

# Impact of COVID-19 on the Indian seaport transportation and maritime supply chain

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## ABSTRACT

Impacts of COVID-19 in maritime transportation and its related policy measures have been investigated by more and more organizations and researchers across the world. This paper aims to examine the impacts of COVID-19 on seaport transportation and the maritime supply chain field and its related issues in India. Secondary data are used to analyze the performance indicators of major seaports in India before and during the COVID-19 crisis. We further explore and discuss the expert's views about the impact, preparedness, response, and recovery aspects for the maritime-related sector in India. The results on the quantitative performance of Indian major seaports during the COVID-19 indicate a negative growth in the cargo traffic and a decrease in the number of vessel traffic compared to pre-COVID-19. The expert survey results suggest a lack of preparedness for COVID-19 and the need for developing future strategies by maritime organizations. The overall findings of the study shall assist in formulating maritime strategies by enhancing supply chain resilience and sustainable business recovery process while preparing for a post-COVID-19 crisis. The study also notes that the Covid-19 crisis is still an ongoing concern, as the government, maritime organizations, and stakeholders face towards providing vaccine and remedial treatment to infected people. Further, this study can be expanded to the global maritime supply chain business context and to conduct interdisciplinary research in marine technical fields and maritime environment to measure the impact of COVID-19.

## 1. Overview

At present, for the past year, the world is going through a critical phase of the emerging Severe Acute Respiratory Syndrome Coronavirus (SARS) virus is named '2019 Novel Coronavirus' by the World Health Organization (Sohrabi et al., 2020; Harapan et al., 2020). After initial exposure, the virus has quickly spread from China to various nations and territories around the world. The World Health Organization (WHO) has acknowledged the COVID-19 pandemic to be a public health emergency that predominantly affects human activities and economic development, and it is termed a quarantine situation (Uddin et al., 2020; North, 2020). COVID-19 pandemic has spread across various nations and territories from the epicentre of Wuhan in China (Ridruejo and Soza, 2020). As of April 30th, 2021, the numbers of infected people worldwide are 15,32,73,146 and the number of associated deaths are 32,11,729 (Worldometers, 2021). The number of infected people in India are 1,95,57,457 with number of related deaths of 2,15,542 and total vaccination count of 15,68,16,031 to COVID-19 as on 30th April 2021 (myGOV, 2021). Also, there has been a strong surge in the number of cases of new double

mutant COVID-19 driving towards Coronavirus 2nd wave outbreak. India has launched a massive vaccination drive and aims to vaccinate 300 million people by July 2021, though it could take additional two or more years to inoculate nearly 1.4 billion Indians (NPR, 2021).

Maritime-related industries are essential in the international economy and social well-being. One of the activities that have also been majorly impacted due to the spread of COVID-19 is the maritime and shipping industry. Since the spread of COVID-19, many nations worldwide have shut down their seaports and have banned most of their export and import activities. The substantial lockdowns and social distancing measures have been enforced in various nations with immediate scale-down in production and consumption (Liu et al., 2020). To contain the spread of the COVID-19, countries have partly or completely closed their borders, thus delaying the flow of goods, capital, and people, disrupting the global supply chains. In the wake of these measures, most nations have already started experiencing a macroeconomic hit caused by this pandemic. There has also been roughly a 60% fall in the world's demand and supply, and 41% of world exports due to this outbreak (Richard Baldwin and Beatrice Weder di Mauro, 2020).

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The COVID-19 pandemic is the most significant global challenge after World War II, not only for its health crisis but also for people losing jobs and income (UNDP, 2020; World Bank, 2020).

For every country's trade and commerce, seaports act as nodes and play a role as facilitators functioning as maritime connectivity across the globe (Kuo, 2020). With the outbreak of COVID-19, the worldwide maritime industry that accounts for 90% of the international trade and supply of cargo, including food, fuel, and medicines, has been impacted (Ship-Technology, 2020; ORF, 2020). Impacts of COVID-19 on the maritime transport domain and corresponding measures taken have been widely examined by more and more researchers and organizations in the world (Zhang and Hayashi,). However, to date, there has been no quantitative study or expert perspective study in maritime-related disciplines in India to analyze the impact of the COVID-19 crisis on the seaport transportation and maritime supply chain sector. The present research in this paper aims at attaining the following objectives:

- To examine and analyze the impact of COVID-19 on the number of vessel calls, cargo volume, and segment-wise cargo volume details for major seaports in India.
- To investigate the impacts, preparedness level, response, and recovery aspects related to COVID-19 on seaport transportation and maritime supply chain in India.
- To propose policy guidelines by analyzing the impact of COVID-19 on India's maritime context.

This paper is structured in five sections: section two covers the review of literature on Covid-19 pandemic impacts on the global seaports and maritime supply chain based on secondary data sources. Section three examines and analyzes the effects of COVID-19 for the major seaports in India by comparing the financial year 2020 (during the COVID-19 crisis) from the financial year 2019 (before the COVID-19 crisis) on quantitative data (vessel count, traffic volume tonnage, and segment-wise cargo details) based on secondary data sources. In the fourth section, expert survey views in the form of agreements/disagreements to the questions about impacts, preparedness, response, and recovery aspects with additional suggestions and extensive analysis are discussed. Section five explains the findings and summary of this overall study to formulate the maritime policy to analyze the impact of COVID-19 in the Indian maritime context. Finally, section six deals with conclusions, limitations of this study, and discussion on the author's future research interests.

## 2. Literature Review on impact of COVID-19 on worldwide maritime sector

Literature regarding coronavirus studies is mainly associated with the effects of COVID-19 on the health and behaviour of people. Effects of the COVID-19 epidemic have mainly been considered to the environmental and transportation aspects. To the best knowledge of the authors, studies on the effects of coronavirus on maritime transportation and supply chain are not heavily investigated. The examinations on maritime transportation in the literature are mainly related to cruise shipping, port, and shipping operations. Since the spread of the COVID-19 epidemic, the amount of maritime freight transportation has shrunk considerably to effectively prevent the spread of the epidemic (Zheng et al., 2020). The behaviour of human activities in the sea has been drastically altered by the COVID-19 pandemic, with seaport restrictions and changes in utilization prototypes impacting numerous maritime domains most notably fisheries, passenger ferries, and cruise vessels sectors which rely a lot on the movement of people and goods (Xu et al., 2021).

Hülya and Eda (2021) investigated the effects of the epidemic on maritime freight transportation and briefed the exposure points of several vessel types. This research study observed that the major change was in container shipping operations and the number of vessels calling

at the seaports decreased radically. Ito et al. (2020) studied whether the movement of cruise vessels affects the spread of coronavirus or not by tracking all cruise vessels around the globe using automatic identification system (AIS) data from January 2020 to March 2020. This study identified those nations which went on to accept cruise ships until March 2020 have faced a higher COVID-19 infection rate compared to other countries. This study also analyzed that the infection ratio is also subject to the vessel size and port operation schedules. This study pointed out that the risk of infection on board increases in large cruise vessels and the majority of these cruise vessel passengers or workers that have an infection were seafaring from the same home seaport to the same seaport of call in a week's time.

Budd et al. (2020) through research study have focused on individual behaviours in COVID-19 situations while taking into consideration community health and wellbeing aspects. This study identified that reorganization of the transport policy is required according to the mobility and financial situation during the post-COVID-19 period. Maritime Safety Agency (EMSA) published a report on 27th November 2020, stating the effects of coronavirus on shipping-related issues by examining numerous aspects such as seaports, cruise vessels, seaport calls both in European Union and far Eastern nations, vessel-related movements, and also congestion at port anchorage. This report identified that the shipping business has been impacted both directly and indirectly from the outbreak of COVID-19 impacts. It was observed through this study that maritime traffic declined especially between Europe and Asia and there has been a severe decline in cruise and cargo transportation (EMSA, 2020).

