

Article

Evaluating the Impact of COVID-19 on Multimodal Cargo Transport Performance: A Mixed-Method Study in the UAE Context

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Abstract: This research is a case study on the United Arab Emirates (UAE), exploring multimodal logistics, which involves transporting cargo using multiple modes of transportation, and investigating its challenges and opportunities during the COVID-19 pandemic from 2020 to 2022. Through a mixed-method approach of qualitative interviews and quantitative surveys, this study examines factors influencing multimodal cargo transport and its performance. Five senior executives from the logistics industry were interviewed to identify key variables, and a questionnaire was administered to 120 participants to assess the impact on shipping costs and utilization. This study reveals a significant relationship between geographical and geopolitical risks and increased shipping costs in certain regions, highlighting the need for secure and cost-effective multimodal solutions in these areas. However, shipping costs did not mediate the performance of intermodal transportation at transit hubs during the pandemic. The findings offer valuable insights for transit hubs to enhance the utilization of multimodal cargo transport during uncertain times, ultimately leading to improved logistics performance in similar hub countries. This study's originality lies in its investigation of the resilience and sustainability dimensions in multimodal logistics during the pandemic, proposing mitigation strategies and enhancing strategic decision making in the logistics industry under volatile business environments. Future research is recommended to expand the model's results by including data from other logistics corridors and hubs.

Keywords: multimodal cargo transport; freight transport; logistics hub; COVID-19 logistic challenges; logistic performance; VUCA theory



Citation: Aljadiri, R.; Sundarakani, B.; El Barachi, M. Evaluating the Impact of COVID-19 on Multimodal Cargo Transport Performance: A Mixed-Method Study in the UAE Context. *Sustainability* **2023**, *15*, 15703. <https://doi.org/10.3390/su152215703>

Academic Editor: Tamás Bányai

Received: 2 August 2023

Revised: 26 September 2023

Accepted: 16 October 2023

Published: 7 November 2023



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1. Introduction

The COVID-19 pandemic caused a major disruption in nearly every industry worldwide in 2020, including the logistics sector, in which companies were unable to move goods from one place to another. Original equipment manufacturers and suppliers rely on a multimodal transportation strategy to balance cost, transit time, and service quality. However, during the pandemic, the implementation of this strategy became a significant challenge for companies where trucks and cargo were piled up at various transit hubs [1], resulting in material shortages and delivery delays that propagated throughout the supply chain. The UAE is considered one of the most successful countries in adopting multimodal transport services with numerous high-tech transit hubs connecting global services.

During the COVID-19 pandemic, the performance and capacity utilization of multimodal transit hubs became uncertain due to unforeseen changes in demand and risks posed by geography and politics [2,3]. Companies struggled to understand customers' purchasing behavior across different channels, leading to increased fluctuations in demand and material flow in the downstream supply chain. Furthermore, the implementation of

restrictions on the inflow and outflow of goods by governments to control the spread of the COVID-19 virus heavily impacted the transportation industry and caused much of the cargo to be halted in transit hubs. While companies tried to reduce geographical risk by reallocating their distribution hubs, this resulted in decreased operational performance and increased logistics costs. The impact of the multimodal transport strategy on the logistics service provider, transit hub, and economy of the UAE during the pandemic has yet to be fully evaluated and assessed. To address this aspect, this study proposes a mixed-model approach to measure the impact of multimodal transport systems during the COVID-19 disruption event. It also incorporates the VUCA business model (Volatility, Uncertainty, Complexity, Ambiguity), as proposed in [4,5], to help logistics managers understand the significant impact of the multimodal transport strategy and develop a recovery strategy during this challenging period.

The concept of multimodal cargo transport has been described in various ways in supply chain management. According to the United Nations Convention on International Multimodal Transport of Goods [6], multimodal cargo transport involves the transportation of cargo or goods from one location to another using multiple modes of transportation [2,7,8]. The modes of transportation change at transit hubs that are located between the origin and destination. The multimodal system is considered an optimization system for the movement, storage, and handling of goods that pass through various economic activities [1,9,10].

Studies have attempted to integrate the VUCA model in the logistics industry to assess its impact on management processes [4,11,12]. VUCA is a business theory model originally developed by the US Army and was first used in 1987. It represents the continuous and unpredictable changes that are now the norm in several industries. The COVID-19 pandemic is considered a VUCA event as it demonstrated Volatility, Uncertainty, Complexity, and Ambiguity [13] as follows:

- **Volatility:** The market's constant state of change and unpredictability means that businesses must be agile and ready to adapt to new circumstances quickly. The pandemic has accelerated shifts in consumer behavior and market dynamics, making it crucial for organizations to navigate these volatile conditions with flexibility.
- **Uncertainty:** The ongoing uncertainty surrounding the pandemic, from its duration to the effectiveness of vaccines, makes it challenging for organizations to plan for the future. Effective decision making requires acknowledging this uncertainty and building contingency plans to mitigate potential risks.
- **Complexity:** The COVID-19 pandemic has introduced a level of complexity that affects various aspects of society and business. The interconnectedness of global supply chains, healthcare systems, and economic markets means that disruptions in one area can have cascading effects. Managing this complexity necessitates holistic and interdisciplinary approaches to problem solving.
- **Ambiguity:** There is no one-size-fits-all solution or clear playbook for organizations to follow when dealing with the challenges posed by the pandemic. Ambiguity requires organizations to embrace experimentation and innovation while acknowledging that they may need to adjust their strategies as new information becomes available. The current situation can be described as the "VUCA world" as it covers all four uncontrollable characteristics. Business leaders use the VUCA model to make decisions and solve problems by looking towards the future. For leaders, VUCA means being more agile or flexible in the face of change [12]. This study will address its theoretical contribution to the VUCA business model.

To understand the practical impact of VUCA on multimodal cargo transport, the researchers conducted interviews with senior executives from the logistics and freight forwarding industries in the UAE. The findings from the interviews provide practical insights into the challenges faced by the industry in the context of the VUCA world, specifically during the COVID-19 pandemic. This information is useful for policymakers, multimodal transportation service providers, and the research community to develop

strategies to better prepare for future pandemics and other unpredictable events. This study aims to address the following three questions:

- RQ1: What are the key challenges faced by the logistics and freight forwarding industries in the UAE during the COVID-19 pandemic?
- RQ2: How has the VUCA world impacted the utilization and performance of multimodal cargo transport in the UAE?
- RQ3: What strategies can be employed in the UAE context to enhance the resilience of multimodal cargo transport in the VUCA world?

The primary objective of this research is to examine the current challenges and opportunities in multimodal cargo transportation with a focus on enhancing international shipping. This research will concentrate on the United Arab Emirates (UAE) as a transit hub and will analyze ways to improve the country's capability to handle transshipments through its terminals, thereby enhancing the global logistics and supply chain. While most existing research focuses on specific countries or regions, such as China, Singapore, and Hong Kong (as indicated in the Section 2), this research will assess the impact of multimodal transport in the Middle Eastern country of UAE during the pandemic.

This study will also aim to understand the effect of such enhancements on the local economy of the UAE, including the impact on local airlines, shipping companies, logistics and freight forwarding businesses, etc. This research will address various factors that impact the choice of a transit hub and the performance and utilization of multimodal cargo transport methods during times of uncertainty, with the goal of identifying alternative transportation methods beyond traditional methods [14,15].

Additionally, this research will provide valuable insights for organizations seeking to access new markets for freight movement during periods of disruption beyond regular shipping methods [16]. Although previous studies have explored supply chain uncertainty and risk, the COVID-19 pandemic has created a unique and unprecedented situation in the global logistics and supply chain network, making it increasingly important to advance research and practices in supply chain resilience [17,18].

This paper is organized as follows. In Section 2, we review the related literature on the multimodal transport system, which is categorized into four themes: the concept of multimodal cargo transport, the impact of multimodal cargo transport on international shipping, the selection of transit hubs during disruptions, and the logistics performance measures in the UAE. Section 3 details the research methodology, while Section 4 presents the results and findings. This paper concludes with an insightful discussion in Section 5, followed by a conclusion and recommendations for stakeholders.

2. Literature Review

To accurately measure the utilization and performance of multimodal cargo transport during the pandemic, it is crucial to consider several key factors. Firstly, companies must understand the fluctuations in demand during the disruption period. Secondly, the ability to match capacity with demand is critical for transit hubs, and the availability of capacity during the pandemic presents a significant challenge for transit service providers [19]. Furthermore, geographical risk, especially with regard to changing government policies in various countries during the pandemic, creates new and complex challenges for logistics managers to respond to quickly [20]. These factors have a major impact on the performance of multimodal transport systems. Consequently, our literature review focuses on these critical factors by studying the concept and impact of multimodal cargo transport on international shipping, the selection criteria for transit hubs during epidemics, and the performance of multimodal logistics in the UAE.

2.1. Impact of Unprecedented Events on the Logistics Industry: A Review

Multimodal cargo transport is a common strategy for logistics companies to reduce the cost and time of transporting goods from origin to destination using multiple modes of transportation [21,22]. Freight mobility, or the smooth and efficient flow of cargo, is a crucial

constraint in the logistics industry [23]. This constraint is due to physical, operational, and regulatory factors, such as physical constraints like connecting rail, sea, and land terminals, operational factors like switch conflicts and terminal yard inefficiency, and regulations like parking restrictions and labor laws [19,24]. Cargo transport is a key element in the supply chain that ensures the timely availability of raw materials and finished products [25,26]. The demand for cargo transport is driven by the geographical distances between producers and customers, and traditional, single-mode transportation methods are becoming less efficient for international trade markets [27].

One of the defining features of multimodal cargo transport is that it allows for a single set of documents, one cost, and one liability for the entire journey [28,29]. The freight forwarder or multimodal cargo operator is responsible for the cargo from the shipper's door to the delivery point, offering a single set of documents and one charge for all modes of transportation [30]. Carriers performing multimodal cargo transport do not necessarily need to own all means of transport, as freight forwarders have evolved from agents to carriers who take on more responsibility and liability as multimodal transport operators (MTOs) [10,31].

Numerous research studies have been conducted on the topic of multimodal transport of cargo and passengers in the international shipping and travel industry [32]. Shen et al. [33] developed a model to evaluate and determine the most optimal multimodal transport route between China and Thailand based on cost, time, and risk factors. The results of the model provided the best route for international shipping, demonstrating its effectiveness and practicality and offering a basis for decision making. The impact of the COVID-19 pandemic on multimodal transport was further investigated by Mavi et al. [22] via a research-focused parallel-ship network (RFPN) analysis. Their findings revealed that transport operations, technological innovation, transport economics, transport policy, and resilience and disaster management were the key factors that impacted freight transport during the pandemic.

Jiang and Zhang [34] analyzed the effects of the airline and high-speed rail via a hub airport with capacity constraints. Their research found that cooperation between the airline and high-speed rail reduced traffic in markets where the rail was accessible but increased tariffs in markets where it was not. This highlights the importance of multimodal transport connectivity and availability in determining the location of a transit hub.

