitigate the respective impacts. Can you please list any other adjustment you experienced, observed, or heard?

We would value any additional comments you may have on the topic. Please write them in the space below.