

Global port supply chain management

Gestión de la cadena de suministro global portuaria

Cruz-Ramirez, Christian*^a, Cruz-Gomez, Marco Antonio^b, Espinosa-Carrasco, María del Rosario ^c and Mejia-Perez, José Alfredo ^d

^a  Benemérita Universidad Autónoma de Puebla •  KQW-9617-2024 •  0009-0005-6833-1513 •  2030977

^b  Benemérita Universidad Autónoma de Puebla •  S-3098-2018 •  0000-0003-1091-8133 •  349626

^c  Benemérita Universidad Autónoma de Puebla •  AAP-2965-2020 •  0000-0002-5094-2800 •  1018747

^d  Benemérita Universidad Autónoma de Puebla •  G-3354-2019 •  0000-0002-4090-8828 •  473808

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*  [\[christian_esc1@hotmail.com\]](mailto:christian_esc1@hotmail.com)




Abstract

90% of trade obeys port route logistics that involve the five global communication channels. The aim of this research was to analyze the evolution of global logistics and management of the global port supply chain with the aim of transforming it into a single window. On the other hand, global port success depends on geopolitics, infrastructure, adhesion to clusters, continuous investment, services, quality, costs and time. However, ports that do not have these parameters will be trunks or failures. A mixed analysis was carried out on the management of the global port supply chain based on the quantification and estimation of statistical control variables, decision making, geopolitics and modernization. The characterization of data obtained from port logistics determined transportation systems of sustainable, sustainable and circular development. The identification of critical routes for the conversion of a port to a single window will be the future work subject.

Resumen

El 90% del comercio obedece una logística de rutas portuarias que involucran los cinco canales de comunicación global. El objetivo de esta investigación fue analizar la evolución logística global a gestión de la cadena global portuaria de suministro con fines transformación a ventanilla única. Por otro lado, El éxito portuario global depende de la geopolítica, infraestructura, adhesión a clústeres, inversión continua, servicios, calidad, costos y tiempo. Sin embargo, los puertos que no cuenten con estos parámetros serán troncales o fracasos. Un análisis mixto fue realizado en la gestión de la cadena de suministro global portuario basado en la cuantificación y estimación de variables de control estadísticas, toma de decisiones, geopolíticas y modernización. La caracterización de datos obtenidos de la logística portuaria determinaron sistemas de transporte de desarrollo sustentable, sostenible y circular. La identificación de rutas críticas para la conversión de un puerto a ventanilla única será motivo de trabajos futuros.

Global port supply chain management		
Objectives	Methodology	Contribution
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Port logistics, Supply chain management, Maritime routes.

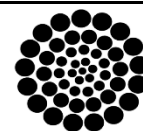
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Introduction

Global maritime trade obeys the logistics of tracing critical routes that involve the five global communication channels: English Channel, Strait of Malacca, Strait of Hormuz, Suez Canal and Panama Canal. Fluid logistics problems in the supply chain on maritime routes have become increasingly frequent in recent years, generating bottlenecks. Because 90% of the goods traded in the world use these routes in an upward evolutionary trade (Ksciuk, et. al. 2023 and Sun, et. al. 2024).

The International Maritime Organization in its 2023 report indicated that disruptions to global trade waterways have affected industry supply chains and the global economy. The fracture of the logistics chain is due to different circumstances, highlighting; COVID-19 pandemic, Ever Given jam in the Suez Canal, drought in the Panama Canal, Russian blockade of Ukrainian ports on the Black Sea and continuous attacks on ships in the Red Sea among others (Hou, et. al. 2022 and Sun, et. al. 2024).

The English Channel is the world's busiest shipping lane with more than 500 ships daily from the North Sea to the Atlantic and from the United Kingdom to continental Europe, and vice versa. Every year more than 16 million people and five million trucks pass through nearly 170 English Channel ports. The main ones are Portsmouth, Le Havre, Cherbourg and Brest (Zelenkov, et. al. 2022).

Strait of Malacca; Located between the island of Sumatra (Indonesia) and the Malay Peninsula, they interconnect the Indian and Pacific oceans. It extends from the Andaman Sea to the South China Sea, passing through the Singapore Strait. Every year around 94,000 ships cross the Strait of Malacca through more than 40 ports. On the other hand, to maintain fluidity, Thailand has proposed a 100 km "land bridge" in the narrowest part of the Malay Peninsula, where goods could be unloaded and transported by rail and road, avoiding the Strait of Malacca.

The Strait of Hormuz, between Iran and Oman, links the Persian Gulf with the Gulf of Oman and the Arabian Sea.

This maritime route covers the transfer of liquefied natural gas and oil from the Middle East, representing 20% of global consumption, which is equivalent to around 21 million barrels of oil. The strait operates with a two-lane traffic system in opposite directions. However, a concern for shipping companies is the security and geopolitical tensions that truncate the fluidity of the canal.

The Suez Canal, in Egypt, connects the Mediterranean with the Red Sea, it is a dividing line between Africa and Asia, it is the shortest maritime route from Europe to Asia, with 200 km in length it receives more than 20,000 ship crossings al anus. This has been affected by attacks on ships in the Red Sea, causing a drop in income to the canal, global effects on the economy and shortages.