Jiang et al. [35] extended this study to examine the impact of air–rail cooperation on market structure. They proposed a theoretical model to address the impact of partnerships between domestic and international airlines and between airlines and rail services. They found that cooperation between international airlines and rail services has a positive impact on both operation costs and passenger travel costs.

Ardliana et al. [36] looked at the supply chain from a sustainability perspective, proposing a multi-echelon and multimodal transport supply chain system that minimizes carbon emissions. They considered multiple products, multiple plants, multiple departures and arrival stations, and multiple customers over multiple periods. Pizzol [37] compared the emissions produced by sea–land multimodal transport and land transport. This study assessed the environmental performance of the carbon footprint of multiple routes in multiple transport corridors in the Scandinavian region, using methods, databases, and software from the lifecycle evaluation field. The findings showed that for long routes, multimodal transport can have a positive impact on emissions and carbon footprint, but this also depends on the sea freight ferries used and the type of fuel used. This study was based on statistics and developed a model to study the impact of transportation modes on the environment.

Beresford et al. [38] focused on the multimodal supply chain and determined the most appropriate multimodal combination for large volumes with high weight-to-volume ratios. The authors analyzed various modes of transportation and concluded that the best combination was sea and rail. The study was conducted on the Australia–China iron ore trade, and the findings were derived using a cost model, interviews, and a questionnaire

to gather primary data. The report is limited to one type of cargo, dense cargo, which suggests the need for further research to determine if the type of cargo impacts the choice of transportation.

Seo et al. [39] compared seven different multimodal methods for transporting shipments from China to the Netherlands. The study evaluated factors such as transportation costs, transit time, distance covered, documentation and transfer costs, and risks. The cost model used was the same one developed by Beresford et al. [38] and was flexible enough to be applied to different operational forms. The analysis of the data for each mode or combination indicated that the most cost-effective and safest method was the combination of inland waterway and sea, while the quickest solution after direct air freight was the road and rail combination. The research only considered transit hubs within the country and did not investigate international hubs.

Yonglei, Guanying, and Jing [40] discussed the impact of the multimodal transport corridor developed by Chinese provinces and ASEAN countries, as well as the freight transport structure in these regions and Europe, in a published paper. The paper compared the New International Land-Sea Trade Corridor with traditional transport methods used in these regions and showed that sea-based multimodal transport was dominant in the China–ASEAN market due to its low cost and ample capacity.

Further, the selection of a transit hub during a disruption period is a challenging task for the industry, and some studies have significantly contributed to this area. Chen et al. [41] proposed the critical factors that influence the selection of a transit hub for multimodal freight transport, including the cost of the route, custom regulations and policies, connectivity, and availability of different modes of transportation. The findings were based on feedback from freight forwarders and shippers.

Huang et al. [42] proposed a hub-and-spoke network design for container shipping during the COVID-19 pandemic. The study focused on selecting and locating ports, allocating non-hub ports to hubs, and selecting backup hub ports. The authors reported that the route replacement cost and congestion cost greatly impact the network design, and having backup hub ports could improve the reliability of global container shipping networks for capacity scheduling and allocation.

The performance of the logistics industry in the UAE was studied by Sundarakani [43]. The author discussed the challenges and opportunities of the logistics industry within the UAE based on company information and interviews. The article highlights the ideal location of Dubai as a logistics transit hub, the development of the logistics industry in the UAE from 1970 to the present day, and the challenges faced by the country over the past decades.

Several research communities have studied the performance of the logistics industry in the UAE. Antwi-Boateng and Jaber [20] reported that the favorable factors that have made the UAE a desirable logistics hub for international trade include its geographical location, multi-modal connectivity, well-developed infrastructure, attractive political environment, and available labor force. These factors have helped the UAE to compete with established hubs like Singapore and Hong Kong [44]. The simplicity of logistics management processes and the well-developed infrastructure in the UAE make it easier to shift transportation modes, reducing response time, handling costs, and fragmenting ownership, resulting in operational benefits [43]. However, the UAE faces issues related to policies and regulations compared to benchmarking countries like Singapore or Hong Kong [45]. The policies and regulations for the export and import of goods in the UAE take longer than in other transit hubs due to delays at customs entities and road bans during peak hours [20].

Additionally, natural factors such as extreme weather conditions during summer, a lack of a sufficiently skilled workforce due to inadequate training [46], an increase in the living costs in the UAE, regional unrest and political issues, and process delays are challenges that the UAE logistics industry faces. Fernandes and Rodrigues [47] compared the performance of the UAE logistics industry to that of Singapore and found that although the GDP of Singapore is 2.88 times higher than the UAE's, the employment in the transport

and communication sector in the UAE is 2.77 times greater than that in Singapore due to the higher productivity of each employee in the UAE. The report also highlights that the scale of sea freight operation in Singapore is larger than in the UAE and suggests that the UAE should reduce its lead time and the number of border organizations involved in import and export operations. To further improve productivity, value-added activities need to be implemented [48].

Based on this comprehensive review of the literature, it appears that the field of multimodal cargo transport has not been well explored in the UAE and the surrounding region. Most of the research focuses on Asian countries such as China, Hong Kong, and Singapore. There is also a scarcity of studies on the combination of the sea–air or air–sea transport, with most research being conducted on land–sea and sea–rail transport.

Furthermore, the existing research has not addressed the impact of the COVID-19 pandemic on the logistics sector, specifically on the usage and performance of multimodal cargo transport methods. The literature review has identified challenges and opportunities associated with multimodal cargo transport, but these findings need to be further explored in the Middle East, particularly the UAE.

This study will shed light on the impact of multimodal cargo transport strategies on the local economy of the UAE, as well as on international shipping, which will improve global logistics and the local economy. Additionally, this research will assist logistics and freight forwarding companies based in the UAE by identifying areas that have not been previously explored. Finally, it will contribute to the body of knowledge for future researchers who aim to study issues in this field and region.

2.2. Hypotheses' Development

2.2.1. Logistic Hub Capabilities

Generally, logistics hubs serve as a transit point for the flow of goods or consignments from one location to another. These hubs must be equipped with the necessary capabilities to handle the efficient movement, transfer, and consolidation of materials between different modes of transportation. However, during periods of disruption, operational uncertainty in logistics hubs is very high, leading to an increase in overall cost factors [49,50]. Many companies expect logistics hubs to be more responsive and agile in the face of changing requirements in various countries [51]. The UAE has responded to these demands by providing high-tech infrastructure capabilities. In particular, the process of documentation and legal approvals for transshipment has been simplified, reducing the complexity present in the existing system. Freight-forwarding companies in the UAE are professional, and their workforce is well educated and capable of handling international shipments robustly. This indicates that the logistics hub capabilities in the UAE may be able to handle uncertain demands efficiently and cost-effectively during the pandemic and improve the utilization and performance of multimodal cargo transport [52].

In theory, an increase in demand for product transportation during the pandemic would result in an increase in shipping costs and utilization. However, logistics companies are struggling to understand the reality of whether shipping costs have increased or decreased during the pandemic period based on utilization. This situation presents a challenge to the research community to measure the impact of shipping costs during the pandemic period empirically. Based on this understanding, we have established the following two hypotheses: H1 and H7.

H1. *A logistics hub with robust handling capabilities for transit shipments will likely lower shipping costs during uncertain times.*

H7. *A logistics hub with robust handling capabilities for transit shipments is expected to positively impact the utilization and performance of multimodal cargo transport.*

2.2.2. Fluctuation of Demand during the Pandemic

Many organizations have reported that the pandemic has severely impacted the transportation industry and disrupted the entire supply chain. The e-commerce sector, in particular, has faced uncertain demand due to various reasons, including a shift in consumer purchasing habits from physical stores to online shopping. This shift has placed a strain on the supply chain, particularly in warehouses and distribution centers that are now highly utilized. Companies are working to fulfill the demand for these facilities in a short lead time, which requires a rapid transshipment hub to efficiently consolidate and transport goods to the appropriate location [53]. This increased demand and variability in product types drive up shipping costs and necessitate the use of multimodal transportation services to meet market demand. This argument is tested empirically via hypotheses H2 and H8.

H2. *Increased demand for products or materials during the pandemic is likely to raise the cost of shipping.*

H8. *Fluctuating demand enhances the utilization of multimodal transportation based on capacity availability.*

2.2.3. Capacity Availability during Uncertain Times

The availability and accessibility of various modes of transportation for transshipment during the pandemic have become a significant challenge. Transshipment hubs require efficient handling of a variety of consignments, which must be consolidated into different modes of transportation within a restricted time frame [54]. To tackle this challenge, countries like the UAE have invested in high-tech infrastructure and skilled professionals.

Several factors contribute to the capacity shortage during the pandemic, including unpredictable spikes in demand, mismatches in capacity between various modes of transportation, lead-time problems between suppliers and manufacturers, and inconsistencies in loading, unloading, and consolidation at logistics hubs. These factors result in an increase in shipment costs. The capacity shortage in one mode of transportation also affects other modes of transportation [42]. To combat this, many transportation companies have converted passenger flights into cargo carriers in an effort to improve capacity availability. To determine the effect of capacity shortage on shipment costs during the pandemic, we propose two further hypotheses, H3 and H9, which will be tested empirically.

H3. *A shortage in capacity during a pandemic is likely to result in increased shipping costs.*

H9. *The availability of capacity in certain modes of transportation enhances the performance of multimodal cargo transport through transshipment hubs.*

2.2.4. Geographical Risk

The effectiveness of logistics hubs is significantly impacted by coordination with the government. Adequate regulations and streamlined documentation processes at border crossings are crucial for efficient transshipment of goods. A flexible regulatory framework during the pandemic helps reduce the risk of disruptions in freight movement. However, political instability in some countries during the pandemic has resulted in negative effects on regional logistics performance [55]. To mitigate geographical risks, many companies have implemented contingency plans that involve reallocating their manufacturing and distribution hubs. This has proved to be beneficial for transportation companies during the pandemic. To determine the extent to which geographical risk contributes to the cost of shipments, we propose two hypotheses, H4 and H10, for empirical verification.

H4. *Geographical risk in certain areas can elevate the cost of shipping in other regions.*

H10. *Expanding geographical risks in certain areas can drive the adoption of multimodal logistics solutions in other regions.*

2.2.5. Environmental Risk during Unprecedented Times

In recent years, governments have imposed city regulations aimed at promoting environmental safety and maintaining a carbon-neutral ecosystem [46]. These regulations pose a challenge for transportation companies, as they must reduce their carbon footprint to comply with environmental standards. To mitigate this, many organizations have adopted environmentally friendly, or “green,” supply chain strategies [56]. These strategies have helped many countries minimize the cost of carbon emissions during the pandemic. However, there is no empirical evidence to support the claim that shipping costs between different modes of transportation increase or decrease carbon emissions. To determine the impact of carbon emissions on shipping costs during the pandemic, we propose two hypotheses: H5 and H11.