Roy (2020) investigated the fiscal slowdown due to the COVID-19 pandemic in the oil, tourism, aviation, economic, and healthcare sectors and indicated that the epidemic has extended quickly all over the globe and affected these industries negatively in terms of business volume, interest rates, market instability, and demand & supply ratio aspects. Yazir et al. (2020), through a research study, has overviewed current maritime-related industry progress, developments, novel challenges, and potential results regarding four major sectors.

This study highlights the understanding of four major sectors which included dry-bulk, tankers, container cargo, and cruise segments in maritime industries with practical insights organized and a brief overview of up-to-date issues of maritime-related operations & management.

According to the UNCATD Review of Maritime Transport report 2020, the short-term position for maritime business is bleak. UNCTAD expects worldwide maritime business development to return to an optimistic outlook and develop by 4.8% in the year 2021, assuming that global fiscal output recovers. This report signifies the need for the maritime transport business to brace for transformation and be well prepared for a transformed post-COVID-19 world and also underscores the imperative need to invest in risk management, international interdependency of nations, and crisis response preparedness in the area of the maritime domain. On the flip side, the Covid-19 epidemic has also highlighted the role of maritime digitalization with increased cybersecurity risks in maritime supply chains and logistics services in global trading activities. (UNCATD, 2020).

The International Association of Ports and Harbours (IAPH) and World Port Sustainability Program (WPSP) have been conducting seaport studies on the impact of COVID-19 to monitor the present situation in global seaports to monitor existing situation world seaports and developments compared to preceding weeks. These developments were compared to preceding weeks starting from the 15th week of 2020 till the 6th week of 2021, through a seaport economic impact barometer providing a comprehensive international and regional analysis of the impact of COVID-19 on seaports (WPSP, 2021). Through this survey, a total of seventy valid answers have been received from worldwide seaports.

The dashboard data was analyzed and reported every week by the WPSP-IAPH COVID-19 taskforce for ports worldwide based on the surveys' responses to four critical questions which included vessel, modal,

freight, and seaport workers. The answer to these four critical issues of the study for fifteen survey weeks is reported as follows:

- i Impact of the COVID-19 crisis on vessel calls: This report signifies that the containerized cargo and other cargo vessels are on a par with, if not above, the normal levels for this period of the year, and there has been stability in the number of other cargo vessel calls at various seaports. Cruise vessels remain the most affected by the COVID-19 infection with some minor improvements than previous week studies. The movement of ships in the present situation has increased in several seaports.
- ii Impact of the crisis on hinterland transport: The report identifies that inland transport volumes in global seaports have increased due to the reopening of the economies in various nations. The report also indicates that there is a rapid surge in volumes in numerous giant business routes due to which the capacity limits of seaports and the inland transport systems are tested. This has led to interruptions in hinterland transport connectivity in some seaports. The report indicates that the situation has not been affected at all compared to normal with the flow of trucks, railways, and barges up to 100% rate. More seaports are concerned with the impending trends and the result of measures endorsed to combat the so-called 'second wave of COVID-19' with the approximation of further limitations concerning boundary controls and passenger travel having a negative impact on the upcoming period.
- iii Impact on capacity utilization-related activities: The report points out that warehousing and distribution activities in seaports have declined due to the plunge in demand for custom products or shutting in the trade units with underutilization of storage capacity for dry bulk products. The report suggests further higher changes in the utilization degree of tank storage for liquid cargo. The report also identifies an increasing level in the consumption of warehousing and distribution services for food items and therapeutic supplies.
- iv Impact on availability of port-related workers: The report indicates a very limited impact on workforce availability in the seaport regions. More online meetings/webinars are being continued instead of physical contacts in the seaport area. The report also identifies that seaport staff activity is back to normal and terminal operations completely unaffected, with vessels are arriving, departing, and undergoing loading/discharge operations as usual. In various ports, all operations and work resumed taking into account the necessary health care protocols.

### 3. Impact of COVID-19 on major seaports of India

India has a 7,517 km coastline and has 12 major seaports and 205 minor seaports (Sagarmala, 2021). The major ports handle about 60% of the country's total cargo traffic. According to Bloomberg, almost \$829 billion worth of goods has travelled through India's seaports in 2018, the 13th highest cargo traffic globally (Bloomberg, 2020). The total cargo traffic volume handled at Indian Major Ports for the financial year 2020-21 was 672.606 Million Tonnes compared to 704.63 Million Tonnes handled for the fiscal year 2019-20 with an overall decline of 4.58% growth in traffic tonnage year on year (Indian Ports Association Report, 2021; IBEF, 2020). To identify the impact of COVID-19 on India's major seaports, patterns for performance data before and during the COVID-19 crisis were examined. Quantitative analysis has been carried out for variables featuring cargo traffic volume and segment-wise cargo traffic volume for Indian major seaports for full-year data for the financial year 2019-20 and financial year 2020-21 based on the availability of secondary data sources (Indian Ports Association Report, 2021). The results indicate a drop in vessel call performance count by 3217 for major seaports in India for the financial year 2020 compared to the financial year of 2019. Table 1 summarizes vessel performance & cargo tonnage handling for twelve major seaports in India for the financial year (2019 v/s 2020).

**Table 1**

Performance statistics for major seaports in India for FY 2019-20 and FY 2020-21.

Sl. No	Major Port	Traffic Period	No of Vessels	Total Cargo(In 000 Tonnes)	Percentage Variation (2020 v/s 2019)
1	Kolkata Port Trust (Kolkata Dock & Haldia Dock Complex)	FY-2019-20	3590	63983	-4.14%
		FY-2020-21	3055	61337	
2	Paradip Port Trust, Paradip	FY-2019-20	1931	112689	1.65%
		FY-2020-21	1889	114549	
3	Vishakhapatnam Port Trust, Vizag	FY-2019-20	2213	72722	-3.96%
		FY-2020-21	1930	69843	
4	Kamarajar Port Limited, Ennore	FY-2019-20	924	31747	-18.46%
		FY-2020-21	772	25888	
5	Chennai Port Trust, Chennai	FY-2019-20	1817	46759	-6.86%
		FY-2020-21	1418	43552	
6	VO Chidambaram Port Trust, Tuticorin	FY-2019-20	1175	36076	-11.88%
		FY-2020-21	1018	31790	
7	Cochin Port Trust, Cochin	FY-2019-20	1757	34038	-7.45%
		FY-2020-21	1609	31503	
8	New Mangalore Port Trust, Mangalore	FY-2019-20	2902	39145	-6.76%
		FY-2020-21	2657	36500	
9	Mormugao Port Trust, Mormugao	FY-2019-20	715	16017	37.06%
		FY-2020-21	689	21953	
10	Mumbai Port Trust, Mumbai	FY-2019-20	6664	60696	-12.15%
		FY-2020-21	5716	53224	
11	Jawaharlal Nehru Port Trust, Mumbai	FY-2019-20	2902	68449	-5.32%
		FY-2020-21	2657	64809	
12	Deendayal Port Trust, Kandla	FY-2019-20	3710	122606	-4.12%
			3673	117558	

(continued on next page)

Table 1 (continued)

