

INTEGRATED SAFETY FOR SEA AND AIR TRANSPORTATION DURING THE COVID-19 PANDEMIC

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Abstract

How to cite this paper: Rizaldy, W., Suparman, A., Octaviani, R. D., Mulyawan, A., Ricardianto, P., Sugiyanto, S., & Endri, E. (2024). Integrated safety for sea and air transportation during the COVID-19 pandemic. *Corporate Governance and Organizational Behavior Review*, 8(2), 19–27. <https://doi.org/10.22495/cgobrv8i2p2>

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ISSN Online: 2521-1889
ISSN Print: 2521-1870

Received: 11.05.2023
Accepted: 18.03.2024

JEL Classification: R40, R41, Q54, Q56
DOI: 10.22495/cgobrv8i2p2

Climate change and COVID-19 have disrupted food supply chains and exacerbated food security challenges (Rasul, 2021). The safety of sea and air transportation in food delivery is also a disruption that impacts logistics in the food value chain (Singh et al., 2021). Integration of sea and air transportation safety during the COVID-19 pandemic, with a focus on the impact of climate change on food supplies and the rapid spread of viruses through air travel, is essential to ensure that food distribution is not disrupted. The research investigates the response of countries and major international organizations such as the World Health Organization (WHO), the International Maritime Organization (IMO), and the International Civil Aviation Organization (ICAO). The methodology used in the study was a systematic literature review (SLR) by identifying 875 journals in the first stage. Then, through strict screening, 50 articles were selected and further analyzed. Covering continents, specific countries, and important ports, the research uses quantitative databases such as the Scopus journal index. The study results reveal the long-term impact of the COVID-19 pandemic on the aviation and maritime sectors and its influence on global passenger and goods transportation. SLR's findings also bring together insights from diverse research on safety integration across different modes of transportation during the pandemic. Research provides recommendations — climate-related changes for safe transportation, applicable in normal and pandemic circumstances. In conclusion, this article comprehensively explains maintaining a safe and efficient transportation network amidst complex challenges.

Keywords: Climate Change, Sustainability, Integrated Safety, Sea and Air Transportation

Authors' individual contribution: Conceptualization — W.R., P.R., and E.E.; Methodology — R.D.O., S.S., and E.E.; Investigation — A.S., P.R., and E.E.; Resources — W.R., A.S., and P.R.; Data Curation — A.S., S.S., and E.E.; Writing — Original Draft — W.R., A.S., and P.R.; Writing — Review & Editing — A.S., S.S., and E.E.; Supervision — A.M., P.R., and E.E.; Project Administration — R.D.O., A.M., and E.E.; Funding Acquisition — W.R., P.R., and S.S.

Declaration of conflicting interests: The Authors declare that there is no conflict of interest.

1. INTRODUCTION

The COVID-19 pandemic since December 2019 has impacted the world, including countries (Nurhayati et al., 2021). The pandemic, the worldwide disaster of the twenty-first century, accurately represents the global economy and community in which we reside. This has resulted in a global shutdown lasting several months, with over seven million verified illnesses and over 511,000 deaths as of July 1, 2020. This pandemic has significantly influenced the worldwide economy and supply networks, including shipping, airplanes, and the workplace (Indrasari et al., 2022). Airlines and shipping lines are the leading worldwide industry supports (Majid et al., 2022). It accounts for 80% of global trade and is vital to supply chains. Airlines and shipping are the most efficient, dependable, and effective modes of transportation, especially for keeping supply chains open so that the cargo as the world's daily needs can be distributed critically during difficult times such as the current COVID-19 pandemic.