H5. *The use of transportation methods with high carbon emissions may result in increased shipping costs.*

H11. *The shift towards environmentally friendly practices in the industry can enhance the utilization and performance of multimodal transportation.*

Furthermore, this study aims to examine the impact of independent variables, such as logistic hub capabilities, the fluctuation of demand during the pandemic, capacity availability during uncertain times, geographical risk, and environmental risk on the utilization and performance of MCT, using the cost of shipping as a mediating variable. This relationship is tested via the hypothesis H6 stated below:

H6. *The high cost of shipping via conventional modes of transportation can have a positive impact on the utilization and performance of multimodal cargo transport.*

2.3. Conceptual Framework

Based on the literature review, five independent variables were identified that could impact the utilization of multimodal cargo transport methods, including logistic hub capabilities, fluctuations in demand during the pandemic, capacity availability during uncertain times, geographical risks, and environmental risks. These independent variables and their relationship with the dependent variable, the utilization of multimodal cargo transport methods, are visualized in Figure 1. The cost of shipping is identified as the mediator variable, helping to explain the causal relationship between the independent and dependent variables. Each hypothesis connecting the independent and dependent variables is described in Figure 1.

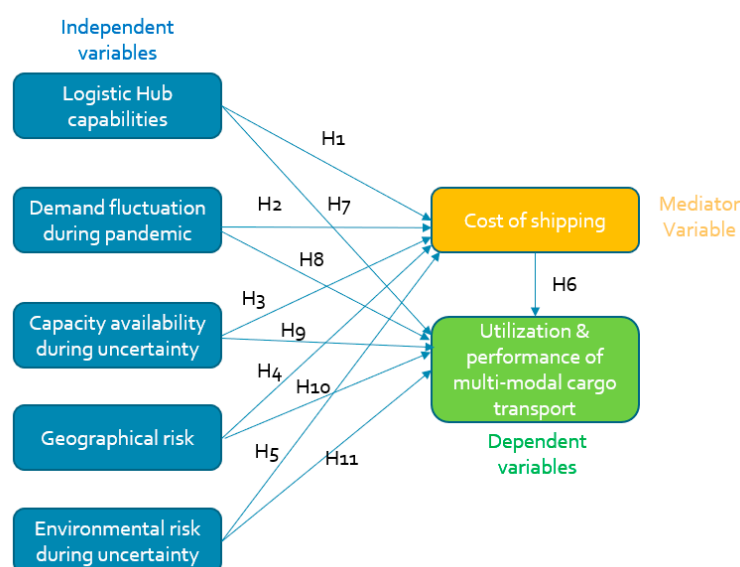


Figure 1. Proposed conceptual framework.

3. Research Methodology

In this study, the qualitative approach was employed to gain insights into the current state of logistics performance in the UAE and to explore the advantages and difficulties of multimodal cargo transportation. The identified variables were validated via interviews with experts in the logistics and freight forwarding industry in the UAE. This study focused on the impact of the ongoing pandemic on logistics and supply chain operations, as well as current market trends and the effect of multimodal cargo transportation on these factors. Open-ended questions were used in the interviews to allow for a comprehensive examination of the challenges and opportunities without predetermined responses.

The information gathered from the interviews was utilized to develop a framework for this study, complementing the data obtained from the literature review. This information was then tested using a series of closed-ended survey questions, which were distributed to a diverse range of stakeholders involved in the UAE's logistics and supply chain industry, including logistics and freight forwarding companies, airlines, governmental organizations, and other relevant parties. The surveys aimed to either support or refute the hypotheses surrounding the variables, which will be presented in the following section. The results of these tests were then analyzed and discussed based on their impact on the variables.

The data for this study were collected via both interviews and surveys. The interviews aimed to assess the effect of utilizing multimodal cargo transportation on the logistics performance index of the UAE, as well as its impact on the international shipping and logistics industry from the perspective of industry professionals. Both dependent and independent variables were derived from the interviews and the literature review, which was utilized to construct the research framework. The literature review, in conjunction with the insights from the interviews, was used to formulate the hypotheses and design the survey questions. The survey then sought to either support or disprove the hypotheses through various analysis tools.

Five senior logistics professionals were interviewed for this study, representing the areas of pricing, procurement management, freight forwarding, warehousing, and logistics operations. The pricing department representatives were selected because they have access to capacity and demand information, and they engage with multiple carrier operators during pandemic situations. Meanwhile, the freight forwarding operators were selected as they have an end-to-end knowledge of the industry and are able to provide valuable insights into the challenges and opportunities faced. The interviews were conducted in both online and face-to-face formats due to the COVID-19 pandemic and the need for remote work in 2021–2022. However, convincing individuals from other freight forwarding companies to

participate in the interview was a challenge, as the researcher works for a competitor freight forwarder in the UAE. To mitigate potential bias, the focus was on conducting interviews within the organization and prioritizing individuals who had recently joined from other freight forwarding companies.

The interviews were conducted with senior industry professionals from the logistics and freight forwarding industry over a period of two months. The voice recordings of the interviews were transcribed using the online tool Otter.ai, which automatically converts speech to text. The transcripts were corrected, verified, and saved as a Word document. The document was then uploaded onto Nvivo 11, a qualitative data analysis software, to facilitate easier organization and analysis of the transcripts. The software was used to create nodes based on common interview questions and to highlight and analyze similar paragraphs, feedback, and comments. The frequency of words used by the interviewees was indicated by the font size, with larger fonts indicating a higher frequency of use. Once the data was collected, it was processed and analyzed using the thematic analysis method [57], which is a common method of analyzing qualitative data, especially interview transcripts. The researcher closely examined the data to identify common themes from the transcripts, using a coding tool to convert the interview transcripts into themes.

This research used a mixed methods approach, as the qualitative findings were insufficient to validate the outcomes. To gather more comprehensive data, a survey was designed based on the results of the interviews and the literature review. The survey questionnaire was distributed to the logistics industry population in the UAE using the online questionnaire tool <https://www.qualtrics.com/> (accessed on 1 August 2023). The close-ended questions, with pre-set answers, allowed the results to be converted into numerical data to prove or reject the hypotheses that were assumed beforehand. The measurement items for each variable are listed in the table below, and they form the survey questionnaire based on the hypothesized constructs. Some of the measurement items were derived from both the literature review and the interview results, as illustrated in Table 1. The survey questions used a Likert scale ranging from 1 to 5, where 1 indicated complete disagreement with the question, and 5 indicated complete agreement.

To ensure accurate results and findings from this research, the target population was carefully selected during the sampling process. The closed-ended survey questions were centered around the objectives and dimensions the researcher is attempting to investigate. These questions were distributed to individuals at various levels within the logistic departments of various organizations. The method of distribution was via LinkedIn, a professional social media platform, where it is convenient to reach individuals who meet the population criteria and contacts within the researcher's own company. The goal was to have at least 120 participants complete the survey, so the survey link was sent to over 500 individuals to account for the typical response rate ranging between 20% and 30% for online surveys. The survey remained open until the target number was reached.

The collected data were transferred from the Qualtrics software 2021 to Smart PLS version 3.3.5 in a comma-delimited data table after checking for missing values, if there were any. The Smart PLS tool is a second-generation multivariate method used to measure the impact of independent variables on dependent variables [58,59]. PLS SEM, as noted by Albishri et al. [60], is equal to ordinary least squares regression, but it is a component-based SEM method different from covariance-based SEM. Hair et al. [58,59] suggest that PLS has several benefits, including its ability to handle multicollinearity and its ability to produce a result compared to CB SEM. In this exploratory study, designed to address a complex model with higher-order construct, the PLS SEM method was a suitable choice. Additionally, PLS SEM was appropriate when the sample size is smaller than what a covariance-based model can handle in practice. In this case, the sample size is 120, and it has been shown that the PLS SEM method can handle smaller sample sizes [59]. Ringle [61] has also shown that PLS SEM can effectively handle sample data with non-normal distributions, as it does not require normality assumptions. There is evidence of PLS-SEM results that outperform CB SEM in terms of robust performance when bootstrapping against multicollinearity [62].

For these reasons, PLS SEM was chosen as the sequential quantitative model to analyze the data in this study for validation. The results from both qualitative and quantitative methods will be analyzed and discussed in detail in the following section.

Table 1. Design of constructs and item measurement.

Construct	Item Measurement
Logistic Hub Capabilities	- The UAE has a strong logistics infrastructure compared to other countries within the region. - Export and import customs regulations and documentation requirements in the UAE are uncomplicated. - The logistic providers and freight-forwarding companies in the UAE are professional and compliant. - The workforce in the logistics sector in the UAE is well educated, professional, and capable of handling international shipments. - The UAE has a variety of transportation modes with strong network connectivity. - Transporting shipments through the UAE is safe and secure.
The fluctuation of Demand at COVID-19 times	- The market demand for products and goods is unpredictable during COVID-19 times. - The change in purchasing channels causes rapid demand fluctuation. (e.g., online shopping, physical stores, etc.) - The increase in the “product switching” behavior of consumers has a strong impact on the supply chain and logistics flow. - The demand fluctuation of products and goods requires fast logistics/distribution solutions.
Capacity Availability at times of uncertainty	- Capacity shortage in one mode of transportation has a strong impact on other modes of transportation. - The constraint in air/ocean freight capacity has a strong impact on the shipping cost. - During COVID-19 times, converting passenger flights into “passenger freighters” improved capacity availability. - Diverting shipments through logistics hubs that have strong access to different modes of transportation reduces the capacity shortage issue.
Geographical and Geopolitical Risk	- The region’s political instability has a strong impact on the logistics performance of a transit hub within that region. - Governmental regulations and processes at country borders have a strong impact on freight movements in and out. - Reallocating manufacturing/distribution hubs is the ideal solution to reduce the geographical risk. - High geographical/physical distance between shippers and consignees reduces the availability/options of logistics solutions.
Environmental Risk During Unprecedented Times	- Organizations are placing greater focus on having an environmentally friendly supply chain during unprecedented times. - Transportation modes with a low carbon footprint highly attract production/manufacturing companies. - During COVID-19 times, companies tend to prioritize the cost reduction in freight movement over the environmental risks. - Environmental issues have a strong impact on consumer’s preference/choice of products. - Transportation methods with low carbon footprint are supported and promoted by governments and corporate leaders.
Cost of Shipping	- Currently, companies prefer low shipping costs with poor quality of service over high shipping costs with good quality of service. - Reallocating manufacturing/distribution hubs is the ideal solution to reduce the cost of shipping. - Low shipping costs improve accessibility to new markets. - The cost of shipping is majorly impacted by fluctuating fuel costs.
Utilization and Performance of MCT	- MCT improves the capacity utilization of different modes of transport. - The transit hub’s capability to handle MCT has a major impact on the MCT performance. - The environmental impacts of transportation have a strong influence on the choice of transportation mode. - The current market demand and supply trends require goods to be transported at a shorter transit time while maintaining low costs.

4. Results and Findings

4.1. Qualitative Results: Insights from Interviews

The purpose of the interviews was to gain insight into the current state of the logistics industry in the UAE, including its performance, challenges, and opportunities, as well as the use of multimodal cargo transportation methods. The goal was to gain a deeper understanding of the topic, which would then inform the development of a research framework through a literature review and industry analysis.