Sl. No	Major Port	Traffic Period	No of Vessels	Total Cargo(In 000 Tonnes)	Percentage Variation (2020 v/s 2019)
Total for no of vessels & cargo tonnage of east coast major seaports (Sl. No 1 to 6)		FY-2020-21			
		FY-2019-20	11650	363976	–4.67%
		FY-2020-21	10082	346959	
Variation in no of vessels & cargo tonnage for east coast major seaports (Sl. No 1 to 6)			1568 (▼)	17017(▼)	
Total no of vessels & cargo tonnage of west coast major seaports (Sl. No 7 to 12)		FY-2019-20	18650	340951	–13.72%
		FY-2020-21	17001	325547	
			1649 (▼)	15404(▼)	
Variation in no of vessels & cargo tonnage for west coast major seaports (Sl. No 7 to 12)					
Total no of vessels & cargo tonnage for all major seaports in India (Sl. No 1 to 12)		FY-2019-20	30300	704927	–4.59%
		FY-2020-21	27083	672606	
			3217 (▼)	63807 (▼)	
Variation in no of vessels and cargo tonnage for all major seaports in India (Sl. No 1 to 12 FY 2020-21 v/s FY 2019–20)					

Source: IPA Report data & authors calculation

Further, analysis has been carried out for cargo traffic volume data, vessel call performance data, and segment-wise cargo traffic volume data. Data analysis also was carried out based on region-wise ports classified as east coast major seaports (six seaports) and west coast major ports (six seaports). Overall cargo traffic volume declined by 4.59% for major seaports in India for 2020 compared to 2019. The findings indicate that except two ports of Mormugao Port Trust (37.06%) and Paradip Port Trust (1.65%) remaining major seaports had negative cargo growth in the study period. Although decreases were evident across India's major ports, there were also differences between east coast region major ports of India and west coast region major ports of India in terms of cargo traffic volume, vessel call performance, and segment-wise cargo traffic volume details.

Table 1 also highlights that there has been a decline in vessel call performance and cargo traffic volume for east coast major seaports and west coast major seaports. For the study period (financial year 2020 and

financial year 2019), vessel call performance reduced by 1568 and cargo traffic volume declined by 4.67% for east coast major seaports. The vessel calls performance reduced by 1649, and cargo traffic volume decreased by 13.72% for west coast major seaports for the study period. Fig. 1 illustrates a graphical representation of cargo traffic volume by major seaports in India for the study period. Further, analysis has been carried out for cargo traffic volume data, vessel call performance data, and segment-wise cargo traffic volume data.

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Fig. 2 illustrates a graphical representation of vessel call performance by Major Seaports in India for the study period. Further, segment-wise cargo traffic volume details for major seaports in India are carried out for the study period as illustrated in Table 2.

The results indicate positive growth only for iron-ore cargo by 29.11%; fertilizer cargo by 23.71% and other misc cargo by 2.42% for the year 2020 compared to the same period in the year 2019. The results indicate negative growth for liquid cargo by 11.9%; coal by 11.5% and container cargo by 3.75% for the year 2020 compared to the same period in 2019. Further, there has been an overall decline in cargo traffic volume for major seaports by 4.59%. Fig. 3 illustrates the graphical representation of segment-wise cargo volume handled by major seaports in India for the year 2020 compared to the year 2019.

#### 4. Expert survey methodology

Considering the variety of uncertainties and unknowns about COVID-19 and its impacts, it is imperative to hear the views and suggestions from domain experts in the field of seaport transportation and maritime logistics. However, there is no study from the perspective of experts in the field of maritime-related disciplines in India. This expert

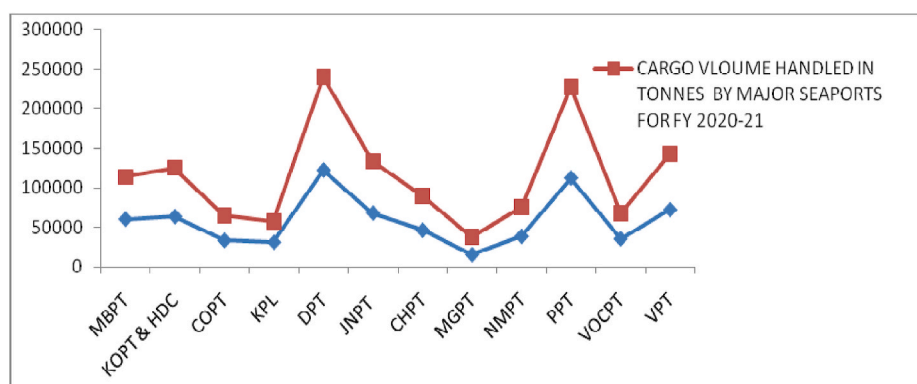


Fig. 1. Graphical representation of cargo traffic volume by major seaports in India for FY 2019 v/s FY-2020.

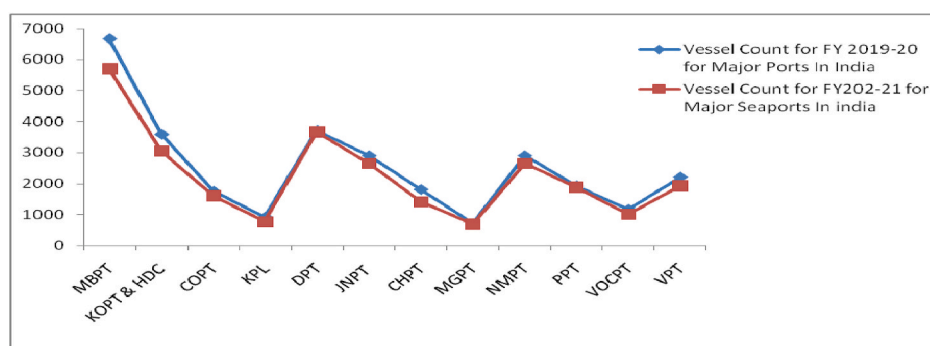


Fig. 2. Graphical representation of vessel call performance handled by major seaports in India for FY-2019 v/s FY-2020.

Table 2

Segment-wise cargo details (in 000 Tonnes) for seaports in India for FY-2019 and FY-2020.

Time Period	Liquid Cargo	Iron Ore	Fertilizers	Coal	Containers	Other Cargo	Total Cargo
FY- 2020	234972	71027	19699	132085	9611	72832	672606
FY- 2019	266710	55010	15923	149312	9985	71000	704927
Difference (2020 v/s 2019)	-31738	16017	3776	-17227	-374	1832	-32321
Percentage Variation of Cargo (2020 v/s 2019)	-11.9	29.11	23.71	-11.5	-3.75	2.42	-4.59

Source: IPA Report data & authors calculation

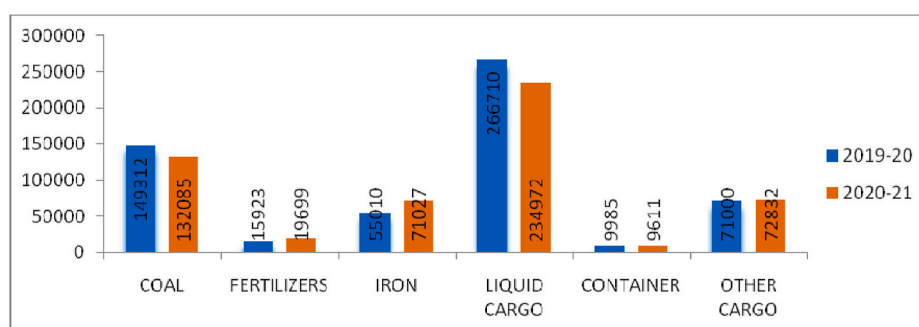


Fig. 3. Graphical representation of segment-wise cargo volume for major seaports in India for FY-2019 & FY-2020.

survey was designed by taking reference from the online web-based survey from Maritime UK COVID19 expert survey and WCTRS COVID-19 Task Force survey (Maritime UK COVID19 Expert Survey (2020); World Conference on Transport Research Society.). The expert survey solicited experts' views in maritime-related domain-specific to seaport transportation and maritime supply chain in India.