Global shipping by air or sea relies on almost 2 million seafarers and aircrew and ground handling for air cargo, allowing the globe to acquire the goods and supplies necessary for daily living. Bringing together all marine and aviation sectors to combat the pandemic and reduce dangers to global trade and human health is an excellent illustration of how a shared adversary, COVID-19, has been and continues to be a source of unity. All nations, governments, international organizations, and maritime actors are interested in the sea (Wahyuni et al., 2022). All relevant United Nations (UN) agencies, such as the International Maritime Organization (IMO), International Labor Organization (ILO), World Health Organization (WHO), and International Civil Aviation Organization (ICAO), and the maritime stakeholders, in particular shipping and ports, have collaborated extraordinarily to combat the pandemic and reduce the risks to global trade and human health. Besides the COVID-19 pandemic, the main problem is climate change, which must be anticipated during normal and pandemic conditions because climate change affects the weather, and the weather may have the potential to interfere or create obstacles such as floods on airports and seaports.

This article presents an outline of the global response to COVID-19 and climate change and their effects on freight transportation by air and sea. This underscores the significance of a deeper understanding of the role of sailors, aircrew, and airport ground personnel as crucial frontline workers during this pandemic and future crisis. In addition, it can assist managers and decision-makers in corporations in establishing appropriate safety risk management models in conjunction with checks conducted by relevant UN agencies, national governments, and maritime and aviation industries to address the effects of COVID-19 and climate change as governance challenges.

This introduction presents a review of several relevant literature related to water and air transportation. Several effects were recorded, especially in water transportation during the COVID-19 pandemic. In general, some research results show that the COVID-19 pandemic has a significant impact on seafarers, and the lack of participation

and involvement of workers in occupational health and safety management is problematic (Kaptan & Kaptan, 2023; Shan, 2022; Zhao & Tang, 2023). Research by Chen et al. (2023), explained that there was a considerable influence on cruise ships, such as a significant decrease in the number of ships, average speed, and average draft. However, there is a minor impact on the number of ferry passengers and a reduction in sulfur oxide (SO_x) emissions on cruise ships and ferries. Another study in China showed that seafarers experienced significantly higher fatigue levels during the pandemic (Zhao et al., 2023).

Meanwhile, air transportation also had an impact during the COVID-19 pandemic era. Some impacts include (Choi & Gibson, 2023; Khatib et al., 2021). So, policymakers and aviation organizations must improve future pandemic prevention mechanisms or extended periods of reduced flight operations. The review added that aviation organizations, with the support of regulators, should promote and integrate a culture of health, well-being, and safety (Cahill et al., 2023). So that aviation workers feel safe to routinely report wellbeing levels and challenges, and their impact on operational safety. In general, the COVID-19 pandemic is also taking rapid action to protect and ensure air transportation and whether adequate measures have been taken to protect flight passengers' health (Vasilj et al., 2021).

The structure of preparing a paper following the research phenomenon is explained in the introductory section as follows. Section 2 conducts a literature review on safety integration in sea and air transportation during the COVID-19 pandemic. Section 3 describes the methodology using a systematic literature review (SLR) to map out the issue of integrated safety for sea and air transportation during the COVID-19 pandemic. Section 4 presents the research results and discusses them in more depth. Finally, Section 5 presents the conclusions of the study findings, limitations of the study, and suggestions for future work.

2. LITERATURE REVIEW

2.1. Integrated safety and COVID-19

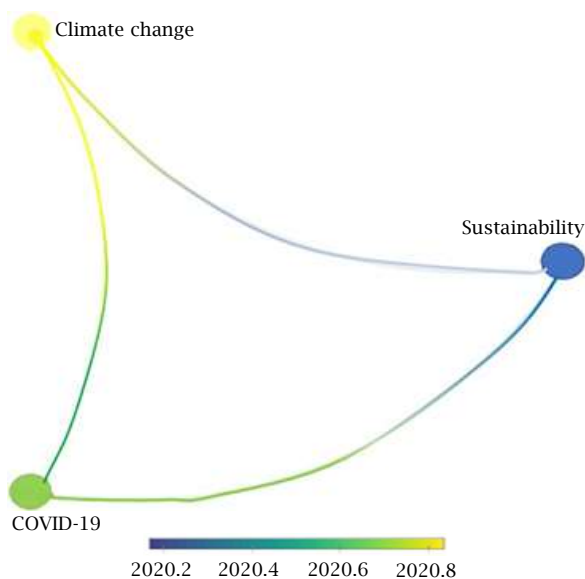
The coronavirus is still spreading, and it is difficult to predict when it will end. The COVID-19 pandemic has many potential effects that require further analysis, especially regarding the interaction and compounding challenges of COVID-19 and climate change. These can be addressed sustainably (Rasul, 2021). Transport is one factor that drives the food supply chain ahead and connects all its components. Several modes of transportation are available, including bulk maritime freight, rail transport, ocean containers, trucking, and home delivery services (Chitrakar et al., 2021). Therefore, there is a need for strategies and ways to combat the coronavirus and climate problem. Today, there is a unique chance to speed the transition to a more sustainable and resilient food system using the disruptive force of the COVID-19 pandemic and accompanying recovery programs (Rasul, 2021).