The interviews were conducted with five senior logistics professionals from the freight forwarding to warehousing industry over a period of two months. The main focus of the interviews was to gain insight into the current challenges facing the logistics industry in the UAE and to understand its performance during the pandemic in comparison to the pre-COVID-19 era. Additionally, the usage of multimodal cargo transport methods and

the advantages and difficulties they present for the entire process of freight transportation were discussed.

The responses from the five interviewees (A, B, C, D, and E) were analyzed and grouped into common themes and quotes using Nvivo 11 software. The views on the current challenges in the logistics industry were largely consistent among the interviewees.

4.1.1. Demand Fluctuation

Participant A discussed the fluctuation in demand during the pandemic.

“When you see the challenges faced by the logistic industry, it has to do with a lot to deal with the fluctuating demand because the demand is dropped completely at one point of time during the pandemic”. (Male, age 55–60)

Participant B also emphasized that demand for consumer products significantly declined during the pandemic.

“There are a lot of businesses that shut down due to COVID especially the consumer products. The business is never like it was pre-COVID. If you talk about the normal consumer goods, for example, the demand went down drastically”. (Female, age 35–40)

Participant C emphasized that the lockdowns imposed during the initial stages of the pandemic were the main cause of the fluctuation in demand.

“There is fluctuating demand as well during COVID-19 as consumer shifted to the online buying. For example, in Italy, eCommerce sales of consumer products raised by around 81% in a single since people could not go to the mall show showroom to buy the product”. (Male, age 50–55)

Participant E, who had extensive experience warehousing a European-based chocolate product, shared some interesting insights.

“At one point when the airports are closed down or restrictedly operating, our products literally kept in the warehouse and duty-free stores for months, which had to be otherwise sold because of perishability in nature. At one point when the partial operation of the air services resumed these products has to be liquidated with 50–70% discount”. (Male, age 40–45)

4.1.2. Capacity Availability during the Pandemic

According to Participant A, there was a shortage of capacity as some operators suspended their operations.

“As a logistic partner for these customers, was finding difficulty to get capacity in or any kind of services be an airline or the road services into the sectors they were asking for because most of the operators had stopped their operations”. (Male, age 55–60)

Participant C highlighted that ocean freight had a capacity shortage as well.

“The main challenge will be the capacity. As you know that the capacity just evaporated in normal times like ocean freight typically carried around 90 percent of the global trade volume. Ocean carriers responded to this by removing their capacity from the market”. (Male, age 50–55)

4.1.3. Geographical and Geopolitical Risks

Participant A noted that the geographical and geopolitical risks posed a significant challenge to the logistics industry during the COVID period. Companies that used the UAE as a hub for their distribution centers faced difficulties in supplying customers in various regions due to disruptions caused by the pandemic.

“There was a geographic risk, you know, so some companies had their distribution centers in UAE, for the Middle East region, and to the African region. And there is certainly a shortage of supply for most of the customers”. said Participant A (Male, age 55–60)

Participant B emphasized the impact of the geographical situation and explained that if the logistics operations in a hub country were disrupted, the overall logistics flow would be affected.

“If you are in a geographical situation where there is shut down from all parts of your neighboring countries, then there is absolutely no way to reach you to provide you any kind of logistics service”. (Female, age 35–40)

4.1.4. Multimodal Cargo Transport Performance and Cost of Shipping

All five participants discussed the promotion of multimodal cargo transport and the factors that influence the choice of this mode during the pandemic. They concurred that companies are seeking to reduce costs, and using multimodal cargo transport is one way to achieve cost savings.

Participant A stated that companies are currently seeking ways to decrease their logistics expenses.

“With the COVID period, where everybody is trying to reduce the cost, nobody wants to move cargo at a very high cost at this point, because everybody is trying to save money”.

(Male, age 55–60)

Participant B also emphasized the potential for multimodal cargo transport to be viewed as a product rather than simply a value-added service in the region.

“This service could be easily promoted to be a product rather than value-added service sold by us and most of the forwarders in the market mainly due to its cost-effectiveness which is again of great importance during the current COVID times where customers want to reduce costs to the bare minimum”. (Female, age 35–40)

Additionally, Participant D pointed out that the smart implementation of multimodal cargo transport can not only decrease turnaround time but also the overall cost of the shipment.

“Multimodal transport is one of the best ways of reducing the total cost of shipping in a decent turnaround time but of course provided the cargo does not have a short deadline to meet”. (Male, age 40–45)

These findings offer interesting perspectives on how multimodal cargo transport can have a positive impact on cost savings even during disruptions in the logistics industry.

4.1.5. Logistics Hub Capabilities during the Pandemic

Regarding question 3, the participants stressed the significance of the UAE as a logistics hub for the utilization of multimodal cargo transport. Participant A mentioned the World Logistics Passport (WLP) initiative, which is being executed in the UAE. This initiative, launched by the Dubai government in collaboration with entities such as Dubai Port World and Dubai Customs, aims to enhance trade between the region and global South countries in South Asia, Africa, South America, and Australia (<https://www.worldlogisticspassport.com/> (accessed on 1 August 2023)). The WLP program provides financial and operational benefits to traders and freight forwarders across the entire value chain, as envisioned by the Dubai government.

“The World Logistics Passport (WLP) is going to play a huge role in the coming days in the UAE logistic market. The whole idea of WLP is to give a very cost-effective solution to the customers, and at the same time, considering the earlier period of Sea-Air, how long the transit time took because of the delays or the requirements of the procedures to follow”. said Participant A (Male, age 55–60)

Participant B also concurred that the UAE’s strategic location enhances the logistics performance of the country.

“The UAE is already very active in promoting itself as the unique and geographically placed hub for multimodal transport, they have all the necessary advanced technology in place that speeds up the process of using multi-modal transport”. (Female, age 35–40)

Participant E quoted that the WLP initiative along the free zone lines for warehousing business as:

“Because the country has more than 36 free zones for businesses, Jebel Ali free zone (JAFZA) being a pioneer provide a sandbox for piloting any new ideas of logistics and to grow along with the country developments. . . , we have witnessed that growth in the past 20 years in Dubai. However, having said that the WLP has a long way to go to reap the full benefit of Dubai being a transshipment hub as the WLP membership countries are only 40 at present”. (Male, age 40–45)

These findings warrant further quantitative-driven investigation among the emerging themes. The main points that the participants talked about are demand fluctuation, capacity issues, geographical and geopolitical risks, and logistic hub performance. The interviews also highlighted that multimodal cargo transport performance is mediated by the cost of shipping, as it is the main reason why multimodal cargo transport can be promoted. With that, demand fluctuation, capacity issues, geographical and geopolitical risks, the logistic hub performance, as well as the environmental risks as the independent variables are validated qualitatively but warrant quantitative evidence. As the qualitative findings do not show the magnitude of the effect of the mediator variable and the impact of the independent variable on the dependent variable, the research requires a comprehensive survey data collection and analysis. In conclusion, the interviews were essential to appraise a framework qualitatively and are to be validated further quantitatively, thus applying a sequential mixed method.

4.2. Quantitative Survey Responses

As soon as the interviews were completed and the researcher was able to design a framework, the next step was to design a survey questionnaire. The questions were selected based on the literature review stories. The survey questionnaire was then pilot-tested with three senior industry executives to ensure/vet the survey was clear and to the point. The pilot test came up with a positive result, so the survey was distributed to selected employees from within the freight forwarding industry, as well as individuals from different companies who have logistics backgrounds. In total, 120 responses were collected through Qualtrics, and the data were exported from Qualtrics to Excel in CSV format (Comma delimited). The data were then cleaned and prepared to include only the data required for the next step of the analysis.

4.2.1. Participants' Demographic Profile

The survey was distributed to 500 individuals, out of which we obtained 120 complete responses. The survey took place from the 19th of February 2021 to the 5th of March 2021 for a duration of 15 days. The average time taken to complete one survey was 11.54 min. Below are the participants' profiles based on the demographical questionnaire.

As per the collected data shown in Figure 2, most participants are between 25 and 34 years old, and only two participants were above 55 years old. Figure 3 shows the participant by gender, in which around 63% of the participants are males and 37% are females. This number is close to the world workforce statistics.

The selected participants had diverse work experiences. Approximately 54% of them possessed more than 6 years of experience, which is valuable for obtaining insights into market changes over time. Meanwhile, 26% of the participants had less than 2 years of experience, providing a fresh perspective.

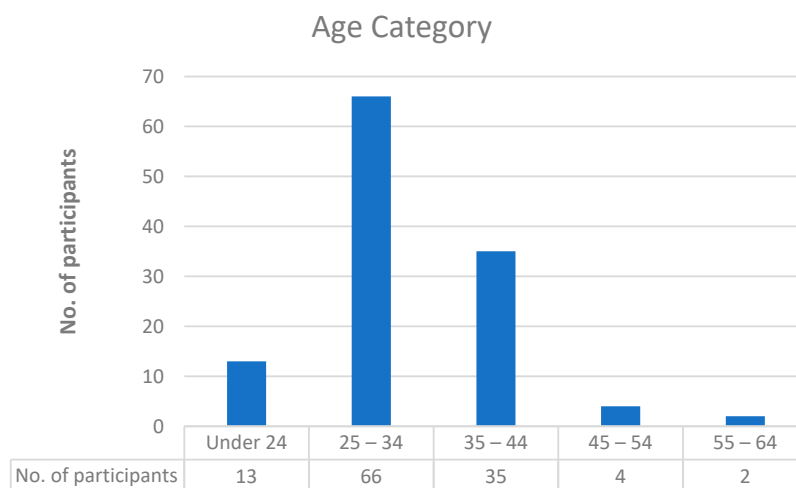


Figure 2. Survey response by age category.

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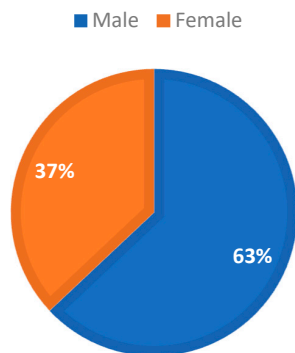


Figure 3. Survey participants by gender.

Figure 4 below shows the current company type of the participants. Most of the participants 67% come from the logistics sector and freight forwarding industry. Only 2% of the participants were retailers. Moreover, 10% of the participants come from different sectors other than the top five, which were mentioned. These other fields include product designing, the construction field, the military, architectural services, academics, digital logistics, industry digitalization, energy, and government sectors.