The expert survey questions were regarding: investigate the impacts of COVID-19 on the maritime supply chain; determining the preparedness level of seaports and related maritime stakeholders and measures taken by the government and maritime organizations to handle COVID-19 pandemic situation; to identify and respond to post-pandemic recovery actions and to frame various strategies that are required to be adopted by maritime business in India after COVID-19 pandemic. The expert survey questionnaire was structured into five parts. The first section includes social demographics, such as name, e-mail address, phone number, gender, age, organization name, research field, experience, and location (question no: 1 to 9).

It follows with the impact of COVID-19 on maritime and its logistics business in India (question no: 10) and selection question comprising of factors that impact and affect negatively on maritime supply chain and seaport logistics operations in India (question No: 11). The third section follows with the level of preparedness from maritime chain stakeholders for the COVID-19 pandemic in India (question no: 12) and adaptability of maritime chain operations during the COVID-19 epidemic in India (question no: 13) and changes in future strategies of marine

organizations in India after the experience of the COVID-19 pandemic (question no: 14).

Following this, questions were based on response and measures criteria concerned with rating the government's response to COVID-19 on maritime-related business in the Indian context. Responses were confined on a five-point Likert-type scale ranging from 'no influence' coded as 1 to 'highly influenced' coded as 5. This question was followed by (question no: 15) perspective question on the need for government support for maritime domain business recovery (question no: 16). Following this, questions were based on recovery aspects dealing with developing a recovery strategy for maritime business after the pandemic (question no: 17). This question was followed by a question based on long-term changes caused by COVID-19 on maritime chain business in the Indian context. Responses were captured on a five-point Likert-type scale ranging from 'fully disagree' to 'fully agree' (question no: 18). This question was followed by a question to rank the factors (from 1 to 9) for picking up the maritime-related business in India to overcome the impacts of COVID-19 (question no: 19).

The last section in an expert survey was a descriptive question (optional) to gather information in suggestions or opinions for recovery and development of measures regarding post-COVID-19 pandemic policies for the maritime transportation and seaport logistics segment in India (question no: 20). The expert survey was implemented online. The survey web page was distributed to major port employees, experts in seaport transportation & maritime logistics, and members of maritime

community networks in India (Refer to Appendix A). The online expert survey was conducted between 25th May 2020 to 15th March 2021, taking into account the need for a balance between port geographies and the type of workplace of experts in the maritime domain. Because of the time limitation, we sent questionnaires to 125 experts, of whom 87 experts responded with valid answers with an overall percentage of 69.6%.

#### 4.1. Socio-demographic characteristics

The gender distribution for the expert survey constituted male respondents with 75.86% and female respondents with 24.14%. Regarding expert experience, 44.83% of experts have worked in range for 21–30 years, which is the highest; followed by experts who worked in the field for 11–20 years with 33.33%; followed by experts worked in range for 31–40 years with 11.49%; followed by experts worked in range for 6–10 years with 8.05% and 2.3% of experts have worked in range for 41–50 years. Table 3 summarizes the descriptive statistics of social characteristics for the expert responses.

The top five professional fields identified are maritime transport -technology & education with 19.54%, maritime transport -administration planning and policy with 18.39%, freight & passenger transport and logistics with 12.64%, maritime transport -economics and finance with 11.49%, maritime-traffic management, operations and safety with 10.34%. Other fields included maritime consultancy-transport infrastructure design and maintenance with 5.75%, maritime transport -climate change and the environment with 4.6%, marine engineering -energy & policy with 4.6%, public health with 4.6%, other categories with 4.6%, and marine tourism with 3.45%.

The place of work of the experts was New Delhi (5.75%), Kolkata (4.6%), Mumbai (13.79%), Chennai (8.05%), Kandla (6.90%), Mormugao (5.75%), Mangalore (16.09%), Cochin (9.20%), Tuticorin (8.05%), Paradip (6.90%), Vizag (5.75%), Haldia (3.45%) and other category places including Bangalore, Hyderabad, and Vadinar (5.75%). Fig. 4 illustrates the graphical representation of the location of the work of the

**Table 3**  
Socio-Demographic characteristics of experts with descriptive statistics (N = 87).

Variable	Value	Frequency	Percentage
Gender	Male	66	75.86
	Female	21	24.14
Age Group	18–25 Years	0	0
	26–40 Years	13	14.94
	41–50 Years	25	28.74
	51–60 Years	43	49.43
	Above 60 Years	6	6.9
Professional Field	Maritime- Traffic, Operations & Safety	9	10.34
	Freight/Passenger Transport & Logistics	11	12.64
	Maritime Transport -Economics & Finance	10	11.49
	Maritime -Climate Change & Environment	4	4.6
	Maritime -Administration Planning & Policy	16	18.39
	Maritime Consultancy- Infra Design& Maintenance	5	5.75
	Maritime Transport -Technology & Education	17	19.54
	Marine Engineering -Energy & Policy	4	4.6
	Public Health	4	4.6
	Marine Tourism	3	3.45
	Others	4	4.6
Professional Experience	06–10 years	7	8.05
	11–20 years	29	33.33
	21–30 years	39	44.83
	31–40 years	10	11.49
	41–50 years	2	2.3

Source: Expert Survey & author's calculation

experts.

#### 4.2. Impacts

Experts responded regarding the impact of Coronavirus had on maritime & seaport logistics-related activities in India. 44.83% of experts reported that COVID-19 had significantly affected. In comparison, 37.93% reported a moderate effect, 14.94% reported that maritime and port logistics were somewhat affected, and 2.3% of experts reported that maritime and port logistics were not affected due to the COVID-19 impact. Table 4 illustrates the descriptive information on the impacts of COVID-19 on maritime & port logistics activities in India.

Experts reported that the percentage-wise factors in the maritime domain contributed to a negative impact during COVID-19 on maritime operations and port logistics issues. Experts identified and ranked the top six factors contributing to the negative impact during COVID-19 on maritime operations and port logistics issues. 92% of expert respondents indicated that labour-related problems were major factors and ranked in the first position that impacted maritime operations and port logistics aspects during COVID-19, followed by 90% of expert respondents indicating that cargo volume decline factor with the second rank. Operational delays in the maritime chain with 85% expert indication were factors ranked in the third position by the respondents followed by disruption issues in maritime chains, with 77% of the respondents ranking as a fourth factor.

67% of respondents indicated that lack of capacity utilization in seaports ranked as the fifth position factor followed by 66% of respondents indicating that sustainability-related issues and restriction measures contributed towards negative impact during COVID-19 on maritime operations and port logistics issues. Fig. 5 depicts the graphical representation of factor-wise issues contributing to adverse effects on maritime operations by the COVID-19 pandemic.

#### 4.3. Preparedness & adaptability

Experts responded regarding the adaptability of maritime business & port logistics operations during the COVID-19 outbreak in India. 61% of experts acknowledged a partial or complete shutdown in activities with significant delays for maritime business & seaport logistics operations during the COVID-19 epidemic in India. In comparison, 31% of experts responded that there were few glitches in operations with minor delays for maritime chain operations, and 8% of expert respondents reported maritime organizations were fully adaptable to the COVID-19 outbreak in India. Fig. 6 depicts the graphical representation of the adaptability of maritime organizations and stakeholders for COVID-19 in India.