The COVID-19 pandemic has impacted human movement via lockdowns, social distancing restrictions, house quarantines, and the complete or partial cessation of transportation. Transport

networks must be robust to future pandemic outbreaks, particularly in big cities in the Global South, where demand for public transportation is strong and limited access might worsen socioeconomic inequities, necessitating immediate evidence-based policy recommendations (Hasselwander et al., 2021). Sustainability of the future of this sector, the industry must comprehend how COVID-19 has profoundly altered shipping and the shipping business regarding risk perception and the whole cruise experience, internal balance autonomy, and institutional leadership. Failure to identify and comprehend the intrinsic changes to roaming produced by the pandemic threatens the future viability of maritime travel (Holland et al., 2021).

According to Harris et al. (2015), an integrated multimodal transportation network is essential for enterprises to properly manage local and international supply chain activities. However, the complexity of multimodal integration, such as the participation of several operators, may hinder the expansion of multimodality. One of the primary hurdles is the need for more effective and efficient information communication across and among diverse forms (water, air, road, and rail). Nevertheless, multimodal transportation is integral to modern logistics systems, particularly long-distance international shipping (Seo et al., 2017). By utilizing VOSviewer and exporting the relevant item from ScienceDirect about integrated safety for sea and air transport during the pandemic, Figure 1 depicts the association between climate change, COVID-19, and sustainability, the three significant variables affecting this multimodal transport integration, notably for air and sea transportation. Moreover, we include the safety variable to ensure the supply chain and logistics function effectively during the COVID-19 pandemic.

Figure 1. Overlay visualization VOSviewer of the correlation between variables in one cluster