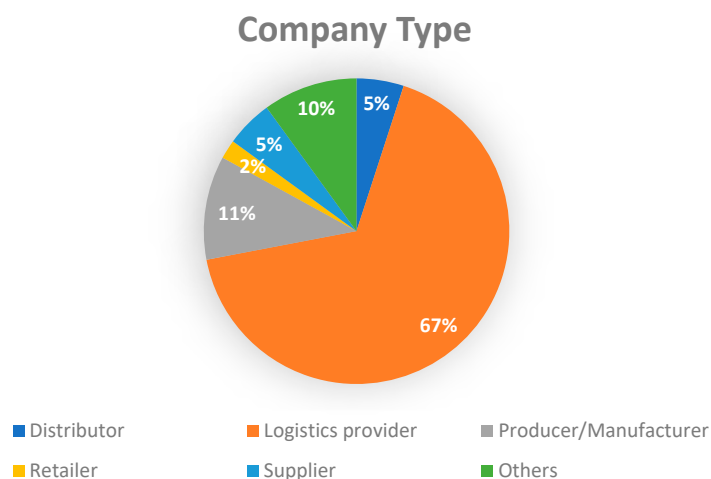


Figure 4. Participants by company type.

In terms of the occupations of the participants, 36% hold specialist or executive positions, 27% hold manager or supervisor positions, and only 2% of the participants hold CEO or founder positions (Figure 5). Additionally, 7% of the participants held “other” positions such as accountant officers, finance and accountants, professors, post-graduate students, data scientists, and interns.

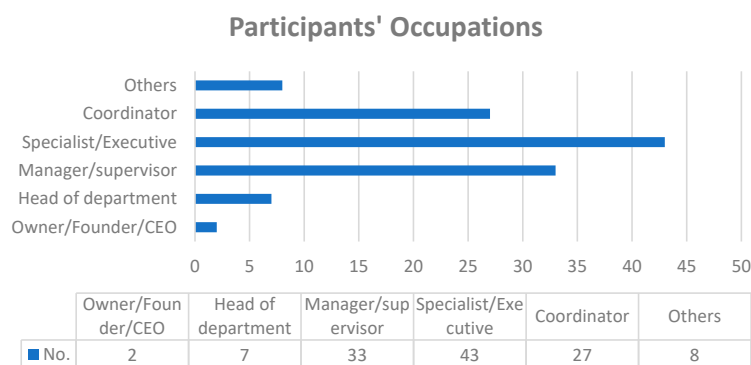


Figure 5. Participants current occupation.

4.2.2. Questionnaire Results and Findings

To be able to analyze the responses of the participants, firstly, the model was designed on Smart PLS software version 3.3.5 (Figure 6). The construct was denoted as independent variables: logistic hub capabilities, fluctuation of demand at COVID-19 times, capacity availability at times of uncertainty, geographical and geopolitical risk, and environmental risk during unprecedented times. The cost of shipping was considered a mediator between the independent variables and the dependent variables, which are the utilization and performance of multimodal cargo transport (MCT). Each of the above latent variables was linked to its measurement items.

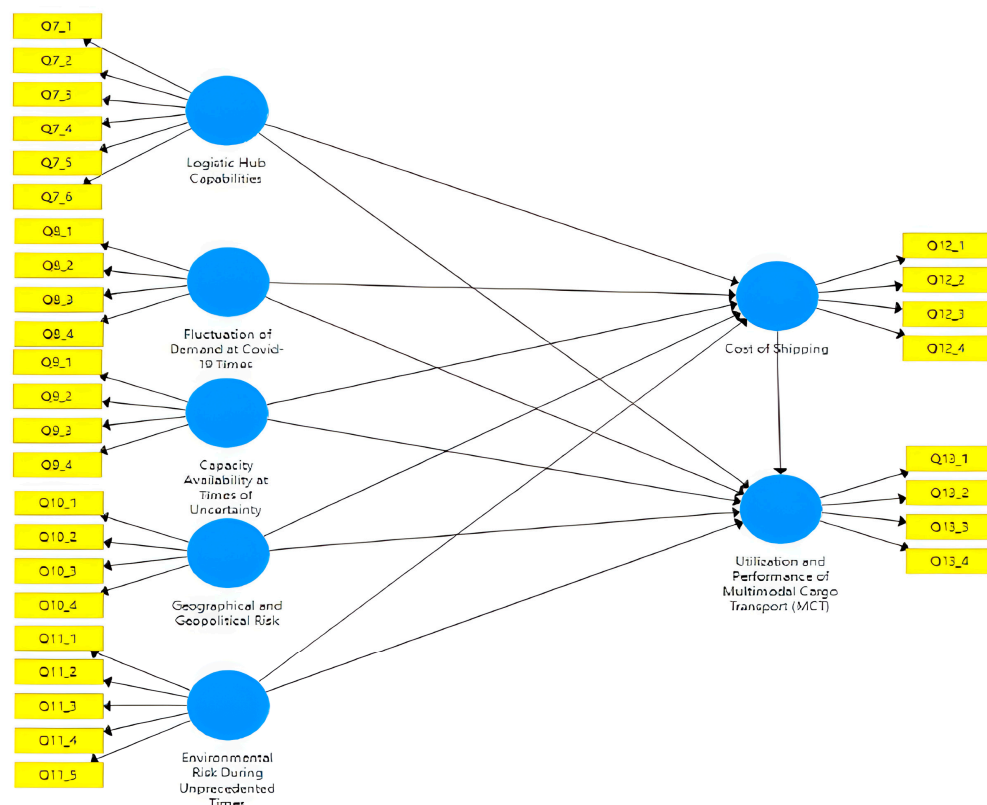


Figure 6. Research framework designed on Smart PLS software.

The analysis using Smart PLS is a two-step approach. The first step is to build and test the measurement model, and then the second approach is to build and test the structural model. The measurement model consists of the questions asked in the questionnaire to measure the variables. They are also called the outer model as they only focus on measuring the variables independently but not the relationship between the variables. On the other hand, the structural model, also called the inner model, measures the relationship between the variables. In this research, there are five independent variables, which can be called exogenous, and two dependent variables, also called endogenous variables. One of the dependent variables is pure, and the other (cost of shipping) is a mediator.

The first step is to assess the measurement model, which can be accomplished by measuring two main validation segments: the convergent validity and the discriminate validity (Figure 7). The convergent validity consists of three factors that need to be measured to confirm the convergence of the questions and their ability to measure the variable. Below are the three measurements.

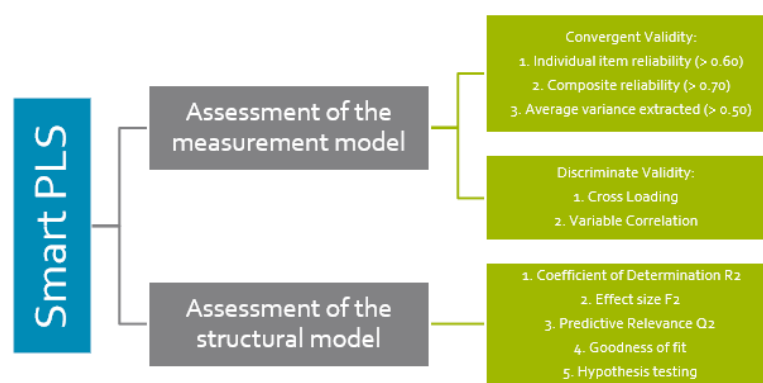


Figure 7. Smart PLS assessment models.

- Individual Item Reliability (also called the factor loading), and this is to be >0.60 . In normal cases, the factor should not be lower than 0.70. However, since the sample is small (120 participants), and according to [63], it is advocated that all items in a factor model should have commonalities of over 0.60 or an average commonality of 0.7 to justify performing a factor analysis with small sample sizes. Hence, all questions with factor loading below 0.60 are removed from the analysis.
- The composite reliability (CR) usually differs from 0.00 to 1.00. The CR 1.00 explains that the reliability is perfect. For exploratory-purpose models, composite reliabilities have to be equal to or greater than 0.60 [64,65], equal to or greater than 0.70 for a passable model for confirmatory purposes [66], and equal to or greater than 0.80 is considered good for confirmatory research [67]. For this research, the CR should be 70% or higher (>0.70) for a passable model for confirmatory purposes.
- The Average Variance Extracted (AVE) can also be used to test both convergent and divergent validity. AVE indicates the average commonality for each latent factor in a reflective model. In an adequate model, AVE should be greater than 0.50 [64,65].

The second segment is the discriminate validity, which advocates that the measures of constructs theoretically should not be very related to each other. In other words, they should not be highly correlated to each other. These are measured using two methods: cross-loading and variable correlation.

The second step is to measure the structural model. This can be carried out by checking the hypothesis testing, coefficient of determination R^2 , effect size f^2 , predictive relevance Q^2 , and goodness of fit of the model. Each will be explained in the next sections.

Once the model design is completed on the canvas, the Partial Least Squares (PLS) algorithm modeling is calculated using the path weight scheme, which is the recommended approach, and a maximum iteration of 1000. Figure 8 shows the results of the calculation below.

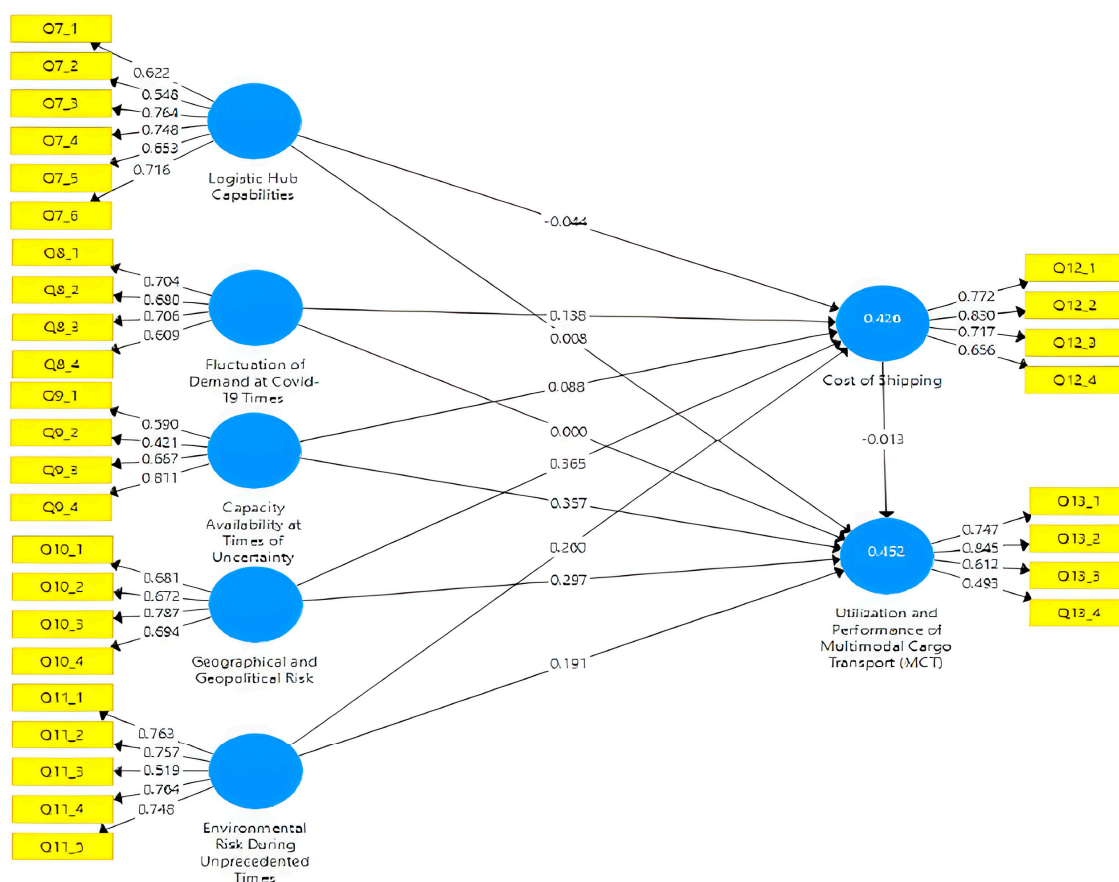


Figure 8. Initial measurement model as extracted.