According to expert's views, the low level of adaptability in the maritime field corresponds to the unknown risk and uncertainty impact of policies; low-level access control to identify potential risk sources; inadequate sharing of information between maritime chain stakeholders; lack of critical infrastructure facilities; low-level usage of early warning technologies, and convergence of COVID-19.

#### 4.4. Response and recovery

Experts responded regarding the change in future strategies of maritime & port logistics-related organizations in India after COVID-19. 91% of experts agreed that there would be a change in future policy. In comparison, 7% of experts reported that there might be changes, and only 2% of experts responded to not being sure about future changes in strategies of maritime & port logistics-related organizations in India after COVID-19. Fig. 7 depicts a graphical representation of change in future strategies of Maritime & Logistics related organizations in India after COVID-19.

The expert's response also highlighted the need for government support for the business recovery of maritime chain organizations in India due to COVID-19. 37% of experts responded that there is a need for

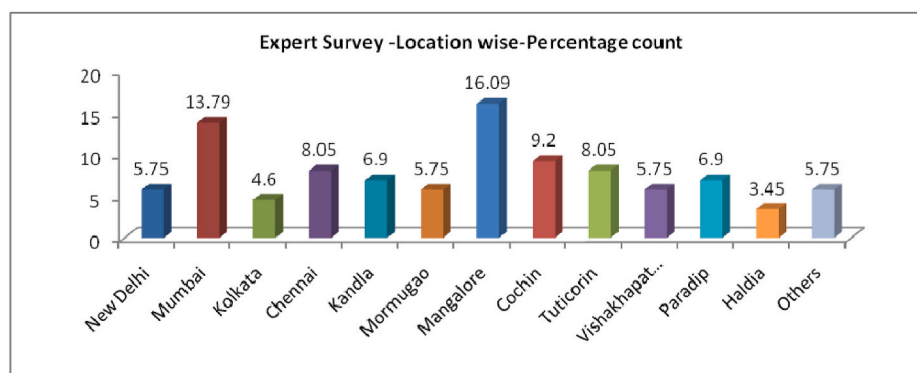


Fig. 4. Graphical representation of place of work of the experts.

Table 4

Descriptive statistics of impact of COVID-19 on maritime & port logistics activities.

Variable	Value	Frequency	Percentage
Impact of Coronavirus on maritime related activities in India	Significantly affected	39	44.83
	Moderately affected	33	37.93
	Somewhat affected	13	14.94
	Not affected	2	2.3
	Unsure	0	0

Source: Expert Survey & author's calculation

government support to maritime domain organizations in India for 6–12 months; while 25% of experts reported the response with the need for government support for a period beyond 12 months; while 20% of experts responded, stating that no assistance is required from the government at the present situation and 18% experts responded that there is

a need for government support to maritime organizations in India for a period from 1 to 6 months after COVID-19. Table 5 highlights the descriptive statistics of recovery & response of maritime organizations and stakeholders for COVID-19.

Experts also responded regarding the need to develop a recovery strategy by maritime domain organizations in India after COVID-19. With 98% of experts reported with response yes and 2% of maybe answer reported by experts, there is a need for the development of a recovery strategy by maritime transportation & port logistics organizations in India after COVID-19. Fig. 8 depicts a graphical representation of the need to develop a recovery plan strategy by maritime organizations in India after COVID-19.

The experts also responded on the rating of the government's support & response to COVID-19 on maritime supply chain and seaport logistics support business in India. All the respondent experts were satisfied with access to government business support measures for COVID-19 in the Indian maritime context. 99% of respondent experts were satisfied with the quality of communication provided on COVID-19 in the Indian maritime context. 82% of respondent experts were satisfied regarding

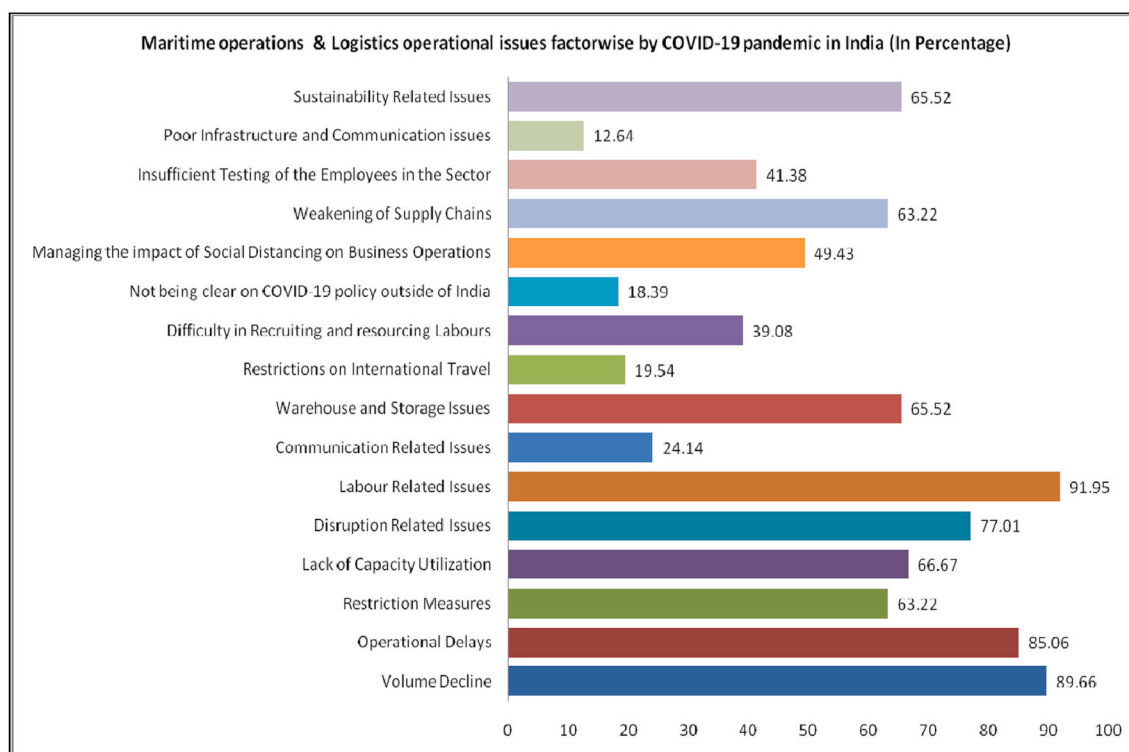


Fig. 5. Graphical representation of Factor wise issues with negative impacts on maritime operations.

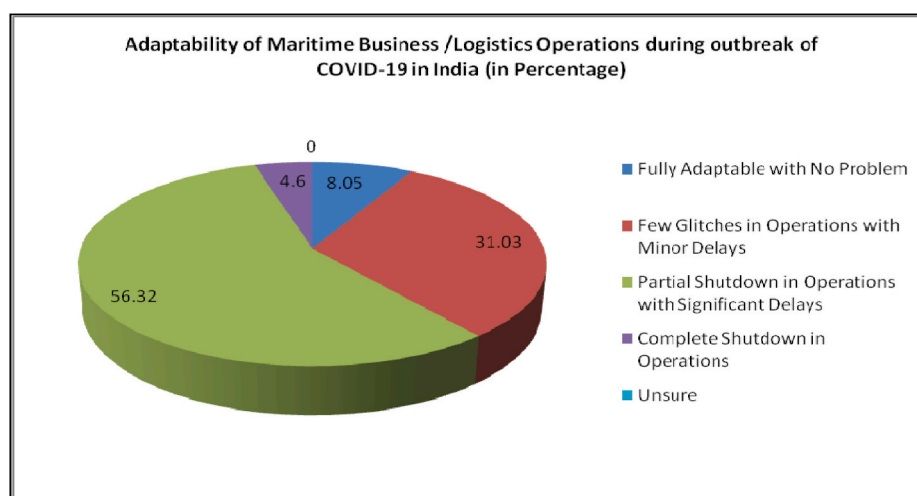


Fig. 6. Graphical representation of adaptability of maritime organizations & stakeholders for COVID-19 in India.