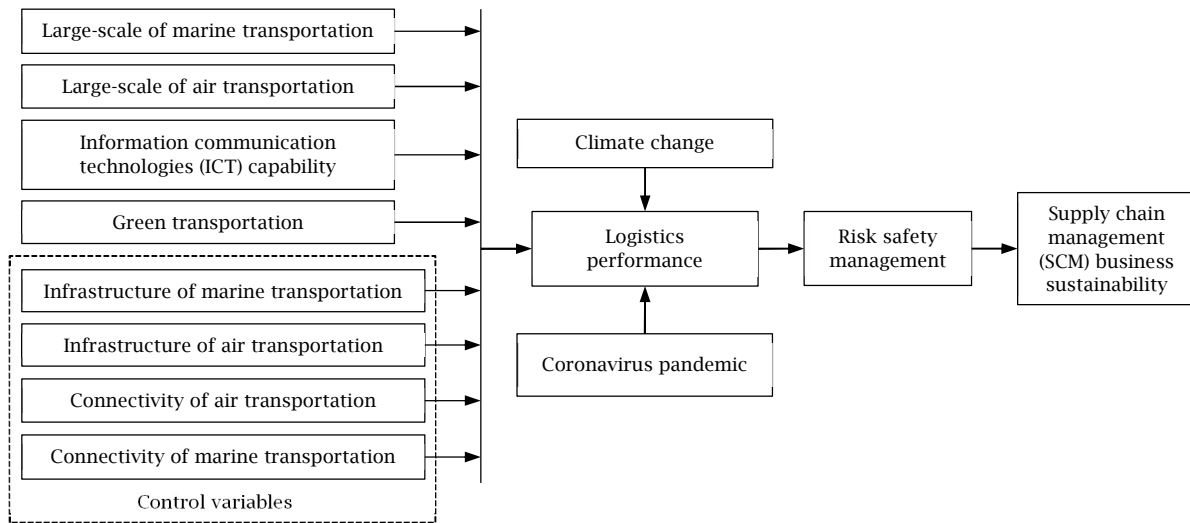


These variables also indicate that climate change and the present influence of COVID-19 on sustainability are the most important factors to consider while exploring multimodal transport integration. According to specialists, quickly changing viruses, the formation and reappearance of pandemics with increasing frequency, and climate-sensitive vector-borne illnesses are anticipated to grow over time. This trend is projected to continue and intensify. Infectious agents develop and spread into new ecological niches and adapt to new hosts in response to susceptible disease hosts, human activities, and environmental changes (Priyadarsini et al., 2020). Air transport is a crucial contributor to worldwide travel and has strict safety and security standards. The present pandemic has had a substantial impact on aircraft ground operations. This standard operating procedure must be revised to accommodate future sanitation needs (Schultz et al., 2020). In contrast to the importance of medical research in determining effective treatment protocols, technological innovation and social research can contribute by defining practical approaches to emergency management, especially in terms of optimizing the complex dynamics that arise between actors and systems during an outbreak or pandemic (Margherita et al., 2021). While climate change also contributes to the weather of a country, it may impact the functioning of facilities.

Already, major airports are at risk for coastal flooding. One hundred airports will be below the mean sea level due to the sea level increase linked with a worldwide average temperature rise of 20 degrees Celsius, whereas 1238 airports are in the low-elevation coastal zone (LECZ). In addition, global research has evaluated airport risk regarding anticipated yearly route delays (Yesudian & Dawson, 2021). Consequently, disruptive innovations in autonomous driving systems, new powertrain designs, and digital mobility are reshaping rural and urban mobility. With this technology potential, new mobility ideas such as demand-responsive transportation (DRT) can increase the cost-effectiveness and sustainability of people's daily travel (Schlüter et al., 2021).

Aircraft drones have been evaluated and may become safer for logistical handling or supply chain; they may also link emergency maritime vessels. Risk management is a requirement for all decision-making activities. In an increasingly internetted and data-centric global supply chain, risk management enables risk managers to make judicious decisions to accomplish desired results (Aboutorab et al., 2021). In addition, the transportation industry is no longer separated into land, sea, and air sectors. Integrated flows of combined transportation are the norm in the logistics sector. In combined transportation, it is crucial to establish a worldwide network through transportation and customs linkages (Cho & Lee, 2020). Then, we add the three factors of connectivity and safety to risk management in this essay. Therefore, the conceptual model will resemble the image below.

Figure 2. Chart of the conceptual model



Source: Cho and Lee (2020).

Pandemic outbreaks have had many overlapping and interdependent effects on the supply chain. As a result, traditional supply chain risk resilience techniques may require modification, such as maintaining an inventory of risk mitigation measures for many weeks of potential interruptions or utilizing subcontracted facilities. Due to the possibility of very lengthy interruption durations, proactive actions such as storing inventories are only helpful early in an outbreak. Similarly, regional, national, or continental lockdowns and quarantines will affect backup suppliers and subcontracted facilities simultaneously or gradually (Ivanov & Das, 2020).