It could be directly noticed that questions 7.1, 7.2, 9.1, 9.2, 11.3, 12.4, and 13.4 have individual item reliability less than 0.60. Therefore, those items were removed from the systems, and the PLS algorithm model was run again with the same initial inputs. Figure 9 represents the final model after removing the poorly loaded items into the construct.

The composite reliability of the measurement model has values mostly above 0.80, as can be seen in the table below. Hence, it satisfies the criteria of >0.70 . The Average Variance Extracted (AVE) values of all the constructs were above 0.50; hence, they satisfy the third criterion. One important point to be noted is that removing a measurement item does not affect the system as reflective items are interchangeable, which means that they can be removed without changing the meaning of the construct [68]. In this research, Cronbach's alpha will not be taken into consideration (although it satisfies >0.50) as composite reliability is more advanced in finding based on the convergence of reliability. Common method bias (CMB) happens when variations in responses are caused by the instrument rather than the actual predispositions of the respondents that the instrument attempts to uncover as evidenced by Podsakoff et al. [33]. Tables 2 and 3 address the shared variance against the Total Average Variance Extracted values, and the associated common method bias was justified in this survey research. Overall, the research followed Craighead et al. [69] approach in handling the common method bias associated with formulating the constructs and validating the construct, thereby minimizing the error associated with theorization and observation.

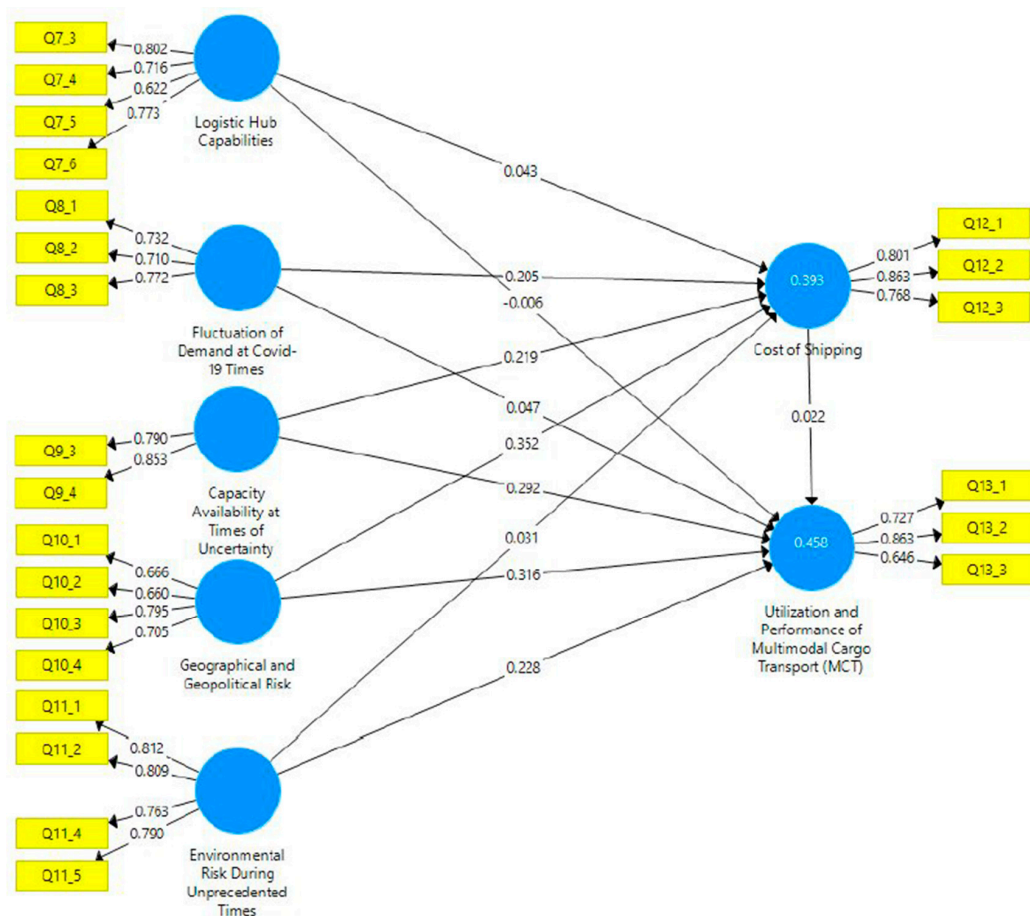


Figure 9. Finalized measurement model.

Table 2. Measurement model results.

Variable	Construct	Factor Loading	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Logistic Hub Capabilities	Q7_3	0.802	0.740	0.737	0.820	0.535
	Q7_4	0.716				
	Q7_5	0.622				
	Q7_6	0.773				
Fluctuation of Demand at COVID-19 Times	Q8_1	0.732	0.588	0.594	0.783	0.546
	Q8_2	0.71				
	Q8_3	0.772				
Capacity Availability at Times of Uncertainty	Q9_3	0.790	0.522	0.531	0.806	0.676
	Q9_4	0.853				
Geographical and Geopolitical Risk	Q10_1	0.666	0.678	0.687	0.800	0.502
	Q10_2	0.66				
	Q10_3	0.795				
	Q10_4	0.705				
Environmental Risk During Unprecedented Times	Q11_1	0.812	0.805	0.810	0.872	0.630
	Q11_2	0.809				
	Q11_4	0.763				
	Q11_5	0.790				
Cost of Shipping	Q12_1	0.801	0.742	0.762	0.852	0.659
	Q12_2	0.863				
	Q12_3	0.768				
Utilization and Performance of MCT	Q13_1	0.727	0.611	0.651	0.793	0.564
	Q13_2	0.863				
	Q13_3	0.646				

Table 3. Discriminant Validity check for cross-loading.

Cnow onst.	Logistic Hub Capabilities	Fluctuation of Demand at COVID-19 Times	Capacity Availability at Times of Uncertainty	Geographical/ Geopolitical Risk	Environmental Risk During Unprecedented Times	Cost of Shipping During Pandemic	Utilization/ Performance of MCT
Q7_3	0.802	0.231	0.190	0.240	0.422	0.203	0.251
Q7_4	0.716	0.114	0.095	0.216	0.432	0.134	0.157
Q7_5	0.622	0.133	0.129	0.074	0.322	0.013	0.064
Q7_6	0.773	0.048	0.240	0.223	0.261	0.237	0.231
Q8_1	0.129	0.732	0.270	0.247	0.303	0.280	0.308
Q8_2	0.083	0.710	0.234	0.250	0.100	0.259	0.226
Q8_3	0.162	0.772	0.271	0.317	0.351	0.398	0.255
Q9_3	0.247	0.236	0.790	0.169	0.325	0.386	0.353
Q9_4	0.157	0.335	0.853	0.404	0.379	0.345	0.506
Q10_1	0.089	0.191	0.167	0.666	0.218	0.241	0.293
Q10_2	0.083	0.365	0.141	0.660	0.161	0.255	0.367
Q10_3	0.294	0.331	0.255	0.795	0.293	0.468	0.351
Q10_4	0.273	0.179	0.388	0.705	0.297	0.461	0.459
Q11_1	0.385	0.315	0.263	0.298	0.812	0.238	0.332
Q11_2	0.372	0.320	0.356	0.199	0.809	0.197	0.471
Q11_4	0.351	0.259	0.298	0.387	0.763	0.377	0.267
Q11_5	0.392	0.243	0.424	0.256	0.790	0.283	0.448
Q12_1	0.155	0.245	0.372	0.328	0.290	0.801	0.317
Q12_2	0.257	0.421	0.350	0.570	0.347	0.863	0.362
Q12_3	0.173	0.362	0.360	0.354	0.186	0.768	0.330
Q13_1	0.090	0.169	0.371	0.250	0.211	0.237	0.727
Q13_2	0.172	0.320	0.530	0.544	0.329	0.429	0.863
Q13_3	0.354	0.286	0.256	0.331	0.548	0.227	0.646

Moving forward, since the model has passed the convergence validity, it is important to check the discriminate validity. This model checks the degree to which items discriminate along with constructs by assessing the correlation between the measures of possibly overlapping constructs.

Firstly, the cross-loading is checked. It can be seen from the below data table that the factor loading of each question or construct has the highest value for its variable compared to the other variables. This means that the question can best represent its variable over other variables. Hence, the cross-loading check is successful.

Further, it is also important to check that the indicators of a variable should represent the variable itself better than the other variables. As a result, the Fornell and Larcker [70] criterion is run, and the data are checked. Tables 4 and 5 show the matrix between the variables. As long as the factor coefficient between one variable and itself is the highest, this means there is no cross-loading, and the questions represent its variable better than other variables. Hence, based on the below data, it can be confirmed that the system has passed the variable correlation and cross-loading between constructs.

After passing the validation and reliability test of the measurement model, the next step is to analyze the structural model and accept or reject the hypothesis through the path model, which was set initially by examining the relationship between the variables. To enable this, the Smart PLS bootstrapping function is run with 1000 subsamples, and the bias-corrected and accelerated bootstrap confidence interval method is selected. The data are then analyzed deeply as follows.

Table 4. Shortcut abbreviations used for Table 5.

Shortcut	Circuitous
A	Capacity Availability at Times of Uncertainty
B	Cost of Shipping During Pandemic
C	Environmental Risk During Unprecedented Times
D	The Fluctuation of Demand at COVID-19 Times
E	Geographical and Geopolitical Risk
F	Logistic Hub Capabilities
G	Utilization and Performance of Multimodal Cargo Transport (MCT)

Table 5. Cross-loading of construct results.

	A	B	C	D	E	F	G
A	0.822						
B	0.441	0.812					
C	0.43	0.343	0.794				
D	0.351	0.431	0.356	0.739			
E	0.36	0.53	0.354	0.37	0.709		
F	0.241	0.247	0.473	0.174	0.287	0.731	
G	0.529	0.416	0.488	0.357	0.53	0.277	0.751

To confirm that the relationship between the variables is significant, the p -value, which is the error, must be less than 5%. Having a p -value higher than 0.05 means that the relationship between the variables is not significant. The p -value explains the relationship between the variables, whether they are significant or not, but does not explain the relationship, whether it is positive or negative. Hence, the standard beta (Std. Beta) will show a positive value if the relationship is proportional or a negative value if the relationship is inversely proportional. The T statistics is a result of dividing the Std. Beta by the Std. Error. The value of T statistics determines how strong the relationship between the variables is.