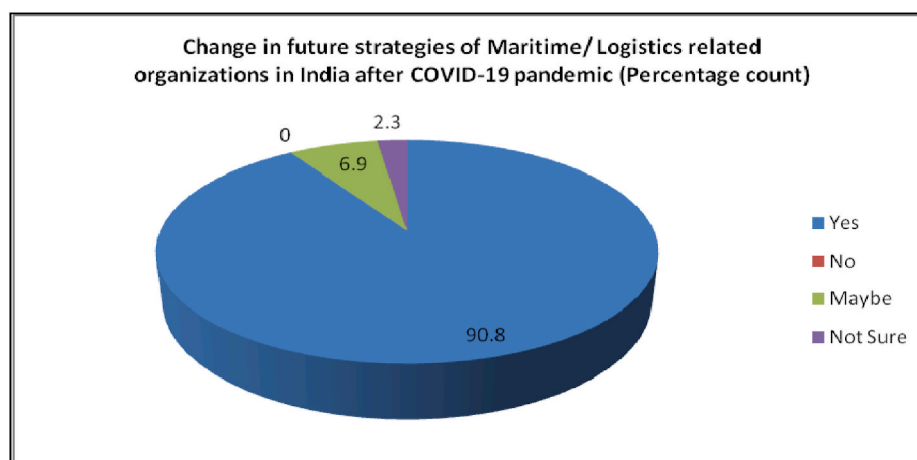


Fig. 7. Graphical representation of change in future strategies of Maritime organizations in India after COVID-19.

Table 5

Descriptive Statistics of recovery & response of maritime organizations and stakeholders for COVID-19.

Variable	Value	Frequency	Percentage
Government support for business recovery of Maritime chain organizations in India due to COVID-19	Support not required at present situation	17	19.54
	Need Support for 1–6 months	16	18.39
	Need Support for 6–12 months	32	36.78
	Need Support beyond 12 months	22	25.29
	Not confidence of business survival	0	0

Source: Expert Survey & author's calculation

clarity of communication & progress of the situation towards the exit strategy of lockdown mechanism from a maritime perspective. 99% of respondent experts were satisfied regarding the government's additional information, and response to COVID-19 on maritime supply chain and port logistics support businesses in India. Table 6 highlights the descriptive statistics for rating the government's support & response to COVID-19 on India's maritime chain business.

The experts also responded on long-term changes caused by COVID-

19 on the maritime & port logistics sector in India based on different variables. 98% of respondent experts agreed or fully agreed that online working would become popular post-COVID-19 in the Indian maritime context. 99% of respondent experts agreed or fully agreed that online services would become a standard service after COVID-19 in the Indian maritime sector.

95% of respondent experts agreed or fully agreed that online training and education would be a standard model in maritime and logistics education in India. 53% of respondent experts agreed or fully agreed that the maritime sector's working hours would become longer. In comparison, 25% of respondent experts disagreed or fully disagreed, and 22% of the respondents expressed their neutral opinions on longer working hours in the maritime-related sector. 98% of respondent experts agreed or fully agreed that digitization & smart technologies (big data, artificial intelligence, IoT, and robotics) would be the solution to the future of maritime supply chain and port logistics businesses in India.

19% of expert respondents agreed or fully agreed that community and fiscal systems would not return to the previous state as before COVID-19. In contrast, 45% of respondent experts disagreed or fully disagreed, and 36% of respondent experts expressed their neutral opinions that social and economic systems will not return to the previous state as before COVID-19. 93% of respondent experts agreed or fully agreed that changes in the maritime transport & logistics sector would improve resilience & sustainability after COVID-19. 78% of respondent experts agreed or fully agreed that cost structure might be altered

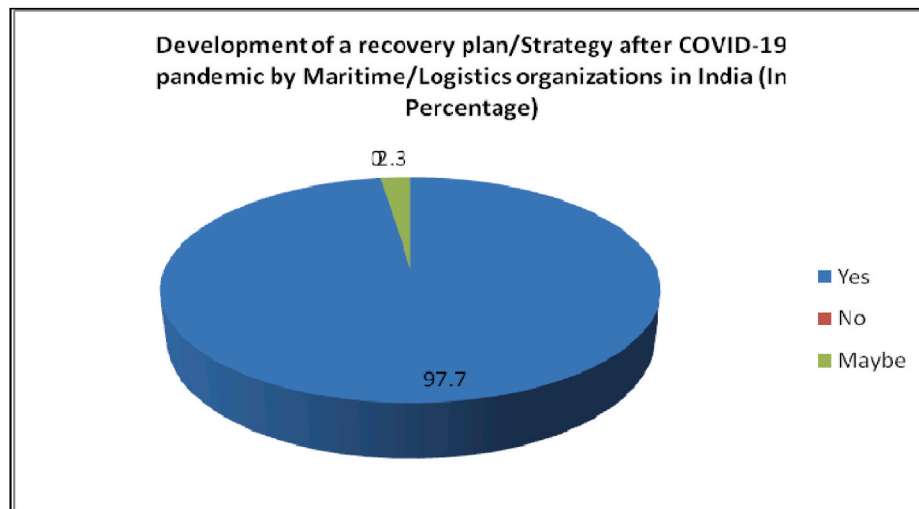


Fig. 8. Graphical representation towards need for development of a recovery plan strategy by maritime organizations in India after COVID-19.

Table 6

Descriptive statistics for rating government's support & response to COVID-19 on maritime business in India.

Rating government's response to COVID-19	Not at all satisfied	Partly Satisfied	Satisfied	More than Satisfied	Very Satisfied
Access to business support	0	0	48.2	44.7	7.1
Communication quality	0	1.2	50.6	44.7	3.5
Progress & clarity to exit strategy	0	18.2	65.9	15.9	0
Additional Information	0	1.2	68.2	30.6	0

Source: Expert Survey & author's calculation

considerably to organize for potential community health threats after COVID-19 in India. In comparison, 9% of respondent experts disagreed or fully disagreed, and 13% of respondent experts expressed their neutral opinions.

98% of respondent experts agreed or fully agreed that intervention of the government's support to the maritime domain would be strengthened after COVID-19 in India. 99% of respondent experts agreed or fully agreed that significant changes would occur, within five years, in marine transport & seaport logistics policy-making by lessons from COVID-19 in India. 61% of respondent experts agreed or fully agreed that induced growth of online business activities and automation in the maritime & seaport logistics domain would lead to more unemployment in India. In comparison, 19% of respondent experts disagreed or entirely disagreed, and 20% of respondent experts expressed their neutral opinions. Table 7 provides the descriptive statistics for long-term changes caused by COVID-19 in the maritime & seaport logistics sector in India.

Experts reported the factors through ranking system percentage-wise to support maritime & seaport logistics business in India to overcome the impacts of COVID-19. The top five factors were identified and ranked, including developing health, safety, and security aspects of maritime stakeholders; sustainable development of stakeholders and collaboration activities; improving proper policies, streamlining the process and strategic measures to fit various contingencies; business mentoring programs and support with skill and training development including recruitment. The other factors were support with resilience planning, enabling digitization & smart technologies, and investment in research & development projects & innovation. Fig. 9 depicts the graphical representation for ranking the factors to overcome the impact of COVID-19

Table 7

Descriptive statistics for long-term changes caused by COVID-19 in maritime & port logistics sector in India.