Supply chain innovation facilitates the attainment of a sustained competitive advantage and the capacity to adapt effectively to rapidly changing markets despite substantial technical uncertainty. Innovation is a complex procedure that overcomes environmental and technological uncertainty to

develop and execute new approaches, ideas, products, and technology that satisfy customers. This is critical for delivering the strategic response to COVID-19's influence on supply chain disruptions (Akintokunbo & Adim, 2020). It is time to study highly disruptive supply chain factors. Pandemics are one example, but climate change, financial crises, terrorist attacks, and political conflicts can result in equivalent disruptions. For instance, insurance companies frequently produce global risk maps for supply networks highlighting geopolitical danger regions. To mitigate this potential geopolitical risk, businesses can consider the techniques mentioned below, such as eliminating single sources from high-risk locations and creating safety stockpiles (Kovács & Sigala, 2021).

When we compare the handling of airfreight and seafreight related to safety, Table 1 is as follows.

Table 1. Safety comparison

Indicator	Cross border trucking 🚚	Airfreight ✈️	Seafreight 🚢
Ease of use	Not as strict as airfreight	Strict safety standards could limit the types of items shipped, and it tougher to ship bulkier items	Not as strict as airfreight
Cost (per volume basis)	Average	Most expensive	Cheapest
Speed	Average	Fastest	Slowest
Notes	In Southeast Asia (SEA), limited to Indochina ^a region	Items shipped via courier (airfreight) benefit from <i>de minimis</i> rules at customs	Most major SEA trade hubs are easily accessible by sea, which lets trade flow by seafreight easily

Note: ^a Indochina region refers to Southeast Asian countries that share land borders like Singapore, Malaysia, Thailand, Vietnam, and others. Source: Leong (2020).

2.2. Safety and sustainability on cross-border trucking, supply chain

The risks placed on different segments of a multimodal supply chain rely on several variables, and many practitioners believe their company's operations are relatively unique. Therefore, effective risk management demands a comprehensive perspective. Increasing supply chain visibility and communication will facilitate the identification of risks, making them easier to manage (Vilko & Hallikas, 2012). Several academics in China have

presented hybrid robotic optimization (RO) and mixed integer linear programming (MILP) methodologies, which connect social restrictions to current supply chain limitations in probability and probability circumstances. When operating under uncertainty, supply chain managers may utilize MILP and RO to assess cost-benefit trade-offs regarding green facility location and supply chain cost decisions (Sundarakani et al., 2021). Several measures have been implemented in Africa, such as reducing tariffs due to the post-COVID lockdown, which will contribute to lowering costs and increasing

the availability of COVID-19 goods and services, as well as reducing taxes and taxes administrative burdens on importers and exporters, food prices, and others. Access to digitally enabled services such as cross-border electronic commerce, electronic payments, electronic signatures, and electronic contracts would facilitate contactless trading and remove any delays in cross-border commerce (Obayelu et al., 2021).

Several proposals guarantee vital, realistic, and sustainable operations in the event of a hypothetical future pandemic:

- 1) import of technology into the delivery of business products;
- 2) social reengineering of business innovation;
- 3) introduction of novel insurance packages (Sackey et al., 2021).

We gained knowledge from Taiwan. Critical elements of the “collaborative governance” model include cooperation between central and local governments, coordination with large non-governmental organizations and associations, mobilization of corporate resources to provide essential goods, and a combination of effectively implemented measures. Blocking, tracking, and isolating potential sources of infection, together with high public compliance, enables Taiwan to obtain an excellent “grade” in the worldwide wave of COVID-19 (Huang, 2020).

Analyzing the network structure and engagement of individual stakeholders, including the crisis management and leadership teams, in how the Antwerp Port Authority (APA) addresses the COVID-19 outbreak. Meeting notes and minutes were used from three sorts of meetings: crisis management team meetings, maritime partners meetings, and leadership team meetings. The data covers 12 weeks (January 20 to April 12, 2020) and contains 53 encounters with 73 individual participants (van den Oord et al., 2020). We want to urge network practitioners and experts to reassess current design and governance by providing descriptive data on structure, governance, and crisis management evolution by the APA lead network before and during the COVID-19 pandemic — a network of groups fighting the COVID-19 pandemic (van den Oord et al., 2020).