After running the bootstrapping function on Smart PLS, it is seen that the direct relationship between the logistic hub capabilities, the current fluctuation of demand, and environmental risk, with the cost of shipping, is not significant. Also, the relationship between the logistic hub capabilities and the current fluctuation of demand, with utilization and performance of multimodal cargo transport is not significant. Finally, there is hardly a relationship between the cost of shipping and the utilization and performance of multimodal cargo transport.

On the other hand, the relationship between capacity availability and geographical and geopolitical risk, with the cost of shipping is highly significant. Also, the relationship between capacity availability, geographical and geopolitical risk, and environmental risk, with the utilization and performance of multimodal cargo transport is highly significant.

Moreover, it can be shown that the hypothesis with a significant relationship has a positive Std. Beta, which means that they all have a positive relationship. Also, the relationship between the geographical and geopolitical risk, the cost of shipping, and the utilization and performance of multimodal cargo transport is the strongest based on the T values (Table 6).

The coefficient of determination (Table 7) R^2 is another method to check the relationship between the variables. The R^2 is the percentage of how much the independent variables have been explained from the dependent variables. Multiple books have suggested the acceptable value of R^2 . According to [71], an R^2 value of 0.10 is considered acceptable. However, [65] suggests that the R^2 values of 67% and above are considered substantial, 33% to 67% is considered moderate, and 19% to 33% is considered weak. If the R^2 value is below 19%, the relationship must be rejected. Hence, based on the R^2 data extracted from Smart PLS, both the cost of shipping and the utilization and performance of multimodal cargo transport can be considered moderate since they fall between 0.33 and 0.67.

Table 6. Hypotheses testing after bootstrapping.

Hyp.	The Relation between IV and DV	Std. Beta	T Statistics	p Values	Decision
H1	Logistic Hub Capabilities → Cost of Shipping	0.043	0.495	0.621	Rejected
H2	Fluctuation of Demand at COVID-19 Times → Cost of Shipping	0.205	1.675	0.094	Rejected
H3	Capacity Availability at Times of Uncertainty → Cost of Shipping	0.219	2.51	0.012	Accepted
H4	Geographical and Geopolitical Risk → Cost of Shipping	0.352	3.237	0.001	Accepted
H5	Environmental Risk During Unprecedented Times → Cost of Shipping	0.031	0.239	0.811	Rejected
H6	Cost of Shipping → Utilization and Performance of MCT	0.022	0.209	0.835	Rejected
H7	Logistic Hub Capabilities → Utilization and Performance of MCT	−0.006	0.066	0.948	Rejected
H8	Fluctuation of Demand at COVID-19 Times → Utilization and Performance of MCT	0.047	0.507	0.612	Rejected
H9	Capacity Availability at Times of Uncertainty → Utilization and Performance of MCT	0.292	2.769	0.006	Accepted
H10	Geographical and Geopolitical Risk → Utilization and Performance of MCT	0.316	2.911	0.004	Accepted
H11	Environmental Risk During Unprecedented Times → Utilization and Performance of MCT	0.228	2.248	0.025	Accepted

Table 7. Coefficient of determination.

Dependent Variables	R ²	Result
Cost of Shipping	0.393	Moderate
Utilization and Performance of Multimodal Cargo Transport	0.458	Moderate

Effect size f^2 examines how much effect each independent variable has on the dependent variables. Like the R^2 , multiple research papers suggest the acceptable value for f^2 [72,73], the effect size is considered low if the value of f^2 varies between 0.02 and 0.15, medium if f^2 varies from 0.15 to 0.35, and large if f^2 varies more than 0.35. An f^2 value below 0.02 is considered to have no effect size (Table 8).

Table 8. Effect size testing.

Latent Variables	Cost of Shipping	Utilization and Performance of MCT
Capacity Availability at Times of Uncertainty	0.059 (low)	0.110 (low)
Cost of Shipping	NA	0.001 (no effect size)
Environmental Risk During COVID-19 Times	0.001 (no effect size)	0.060 (low)
Fluctuation of Demand at COVID-19 Times	0.054 (low)	0.003 (no effect size)
Geographical and Geopolitical Risk	0.155 (medium)	0.122 (low)
Logistic Hub Capabilities	0.002 (no effect size)	0.000 (no effect size)

The predictive relevance Q^2 is a tool that is used to check the capability of the model's independent variables to predict the dependent variables. To check for Q^2 , the Smart PLS blindfolding function is run with seven omission distances. In this model, Q^2 of the cost of shipping is 23%, and the utilization and performance of MCT is 20.80%, which are acceptable values (Table 9).

Table 9. Predictive relevance checking.

Latent Variables	SSO	SSE	$Q^2 (=1 - SSE/SSO)$
Capacity Availability at Times of Uncertainty	240	240	0.230
Cost of Shipping	360	277.14	
Environmental Risk During Unprecedented Times	480	480	
The Fluctuation of Demand at COVID-19 Times	360	360	0.208
Geographical and Geopolitical Risk	480	480	
Logistic Hub Capabilities	480	480	
Utilization and Performance of MCT	360	285.276	

The goodness of fit (GoF) measures the accountability of the model, taking into consideration both the measurement and structural model, with a focus on the overall performance of the model. The calculation formula is given below:

$$GoF = \sqrt{(R^2 \times AVE)}$$

If the GoF value is less than 0.10, the model is not fit. If the value was between 0.10 and 0.25, the model has a small GoF. If the value was between 0.25 and 0.36, the model has medium GoF. Lastly, if the value was greater than 0.36, the model has a large GoF. These values are suggested by [74]. In this model, the average R^2 is 0.4255, and the average AVE is 0.587. calculating the GoF gives a value of 0.50, which is greater than 0.36. Hence, the GoF is large (Table 10).

Table 10. Testing for mediation effects.

Indirect Relationship	T Statistics (O/STDEV)	p Values
Capacity Availability at Times of Uncertainty → Cost of Shipping → Utilization and Performance of Multimodal Cargo Transport (MCT)	0.193	0.847
Geographical and Geopolitical Risk → Cost of Shipping → Utilization and Performance of Multimodal Cargo Transport (MCT)	0.188	0.851
Environmental Risk During Unprecedented Times → Cost of Shipping → Utilization and Performance of Multimodal Cargo Transport (MCT)	0.052	0.959
Fluctuation of Demand at COVID-19 Times → Cost of Shipping → Utilization and Performance of Multimodal Cargo Transport (MCT)	0.183	0.855
Logistic Hub Capabilities → Cost of Shipping → Utilization and Performance of Multimodal Cargo Transport (MCT)	0.081	0.936

To check if the mediator is significant, the indirect effects between the IV and DV need to be checked. The indirect effect shows the effect of the IV on the DV via mediation. The mediator, in this case, is the cost of shipping. The criteria to consider the mediator significant is to have a p -value (error) less than 5%. After running the bootstrapping and checking the specific indirect effects, it can be seen that the p -value of all the paths is high. This means that there is no significant effect of the mediator in the model, which means shipping cost does not play a significant role as a mediator for logistics hub capability at times of COVID. These findings complement previous qualitative evidence that the WLP initiative for Dubai as a logistics hub has a long way to go in order to reap the benefit and are thus not just short-term focused.

5. Discussion

The results of this case study provide insights into the logistics industry, particularly within the context of the UAE. The interviews conducted elucidated the challenges and opportunities facing the logistics industry in the UAE. According to the interviewees, current challenges in the UAE context include fluctuations in demand, capacity availability, and geographical and geopolitical conflicts. These challenges are consistent with prior research findings in other parts of the world. For instance, previous studies such as Yonglei, Guanying, and Jing [40] have explored the impact of capacity and demand on multimodal cargo transport in China, Central Asia, the ASEAN countries, and the EU. Similarly, research by Jiang and Zhang [34] has emphasized the significance of capacity constraints in influencing the choice of multimodal cargo transport. Moreover, scholars like Chen, Cheung, Chu, and Xu [41] have linked geographical location and logistics hub capabilities to the choice of logistics hubs and, consequently, the performance of multimodal cargo transport. Environmental considerations, specifically the potential of

multimodal transport to reduce carbon emissions, have been discussed as a recurring theme in multiple research papers. On a positive note, the interviewees expressed confidence in the UAE's logistics hub's capacity to handle multimodal cargo transport, highlighting it as an opportunity for further investment. Additionally, the interviewees underscored the impact of shipping costs, which are influenced by the aforementioned challenges and opportunities. Existing research, such as [35], has also emphasized the market's preference for cost-effective shipping methods, positioning the affordability of shipping via multimodal transport as a mediator between independent and dependent variables.

To address the second research question, we assessed the challenges and opportunities mentioned above in relation to multimodal cargo transport performance, specifically examining their impact on shipping costs. We formulated 11 hypotheses for testing, and the survey analysis revealed that 5 of these hypotheses were statistically significant, while the remaining 6 proved insignificant. Notably, H3, which associates a capacity shortage with increased shipping costs, and H9, which links the availability of specific transport modes to improved multimodal cargo transport through transit hubs, underscored the crucial role of capacity in both shipping costs and multimodal cargo transport utilization. Consequently, various research papers have proposed diverse strategies for enhancing capacity availability and management. Levina, T., Levin, Y., McGill, J., and Nediak, M. [75], for instance, introduced a computational method based on linear programming and stochastic simulation to identify estimated control strategies and examine their structural properties. This approach demonstrates flexibility by utilizing historical capacity booking data and decisions from default control policies, enabling capacity prediction and mitigation of shortages. Moreover, [75,76] offered four recommendations to optimize cargo capacity utilization during the COVID-19 pandemic: adjusting plans to enhance lead-time accuracy, improving communication, focusing on core routes, optimizing fleet management to maximize space usage, exploring passenger freighter solutions for routes with limited passenger but constrained cargo capacity, and establishing carrier relationships and alliances to enhance capacity accessibility [76].

Furthermore, the results indicate a significant correlation between specific regions' geographical and geopolitical risks and increased shipping costs in other regions (H4). As geopolitical and geographical risks escalate, shipping costs rise because companies must seek alternative, potentially longer, and more expensive shipping routes. An article by Rebecca Spong on <https://www.arabnews.com/> (accessed on 1 August 2023) highlighted that persistent geopolitical risks, such as attacks on ships carrying Saudi cargo, present shipping companies with two options: altering routes or bearing the additional cost of war risk insurance premiums, thereby increasing operational expenses [77]. Additionally, the global index [78] illustrates a growing trend in geopolitical risks, which will likely have similar financial repercussions for supply chain and logistics. Concerning the relationship between geographical and geopolitical risks and the performance of multimodal cargo transport, it is apparent that regions with high risks are inclined to seek alternative shipping solutions through low-risk hubs like the UAE, ultimately enhancing the performance of multimodal transport.

Consequently, countries aiming to promote multimodal cargo transport through their hubs, like the UAE, must prioritize offering secure and cost-effective multimodal solutions to companies operating in regions fraught with geopolitical risks. This strategic approach should emphasize geographical considerations, establishing a resilient supply chain capable of responding to geopolitical or cascading risks, such as those witnessed during the global spread of COVID-19.