Long-term changes in Indian maritime sector due to COVID-19	Fully Disagree	Disagree	Neutral	Agree	Fully Agree
Online Working popularity	0	1.2	1.2	72.9	24.7
Online services as a standard	0	0	1.2	64.7	34.1
Online Training and Education model	0	0	4.7	84.7	10.6
Longer Working Hours	4.7	20	22.4	49.4	3.5
Future use of digitization & Smart technologies	0	0	2.4	47.1	50.5
Social and Economic system status	11.8	32.9	36.5	15.3	3.5
Contribution to improve resilience & sustainability process	0	1.2	5.9	77.6	15.3
Alteration in future cost structure	2.4	7.1	12.8	70.6	7.1
Strengthening of maritime sector post government support	0	0	2.4	55.2	42.4
Changes within 5 years in sector	0	0	1.2	71.7	27.1
Unemployment situation due to growth of online activities	3.5	15.3	20	56.5	4.7

Source: Expert Survey & author's calculation

for seaport transportation maritime logistics business in India.

#### 4.5. Expert additional suggestions

The online expert survey included an optional question regarding suggestions or opinions about the ongoing measures and the post-COVID-19 long term maritime/pandemic policies to recover the maritime transport and seaport logistics sector in India. The response to this question was responded by 19 experts in the online questionnaire survey. Expert's additional suggestions part was vital because it is a valuable information source that experts want to share what was happening in their location involving issues in the maritime area. These aspects also included sharing the expert's opinions about future changes and policies that could not be fully reflected in the question no.7 to 19 of the survey. Nineteen experts responded to the response to this question by providing opinions regarding ongoing measures and post-COVID-19 pandemic

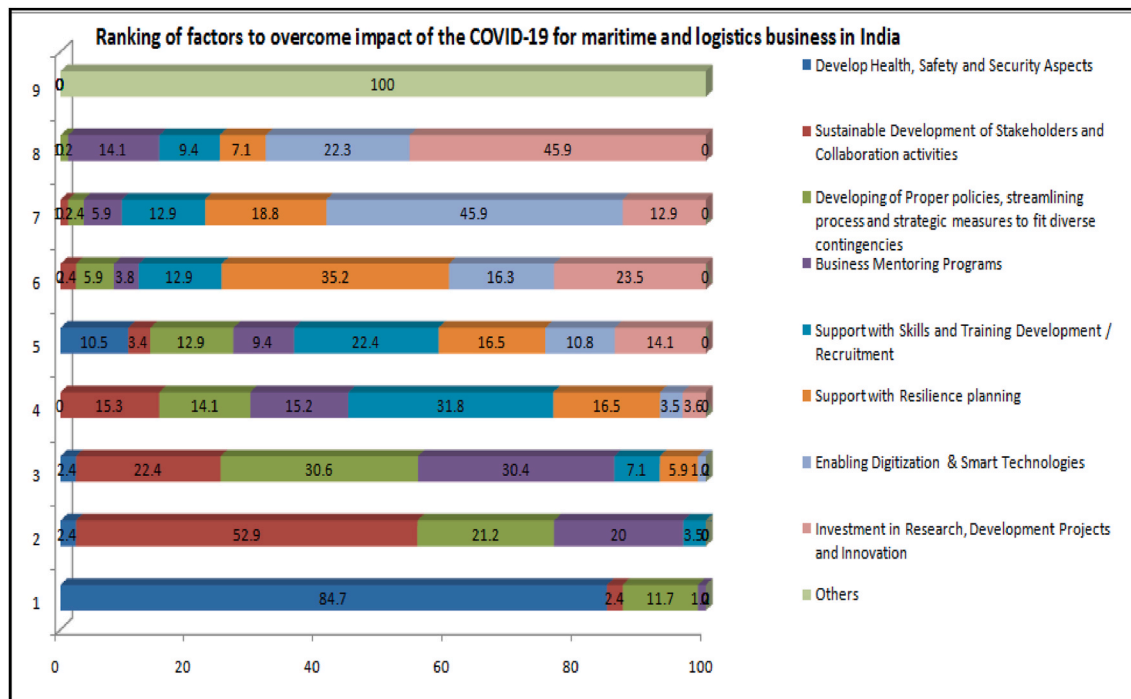


Fig. 9. Ranking factors to overcome impact of Covid-19 for maritime related business in India.

policies for the recovery of the maritime transport and seaport logistics sector in India. The detailed responses provided by 19 experts are highlighted in [Appendix B](#) section.

## 5. Discussion of policy implications

Seaports in India contribute around 1% of to India's GDP growth and maritime sector has been constrained due to many developmental, procedural and policy-related challenges of limited port infrastructure, sub-optimal transport modal mix for freight movement, limited hinterland transport linkages, low access of coastal and inland shipping, limited digitization & mechanization and procedural bottlenecks at various ports in India. The COVID-19 pandemic has prioritized the need for social responsibility of ports and more investment in healthcare services across the country. Also, much of the impact depends on the spread of the COVID-19 virus and on how the governments of different nations respond at the different stages of the pandemic. In wake of an outbreak of the COVID-19 Pandemic, the Government of India has specifically given exceptions to the operations of seaports for cargo movement, in order to ensure a regular supply of goods in the country. In wake of an outbreak of the COVID-19 Pandemic, the Government of India has specifically given exceptions to the operations of seaports for cargo movement, in order to ensure a regular supply of goods in the country.

To ensure smooth maritime operations and to handle the COVID-19, the Ministry of Port, Shipping, and Inland waterways has taken the following measures which include: waiver of the penal fee; digitization activities; force majeure on works; port safety measures; waiving off all charges for vessels carrying oxygen and oxygen related equipment cargo at major ports in India; utilization of seaport CSR funds to medical and community development activities during pandemic and return of seafarers (Ministry of Ports, 2021; IPA, 2021). On 16th January 2021, India started its national vaccination program against the SARS-CoV-2 virus which has caused the COVID-19 pandemic with the usage of Covishield and Covaxin as vaccines at different phases (MOHFW India, 2021). The Maritime India Vision-2030, a 10-year blueprint from Govt. of India, with the aim of overhauling the Indian maritime sector, with a complete

road map for the future aim to achieve Atmanirbhar Bharat through the Atmanirbhar Maritime Sector envisages Rs.3 lakh crores investment in port projects and generation of employment for 20 lakh persons (MIS, 2021).

The findings of cargo traffic volume, vessel call performance, and segment-wise cargo traffic volume are objective, accurate, reliable, and collected continuously throughout major seaports since they provide a basis of comparison between conditions before and during COVID-19 detection in the Indian maritime context. Through this study, data for cargo traffic volume, vessel call performance, and segment-wise cargo traffic volume could serve as a reflection of maritime societal and economic activity and, to an extent, the likelihood of maritime stakeholder interaction. The results indicate negative growth for cargo traffic volume, vessel call performance, and most segment-wise cargo traffic volume in major seaports. The results could serve as a reflection of low economic growth and an increase in unemployment in the Indian seaport transportation and maritime supply chain sector.

Further, major seaport's quantitative data and its analysis with research results present the pandemic's impacts in major seaports context. The results presented may be useful for future operational and strategic planning, recovery efforts, and for dealing with future epidemics in the maritime business in India. The efforts must be aimed at mitigating potential crippling consequences of the pandemic and measures involving improving operational efficiency, focus on cost reduction by the concept of rethink pricing; improving asset utilization & productivity; up-grading port capabilities & support infrastructure; streamlining and automating processes, and enhancing stakeholder participation.