2.3. Safety and sustainability of airfreight, drone, and new technology

Existing vehicle routing models are suitable and may be extended to include drones since one perspective on drones is that they are merely an additional mode of transportation with specific capacity, range, cost, and performance characteristics. A different viewpoint is that drones are a disruptive technology with new capacities to deliver new services, necessitating a new routing paradigm. The first perspective leads readily to expanding current optimization models for vehicle routing problems (VRP), arc routing, and location routing to include drones. Significant work has been achieved in this direction (Poikonen & Campbell, 2021) on how a backup transportation system built on current drone infrastructure may be crucial in addressing the COVID-19 pandemic and similar crises.

Based on practical facts, we identify several cases in which time or cost savings might be utilized; still, drones provide a contactless, flexible,

and fast alternative to conventional forms of transportation. Utilizing the current drone infrastructure, we built a comprehensive disaster response mechanism requiring little or minimal investment (Kunovjanek & Wankmüller, 2021). The use of drones or their integration with other forms of transportation to ensure the supply of necessities while preserving social distance are some specific potential research areas, as well as synthesizing the results of the studies that have been reviewed by grouping them into four main themes: the impact of the COVID-19 pandemic on supply chains, strategies to deal with these impacts, the role of technology in implementing these resilience strategies, and sustainable supply chains (Chowdhury et al., 2021; Ricardianto et al., 2022).

2.4. Safety and sustainability of seafreight, cruise port, and maritime

It is difficult to predict the future, but by examining the potential of various maritime futures, it is possible to gain insight into the possible maritime sector options that the European Union (EU) and member states can pursue, as well as the enabling and constraining conditions for addressing the uncertainties of the post-COVID-19 period (van Tatenhove, 2021). This article analyzes the enabling and inhibiting conditions for the EU, member states, and maritime sector to deal with the consequences and uncertainties of the COVID-19 pandemic based on various future options (“on board”, “single-handed sailing”, “all hands on deck”, and “to provide a wide berth”). The COVID-19 crisis may rebalance strategic and operational difficulties in Mediterranean Cruise Ports.

Monitoring the situation and analyzing the re-emergence of equilibrium is crucial (Pallis & Papachristou, 2021). This calamity has proven the necessity for improved post-disaster response management, recuperation, and restoration of social and economic activity. Spectacular deficits, massive corporate bankruptcies, job losses, massive disruptions, dislocations, and human suffering have occurred, necessitating more research on the crucial role transportation plays in the recovery from these calamities (Kim, 2021). In Colombia, the government restricts passenger air travel and only permits airfreight for medical and essential supplies. In addition, public vehicles can be at most 35% of their capacity. Such a program will have detrimental effects on the transportation industry’s economy, aggravating the financial crises of public transportation system operators and airlines. During the initial three months of COVID-19, freight was the most resilient aspect of transportation. Therefore, the government should pay subsidies to sustain the system’s supply to prevent overcrowding and encourage active transportation by allocating less-frequented road space to bikes and pedestrians. Shortly, transportation service companies will seek government aid to recover from a financial crisis aggravated by the pandemic (Arellana et al., 2020).