The Panama Canal connects the Atlantic and Pacific oceans, it works through locks to raise and lower ships that cross the isthmus of Panama. It connects almost 2000 ports in 170 countries. Lately the drought has affected the lakes that supply the canal locks with more than 100,000 cubic meters of water. This has meant that the passage of ships has decreased, increasing waiting times from hours to weeks or even months, generating reservations and auctions for permits to pass through the Panama Canal.

Although the modernization of the lock system was launched with water-saving measures, ships have had to reduce their draft, stand in physical and virtual waiting lines to access the canal (Bedoya, et. al. 2024 and Ksciuk, et. al. 2023).

At the World Economic Forum, the congestion of ports and airports in global freight transport was analyzed. Transit delays, natural disasters and socioeconomic disruptions affect supply chains facing transportation challenges that involve; waterways, climate crisis, geopolitical instability and congestion that combine with social factors, such as labor conflicts and the increase in the cost of living. International trade is a system that evolves unpredictably, which is why freight transport companies consider it crucial to boost economic growth through global connectivity.

The efficiency of the movement of goods has been possible thanks to supply chain logistics applied to the network of global maritime routes. An analysis of the global trade logistics of the five busiest maritime routes in the world will help understand and propose applicable strategies in the short, medium and long term (Ji, 2024).

The aim of this research was to analyze the evolution of global logistics and the management of the global port supply chain with the aim of transforming it into a one-stop shop. The characterization of data obtained from port logistics determined transportation systems of sustainable, sustainable and circular development.

The Trans-Pacific maritime trade route is one of the world's busiest and most crucial maritime corridors, spanning the Pacific Ocean. This links the manufacturing centers of East Asia, where China as a power covers the consumption markets of the west coast of North America, highlighting the United States, which had commercial activity of approximately 28 million TEU container units in 2022.

Transpacific route is paramount in global trade, a wide range of goods and manufactured products in Chinese ports such as Shanghai, Shenzhen and Hong Kong are the main exporters, while US ports such as Los Angeles, Long Beach and Seattle are import destinations. The route covers waterways such as the Taiwan Strait, the South China Sea and the Pacific Ocean. The Panama Canal represents the main link of trade between Asia and the United States. Therefore, the Asia-East Coast of the United States route is considered the busiest trade route (Liu, et. al. 2023, Nicolet, et. al. 2023 and Yin, et. al. 2020).

The Asia-Europe maritime route extends throughout the Eurasian continent, being the main route of global trade, connecting the manufacturing centers of Asia, led by China, South Korea and Japan, covering the main markets of Europe, and economic powers. such as Germany, France and the Netherlands.

The Suez Canal, providing fluidity to an annual load volume of one billion tons in 2019, between the Mediterranean Sea and the Red Sea, with an extension of 193 kilometers, connects the north of Port Said with the south of Suez.

The Asia-Europe maritime route faces a series of challenges such as the blockage of the Suez Canal by the Ever Given in 2021, in addition to geopolitical conflicts in the Middle East, which disrupt the flow of maritime traffic, making the Suez Canal an impassable route. Due to this, ships are forced to navigate around the southern tip of Africa through the Cape of Good Hope, generating delays and million-dollar losses (Farah, et. al. 2024).

The Transatlantic maritime route crosses the Atlantic Ocean, linking North America with Europe. It connects ports such as New York, Norfolk and Miami in North America with European port centers such as Rotterdam, Hamburg and Liverpool.

This route interacts with the North Atlantic Ocean and the English Channel, which separates the United Kingdom from continental Europe and connects the North Sea with the Atlantic Ocean. The English Channel serves as a passage for more than 500 ships per day, with an extension of 560 kilometers. The Dover Strait is the narrowest part of the English Channel and is used daily by more than 400 ships (Zelenkov, et. al. 2022).

The Intra-Asian maritime transport trade route covers the Asia-Pacific region, linking ports in East Asia that include countries such as China, Japan and South Korea, with Southeast Asia, covering countries such as Singapore, Malaysia and Vietnam, as well as ports in South Asia, belonging to India, Sri Lanka, and those of Oceania, including Australia and New Zealand.

The intra-Asian route drives economic growth throughout Asia, the waterways of the South China Sea, the East China Sea, the Indian Ocean and the Strait of Malacca, with around 50,000 ships per year. However, it faces challenges such as port congestion, trade disparities and disruptions (Farah, et. al. 2024).

South America-Europe maritime trade route is the maritime trade corridor that spans the Atlantic Ocean, uniting ports in South America, including countries such as Brazil, Argentina and Chile, with European ports in countries such as Spain, Portugal, the United Kingdom and the Netherlands.

The route is the South Atlantic Ocean and the North Atlantic Ocean, they have efficient logistics and infrastructure for reliable load flow. Challenges include variable weather, large distances and precise supply chain management, bottlenecks, among others (Ji, 2024 and Ksciuk, et. al. 2023).