The final significant hypothesis, H11, pertains to the industry's commitment to reducing carbon footprints, thereby enhancing the utilization and performance of multimodal transport. Notably, numerous pre-pandemic research papers have lauded multimodal cargo transport for its environmentally friendly attributes, and this research reaffirms that the momentum towards sustainable logistics remains steadfast post-pandemic. A report from the Colombian company Impala illustrates the benefits of adopting multimodal

cargo transport, showcasing a remarkable reduction of nearly 70 percent in greenhouse gas emissions for oil product transportation and close to a 60 percent reduction for dry cargo [79].

Conversely, the survey failed to establish a connection or validate the hypothesis concerning the strong logistic hub capabilities of the UAE leading to reduced shipping costs (H1). This outcome aligns with a research paper by Fernandes and Rodrigues [47], which pinpointed the issue of high logistics operational costs in the UAE contributing to elevated shipping expenses. Factors such as soaring rents and subsequent labor cost increases, largely driven by inflation, likely explain why survey participants could not discern a clear correlation between these variables [47].

Both hypotheses related to the influence of demand fluctuation on shipping costs and the utilization of multimodal cargo transport were rejected, as no direct or indirect relationship was identified between the independent variable (IV) and the mediator or dependent variable (DV). It is possible that demand fluctuations might not directly impact shipping costs but could affect them indirectly through factors like capacity availability. An increased demand might strain logistic providers' space, leading to higher rates and potentially boosting the use of multimodal transport, as capacity availability has a significant connection with it. This assumption requires further investigation, which is beyond the scope of this project and left for future research.

Another hypothesis, H5, asserting that high carbon emissions transportation methods increase shipping costs, was also rejected. Green transportation methods typically incur higher capital costs initially, such as investments in cleaner technology or modern fleets, even though they can reduce operational costs in the long term. Rahm [80] discussed the cost implications of transitioning to green shipping, noting that delayed investment in cleaner technology might necessitate sudden and unprepared expenses. Rahm [80] also highlighted that one way to go green is by reducing fuel consumption. However, in the current context of low oil prices, companies may prioritize efficiency commitments over immediate fuel savings.

The last hypothesis, H7, suggesting that a logistics hub with strong transit shipment capabilities would enhance the utilization and performance of multimodal cargo transport, was rejected due to its low significance. While interviewees strongly supported this hypothesis regarding the impact of the UAE's logistic hub capabilities, survey analysis produced contradictory results. This topic warrants further investigation, and one possible explanation could be that the survey questions did not sufficiently capture this variable due to limited available literature.

This study considers the cost of shipping as a dependent variable influenced by five independent variables while also exploring its role as a mediator between the IV and DV. The evaluation of this mediator revealed non-significant results. The cost of shipping could not effectively act as a mediator in this study. Generally, if an IV has both direct and indirect effects on a DV, it indicates partial mediation, while an IV with only an indirect effect suggests full mediation. If there are no indirect effects, mediation does not exist. In this case, the cost of shipping had no discernible impact on the utilization and performance of multimodal cargo transport. The generalization of shipping costs across all transportation methods was deemed impractical, as costs vary among methods, and their influence on multimodal cargo transport performance can only be examined through other mediators like transit time. Consequently, the direct effect of shipping costs on multimodal performance was found to be insignificant, leading to an equally insignificant indirect relationship that could not elucidate the mediator's effect.

Capacity availability, influenced by pandemic-related volatility, can be addressed by improving the capacity management of airlines and shipping companies. This entails long-term capacity planning and the ability to swiftly adapt to changing capacity demands, with support from governmental authorities.

Geographical and geopolitical risks stemming from pandemic-induced uncertainty and complexity can be mitigated by simplifying governmental regulations concerning tran-

sit hubs. This includes streamlining customs regulations and border processes, especially with neighboring countries exposed to geographical and geopolitical risks. These measures can foster resilient and stable logistics operations, ultimately enhancing the overall logistic performance of the hub.

While there is not a one-size-fits-all best practice for logistics organizations to navigate the challenges posed by the COVID-19 pandemic, they can prioritize efforts to reduce environmental risks. Doing so will have a direct positive impact on the performance of logistic hubs, consequently benefiting these organizations' overall performance.

6. Conclusions

6.1. Practical Implications

In conclusion, this research successfully achieved its goal of assessing the challenges and opportunities for multimodal cargo transport, particularly within the context of the UAE during and after the COVID-19 pandemic. This study honed in on the prevailing market conditions characterized by instability and unique challenges that emerged during this period. These dimensions were systematically evaluated to discern their impact on the performance of multimodal cargo transport.

To gather insights, interviews were conducted with professionals deeply embedded in the UAE's freight forwarding industry, possessing comprehensive knowledge of the end-to-end freight and logistics processes. These interviews illuminated the prevailing challenges and opportunities within the UAE's logistics sector amid the current market conditions. The findings from these interviews informed the selection of variables to be rigorously tested in the research.

Subsequently, an extensive research framework was devised, accompanied by tailored questions to measure these variables effectively. These questions were incorporated into an online survey, which was then distributed among a carefully selected sample population. The collected data was analyzed using Smart PLS software, with multiple iterations refining the measurement model to retain only the significant variables. The structural model was subsequently tested to validate the hypotheses and elucidate the substantiated relationships between these variables.

Drawing from the research analysis and discussions, several noteworthy suggestions and outcomes emerge. Primarily, the UAE, serving as a pivotal transit hub for international shipping, should strategically examine capacity management. Encouraging more airlines and shipping companies to establish the UAE as their hub can be achieved by reducing operational and administrative fees at the UAE's terminals. Additionally, regulations can be imposed to discourage locally registered flight and ship operators from dispersing their assets to locations far from home, as this practice exacerbates capacity shortages within the UAE. The utilization of alternative transportation methods, such as the Etihad Rail routes, can significantly bolster capacity within the GCC sector upon their operational launch.

The UAE should also prioritize green transportation methods, as research has consistently demonstrated a preference among companies and global organizations for shipping methods with lower carbon emissions. Consequently, this approach would bolster the performance of multimodal cargo transport via the UAE. The imposition of environmental regulations on cargo operators traversing or operating within the UAE would reduce carbon emissions, thereby lowering freight costs and rendering the UAE more appealing as a transit hub for freight movements.

Lastly, the research findings underscore the profound impact of the current geographical and geopolitical landscape on multimodal cargo transport performance in the region. As a strategic move, the UAE should actively promote its transit hub capabilities by offering tailored shipping solutions to companies grappling with geographical and geopolitical constraints.

It should be noted that the resilience and efficiency of multimodal logistics, as explored in this case study on the UAE during the COVID-19 pandemic, holds significant implications for food safety in the nation. As the UAE relies extensively on imported food

items, the robustness of its transportation and logistics infrastructure becomes paramount in ensuring the timely delivery and quality maintenance of perishable goods. Multimodal transportation, by utilizing various modes of conveyance, has the potential to expedite shipments and reduce the time food items spend in transit, thereby reducing the risk of spoilage and contamination. However, the challenges identified in the study, especially heightened shipping costs linked to geographical and geopolitical risks, can pose threats to the consistent availability and affordability of imported foods. If not addressed, these logistical challenges could lead to delays, increasing the likelihood of food spoilage, or pushing suppliers to cut corners in food safety protocols to offset increased shipping costs. By enhancing the utilization of multimodal cargo transport and adopting the mitigation strategies proposed in the research, the UAE can not only improve logistics performance but also ensure the consistent flow and safety of food supplies, especially during uncertain times. This relationship underscores the interconnected nature of logistics performance and food safety, emphasizing the importance of a holistic approach in policy-making and strategic planning.

6.2. Theoretical Contribution

This study underscores the current reality of residing within a VUCA (Volatility, Uncertainty, Complexity, Ambiguity) world, aligning with the VUCA theory, as previously discussed by [5]. The realm of supply chain and logistics, which is inherently intricate and deeply interconnected, faces the challenges posed by the COVID-19 pandemic [81]. To enhance the effectiveness of transportation strategies benefiting global logistics and supply chains, along with the logistic performance of hub countries, a two-fold approach was adopted. Firstly, it entailed comprehending the factors influencing these strategies and, subsequently, devising methods to mitigate the impact of VUCA while proposing strategies to ensure the resilience of supply chain performance.

Therefore, this study advances the VUCA theory by introducing sustainable supply chain elements such as sustainable landed cost management, carbon emissions reduction in multimodal transportation, and the sustainable management of transit hub performance. Initiatives like logistics collaboration and innovation, exemplified by WLP through corridors, have the potential to significantly propel the industry forward. Furthermore, the logistics industry's adoption of a hybrid work model, partly influenced by the pandemic, contributes to the evolution of VUCA theory within the business landscape.

6.3. Limitations

This research has some limitations worth noting. Firstly, there is a scarcity of prior research on the subject of multimodal cargo transport, primarily because this topic leans more towards practical business concerns rather than being extensively covered in academic literature. Existing research predominantly delves into specific aspects of multimodal transport, such as sea–land, sea–air, or air–land, rather than comprehensively addressing all multimodal methods. Additionally, much of the existing research is not up-to-date, lacking insights into multimodal cargo transport during the COVID-19 period, which renders this research novel.

Secondly, due to time constraints, the research sample size was limited to 5 interviewees and 120 survey respondents. Expanding the sample size and exploring different regions could yield further valuable insights for industry practitioners.

Thirdly, this research focused exclusively on the UAE, overlooking the influence of other GCC countries that have recently developed robust logistic hubs to compete with the UAE. Future research should consider assessing the impact of these regional changes on the logistic performance of the UAE.

Lastly, some relationships between variables, particularly those pertaining to specific Middle Eastern geographical locations like Dubai as a logistics hub, remain unexplored. To address this, replicating the study in similar logistics transit hub cities such as Singapore,

Hong Kong, and Amsterdam under post-COVID conditions could provide comparative insights and enrich the findings.

Author Contributions: Conceptualization, B.S. and M.E.B.; methodology, R.A., M.E.B. and B.S.; formal analysis, R.A., B.S. and M.E.B.; data curation, R.A.; writing—original draft preparation, R.A., B.S. and M.E.B.; writing—review and editing, B.S. and M.E.B.; project administration, B.S. and M.E.B.; funding acquisition, B.S. All authors have read and agreed to the published version of the manuscript.

Funding: This study was partly funded by the Ministry of Education of the United Arab Emirates through the Collaborative Research Program Grant 2019, under the READY project [Grant number: 1733833]. The funders have had no role in the design of this study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and approved by the Social Sciences Human Research Ethics Committee of the University of Wollongong.

Informed Consent Statement: Informed consent was obtained from all subjects involved in this study.

Data Availability Statement: Not applicable.

Acknowledgments: We acknowledge the enthusiastic support from all participants of this research for their valuable inputs at each stage of the exhaustive data collection process.

Conflicts of Interest: The authors declare no conflict of interest.

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