3. RESEARCH METHODOLOGY

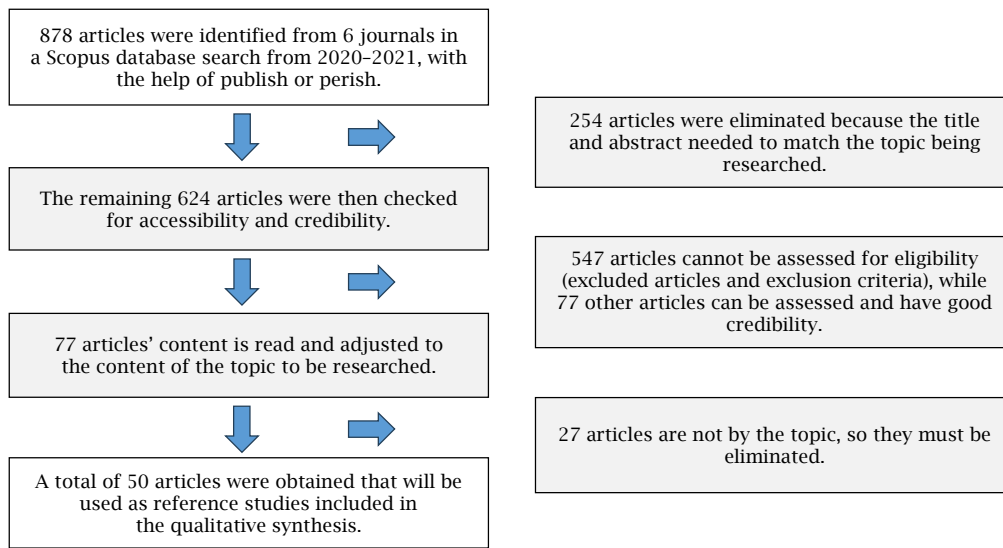
Okoli and Schabram (2010) developed an SLR strategy. Typical explanations for a literature review include the following.

There are six motives for performing a literature review. This project involved a thorough literature evaluation on the issue of integrated safety for sea and air transportation during the COVID-19 pandemic. An SLR is a research approach that identifies and evaluates relevant research and collects and analyzes study data.

This review aims to offer a current summary of the state of research knowledge (Setiawati et al., 2022) systematic literature. The study also addresses the most common difficulties in research, particularly prejudice. This SLR gathers all empirical material that satisfies the predetermined eligibility criteria to answer the research question. A flowchart illustrates how researchers look for and choose journal articles

for their research. We identified 875 journals in the first stage. A bigger sample size can give more complete coverage of the available evidence and boost the review’s statistical power. It also enables more thorough analysis, subgroup comparisons, and investigation into potential causes of variability among research. Then, we processed the selected journal, obtained the number of related journals, and quantified these journals to arrive at 50 articles or around 5.71%. In an SLR, filtering the sample is a critical stage in the research process. Filtering is applying predetermined criteria to the original pool of studies obtained through the literature search to pick the most relevant and appropriate research for inclusion in the review.

Figure 3. Chart of the process of searching



4. RESULTS AND DISCUSSION

Figure 3 above and Table 2 below chronologically explain the collection data process from the first 878 articles related to the title. Then, after filtering three times, the last number of articles related to the matter became 50.

Below are the results of quantitative research on SLR in Table 2. This screened matter of integrated safety for sea and air transportation during the COVID-19 pandemic.

Table 2. Steps for selecting journals and data extraction

Journal name/ Link name	Total records identified through database search (2020-2021) n = 878	Based on research/review research (journal)/ records screened n = 624	Full-text articles assessed for eligibility (excluded articles and exclusion criteria)	Studied included in the qualitative synthesis
ScienceDirect	98	78	19	19
Emerald	20	16	2	2
Springer	13	4	2	2
Wiley	23	22	3	3
Taylor & Francis	5	4	1	1
Google Scholar	719	500 (related to transportation)	50	23
Total collected articles			77	50

Journal analysis of research questions in SLR related to integrating safety for sea and air transportation during the COVID-19 pandemic on Scopus (for Google Scholar). After we learned from

the countries and matters faced by them in the above references, below is the table related to the country.

Table 3. Countries or areas affected by the COVID-19 pandemic and how they act to solve the matters by supply chain management