The online expert survey results have important implications for seaport transportation and maritime supply chain for India. It was observed from this study that there is a high percentage impact of COVID-19 on maritime supply chain & seaport transportation activities in India. Hence, maritime policymakers should take such a high percentage of the effects of COVID-19 on the maritime domain by critically examining the major negative factors. The study also observed that there is a low percentage of preparedness level by maritime organizations and stakeholders for the COVID-19 pandemic situation.

Due to a lack of preparedness in operations, the maritime business had to face difficulties in adaptation during the COVID-19 situation, observed from low percentage results. Hence, maritime policymakers should take such a small percentage of complete preparedness level seriously and examine why there was a lack of preparations and difficulty in adaptation, considering that several pandemics had already occurred in the past in the Indian maritime context. The efforts must be aimed at developing a framework and guidelines for maritime stakeholders, preparing a business continuity plan, national logistics policy, development of the consolidated national institutional framework, and disaster management plan for the emergency circumstances to minimize the impact of a pandemic. Therefore, maritime authorities and the government should implement strict countermeasures at marine organizations in their jurisdiction.

Further, it is also observed from the expert study that there is a high percentage possibility of change in future strategies of organizations in India post COVID-19 pandemic situation. The expert study results indicate long-term changes in the Indian maritime sector due to COVID-19 digitization revolution reforms (e.g., the concept of online work from home, online maritime training & education services, online maritime stakeholder activity services). Marine transport service providers and cargo owners have to better forecast predictions and tools to foresee disruptions and improve maritime supply chain transparency and flexibility.

Based on the research study, short term policy suggestion to maritime authorities and policymakers is to prioritize the physical safety of their organizational employees and maritime chain stakeholders. They should place the necessary emergency response procedures to ensure that ports and shipping activities remain open for business. The short-term policy suggestion to the government from this study is to support maritime stakeholders through fiscal policies and ensure that social and economic systems are restored to the previous state as before COVID-19. A concerted response is needed from the government in close coordination with the private sector parties and other maritime stakeholders.

Further, support in the form of business recovery, providing quality information with proper communication, improvement of resilience & sustainability processes in the sector besides prime aspect of ensuring more employment opportunities and cost structure control for future public health threats. Government must also develop macroeconomic, fiscal, maritime trade, and labour growth policies, fostering innovation and encouraging private sector participation. The Government must lower industrial development barriers to promote localization of maritime supply chains that are required at times of crisis. The government should establish post-crisis innovation funds and build links between small maritime firms and research organizations to encourage shipping and marine innovation and enhance national competitiveness by promoting renewable energy, resilience infrastructure, and digitalization.

For seaport transportation & maritime decision-makers, the crisis poses a difficult challenge, yet it also offers an opportunity to learn from the developments, contribute to countering multiple pandemic waves, and prepare for a post-COVID-19 world. Marine transport service providers and cargo owners have to better forecast predictions and tools to foresee disruptions and improve maritime supply chain transparency and flexibility. The COVID-19 epidemic has reminded prior outbreaks and it is understood that there may be new future pandemics impacting on the businesses due to the restrictions and postponements in the trade cycles. Seaports need to be prepared and adaptive for awareness of new operation patterns the infrastructure and operations accordingly.

The current COVID-19 crisis is an opportunity to reset the maritime ecosystem that has relied on outdated processes in India. Creating smart and agile maritime supply chains is the key to building a global trade and investment setup that's capable of facing future pandemics. government should judge the efficacy and impact of recovery programs, governments need impact assessment capabilities. Thus, from a broad perspective of this research study, government & maritime policymakers may consider various long term supporting factors and measures to

overcome the impact of COVID-19 in the post-pandemic recovery phase are:-

- Development of health, safety, and security aspects (e.g., preventive measures of social distancing and allocate resources to permit hygienic usage, subsidizing medical supplies for the maritime workforce, usage of arogya setu application, infection inspection through testing and thermal gates, getting COVID-19 vaccination doses and analysis of mutation of the coronavirus);
- Sustainable maritime development of stakeholders & collaboration activities(e.g., complete operational functionality of maritime chain, development of marine clusters, addressing of financial distress of the maritime stakeholders by provisionally restoring the maritime transport services, environmental protection initiatives, community development, information sharing by various maritime stakeholders, training & education on COVID-19 through knowledge exchange & conference, job creation process, stakeholder support & participation, allocation of resources, proper decision making);
- Developing proper shipping related policies, streamlining the process and strategic measures to fit diverse contingencies(e.g., comply with standard operational procedures, congestion reduction, the concept of work from home, capacity building);
- Maritime Business mentoring programs (e.g., maritime entrepreneur business start up& support, strategy development, consultancy);
- Support with skill& training development in maritime and seaport logistics sector (e.g., maritime organizational internal training, employee personal skill development, job creation);
- Support with maritime resilience planning (e.g., development of maritime crisis cell, resilience infrastructure development, develop business continuity plan & disaster management plan for the emergency circumstances to handle critical activities of maritime supply chain and port logistics);
- Enabling digitization & smart technologies in maritime chain activities(e.g., maritime service automation activities, accessing of the document in digital form across the supply chain, usage of intelligent systems -AI, IoT, big data, block-chain technologies for maritime chain activities);
- Investment in maritime supply chain R&D projects &concept of innovation (e.g., reactivate/new investment projects, Industry-academia inter-disciplinary research, and collaboration).

## 6. Conclusion and future scope

This paper attempts to investigate the impacts of COVID-19 on seaport transportation and the maritime supply chain field and its related issues in India. This research paper initially discusses and presents a summary of the effects of COVID-19 on the present status of global seaports. This paper examines the impact of COVID-19 on major seaports in India by identifying the patterns for performance data before and during the COVID-19 crisis through secondary sources. The main findings from this study indicate that there has been a decline in total cargo traffic volume and a decrease in the majority of segment-wise cargo traffic volume and a reduction in vessel call performance during the COVID-19 period compared to the period before the COVID-19. This study explored the expert's views in the form of agreements and disagreements to the structural questions about impact, preparedness, response, and recovery aspects with additional suggestions through the free answer for seaport transportation and maritime logistics sector in India. Based on the results and extensive analysis of the expert survey's main findings, it is observed that there is a negative impact of COVID-19 on the maritime-related sector with a low level of preparedness and adaptability to handle the pandemic situation. We use the results and findings of this overall study to formulate the maritime policy to analyze the effects of COVID-19 in the Indian maritime context. There is a need to develop a future recovery strategy for organizations from a long-term perspective and support from the government to overcome the impact of

COVID-19 for maritime domain organizations in India. Further studies are required in the area in order to properly ascertain the extent of the impact on the health of maritime workers and also business, if a future epidemic is going to have holistic remediation within the maritime trade, with minimal crises unlike that witness in the Covid-19 crises. The work presented in this study can be expanded to global seaports to determine the impact of COVID-19 on maritime supply chain and seaport transportation. It would also be worthwhile for future work to conduct interdisciplinary research with other maritime technical fields and measure the impact of COVID-19 on the maritime environment.

### CRedit authorship contribution statement

**Prathvi Thumbe Narasimha:** Conceptualization, Writing – original draft, Carrying out Literature Review, Online Expert Survey Deployment & Response Parsing. **Pradyot Ranjan Jena:** Resources, Investigation, Supervision, Interpretation & Analysis of Data, Writing – review & editing, Providing Feedback to Manuscript. **Ritanjali Majhi:** Resources, Supervision, Interpretation & Analysis of Data, Writing – review & editing, Providing Feedback to Manuscript.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.tranpol.2021.05.011>.

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