No.	Continent/country/area affected	Certain matters on transportation and supply chain	Specific solution from the party concerned
1	Africa	Tariff reductions due to the post-COVID lockdown will contribute to cost reductions and increased availability of COVID-19 goods and services, reduced tax and administrative burdens on importers and exporters, costs of food and other products consumed by people experiencing poverty, and support economic recovery and building resilience.	Access to digitally enabled services such as cross-border electronic commerce, electronic payments, electronic signatures, and electronic contracts will help facilitate contactless trading and eliminate delays in cross-border trade.
2	Colombia (South America)	Prohibit air transportation for passengers and only allow air cargo for medical purposes and necessities.	The government should provide subsidies to maintain system supply to avoid overcrowding and promote active transport by allocating less-used road space for cyclists and pedestrians.
3	China	Proposed hybrid RO and MILP methods that relate social constraints to modern supply chain constraints in situations of probability and probability.	When operating under uncertainty, supply chain managers can use MILP and RO to examine cost-benefit trade-offs concerning green facility location and supply chain cost decisions.
4	Taiwan	In the "collaborative governance" model, key elements include collaboration between central and local governments, coordination with non-governmental organizations and significant associations, and mobilization of corporate resources to provide essential goods.	Have an outstanding "report" on the global wave of COVID-19.
5	Mediterranean	The COVID-19 crisis may once again shift the balance between strategic and operational challenges.	Further adjustments due to COVID-19 or similar crises.
6	Antwerp Port Authority (APA)	Provide descriptive evidence on the development of structure, governance, and crisis management.	leading the network before and during the COVID-19 pandemic, we look forward to engaging network practitioners and experts to rethink the design and governance of today's organizational networks in the organizational field.
7	European Union (EU)	Face the consequences and uncertainty of the COVID-19 pandemic according to different alternatives in the future.	It limits and enables the conditions to deal with the uncertainties of the post-COVID-19 period.

From 7 countries affected by the above, in Africa, post-COVID lockdown, the tariff reductions will lower costs, increase COVID-19 goods and services availability, alleviate tax burdens, support economic recovery, and consider restrictions on passenger air transportation in favor of essential cargo. In Columbia, South America, passenger air transportation is prohibited, allowing only essential air cargo for medical purposes and necessities. While in Asia, especially in China and Taiwan, the proposed hybrid RO and MILP methods integrate social constraints with modern supply chain constraints, considering probabilistic scenarios and the "collaborative governance" model involves central and local government collaboration, coordination with non-governmental organizations and significant associations, and leveraging corporate resources to ensure the provision of essential goods, in Europe where Mediterranean and Antwerp, as well as the EU, the COVID-19 crisis has the potential to reshape the balance between strategic and operational challenges, necessitating a focus on the development of structure, governance, and crisis management to address the uncertain consequences of the pandemic.

The solution for the overall countries affected above is as follows: the availability of digitally enabled services can streamline cross-border trade, while subsidies for system supply and active transport promotion can alleviate overcrowding; MILP and RO can aid supply chain managers in making green facility location and cost decisions amid uncertainty; a comprehensive report on the global COVID-19 wave is expected to drive rethinking of organizational network design and

governance, enabling better adaptation to post-pandemic uncertainties.

However, numerous contradicting difficulties with digital solutions were discovered. Some buyers hesitated to order online because they were concerned that the product may be contaminated after delivery. Respondents suggested that the products be sterilized before being delivered. Second, clients were hesitant to get a product from the delivery person because the delivery person could potentially be ill with it (Mazhar et al., 2021).

5. CONCLUSION

COVID-19 has continued to be recovered in the air and maritime industry and world passenger traffic and cargo logistics for the foreseeable future. Climate change must be anticipated for safe transport in standard or during the COVID-19 pandemic. From the analysis of SLR that has been conducted to investigate adoption problems, assesses, and combine the results of individual studies related to safety integration among multimodal transport involved during the pandemic with quantitative $n=875$ Scopus journal, after screening ended up with most 50 relevant articles (now still 29 of 50). The most common practice to integrate the safety of sea and air transportation during the pandemic is to get government or port authorities to proactively consolidate and organize the stakeholders with proper plans and execution of some new recommendations and technology introduced by practitioners and researchers to recover and confidently face the pandemic COVID-19

to ensure sustainable supply chain of logistic, and this to maintain the macroeconomic on the countries affected. Our limitation of this research is that the pandemic is still a new thing in 2020; even though many researchers have submitted article

previously, COVID-19 has moved to a new phase because some new variant of the strain has been found in some countries; therefore, need more attention for the researcher on following research to have a better way on this new variant matter.

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