The global logistics evolution to global port supply chain management as a one-stop shop is a source of desire for many ports as sustainable, sustainable and circular development systems, due to the avant-garde importance that this represents, but how to achieve port success?

This depends on geopolitical factors, infrastructure, adhesion to clusters, quality of service in a continuous reduction of costs and delivery times, for this reason port systems are increasingly opening their range of opportunities to a line of business with private investors. as majority capitalists while the investment and dependence of countries and governments are reduced to compliance with regulations and payment of partner taxes, reducing the impact on the GDP (Gross Domestic Product) of the host country.

The identification of critical routes for the conversion of a port to a single window will be the subject of future work.

Sea Route Layout Logistics with Global Underpowered Iteration

An infinite number of shipping routes can be laid out making the system complex and busy, but the configuration of the global shipping system is simple. The central axis of the globe (Ecuador) is a circum-equatorial corridor that links North America, Europe and Asia-Pacific through the Suez Canal, the Strait of Malacca and the Panama Canal.

These routes support most of the global port traffic, but there are other routes for cabotage maritime transport (which is a sub-feeder maritime transport between two ports for the transfer of goods), the transatlantic and transpacific route covers a wide variety of ports. with a route along the circum-equatorial corridor.

Trans-Indian traffic is predominantly between the Asia Pacific and Europe, involving a series of clearly defined routes between the Strait of Malacca and Bab el-Mandeb. However, when these main routes are affected, alternative routes emerge to complement marine transportation and prevail as sub-feeder routes, complementing the system in an emergent way.

Maritime routes are determined by mandatory passage points, which are strategic locations that act as bottlenecks. The physical limitations (coasts, winds, ocean currents, depth, reefs, ice, among others) and political borders that influence the configuration of maritime routes with customs clearances.

Primary routes support major commercial shipping flows serving major markets, and secondary routes are connectors between smaller markets.

Bottlenecks in maritime routes

Geography, geopolitics and trade flows play a strategic role in the global maritime network labeled as bottlenecks of global trade. These include the 2021 Suez Canal blockage, delays in the Panama Canal due to drought recently, and geopolitical conflicts in the Strait of Malacca and Bab el-Mandeb.

A second type of bottlenecks are those that connect to maritime dead ends such as the Strait of Hormuz, which provides access to the Persian Gulf, and the Bosphorus Strait, which provides access to the Black Sea. The Oresund Strait is the only access to the Baltic Sea and Russia's main ports.

The closure of these bottlenecks forces the use of alternative land routes that are unlikely to have the capacity to handle port load volumes. Other secondary choke points are the Magellan Passage, Dover Strait, Sunda Strait and Taiwan Strait. The most notable bottlenecks are the Yangtze, the Rhine, the Mississippi, the Danube and the St. Petersburg. Lawrence (Dong, et. al. 2020 and Liu, et. al. 2023).

Investigation methodology

This research had a mixed approach, applying both quantitative and qualitative technologies, using systematic processes, as well as records and estimated data.

The aim of this research was to analyze the evolution of global logistics and management of the global port supply chain with the aim of transforming it into a single window.

For this, the application of the quantitative method was relevant in the identification of control variables involved in previous studies such as; statistics, decision making, geopolitics and port modernization. The characterization of data obtained from port logistics determined transportation systems of sustainable, sustainable and circular development.

The records of results obtained by different port companies, governments of different countries and previous studies of logistics experiences in port systems that formulate analysis of global supply chain management, were considered as the application of the qualitative method that allowed the possibility of obtaining results of the estimation of variables, which played an important role in decision making to understand the evolution and trends of a global port culture.

The operational data resulting from this research determined special adjacent requirements such as an uncertainty in the way each port adapts port conditions depending on its geopolitics, infrastructure, adhesion to clusters, quality of service in a continuous reduction of costs and delivery times, among others.

Finally, through the mixed method, an analysis of the control variables that allow involvement in; management, logistics, scale, offshoring, nearshoring and farshoring in the global logistics evolution management of the global port supply chain as a single window is a source of desire for many ports as sustainable, sustainable and circular development systems.

Port systems are increasingly opening their range of opportunities to a line of business with private investors as majority capitalist partners, while investment and dependence on countries and governments is reduced to compliance with regulations and payment of taxes, reducing the impact on GDP. (Gross Domestic Product) of the host country.

Port typology

A seaport is a logistical and industrial node in global supply chains with a strong maritime character and a functional and spatial grouping of port-related activities. This is a transit zone, a gateway through which goods and people circulate to and from the sea. It is a node where maritime and land transportation systems interact.

This is considered a place of convergence of different modes of transportation, because maritime and land transportation modes have different capacities, the port assumes the role of a load breakpoint where load is consolidated or deconsolidated. Sea Ports can be classified based on many dimensions that are related to the logistics of services they can provide.

“Scale” is an assessment of the size of the port in terms of its area, it is associated with its economic and commercial importance, annual load performance, size of its interior, number of shipping services to which it is connected or number of customers. “Geographic attributes” are the characteristics of the site and port location, coastal and inland geographical conditions (bay, coast, river or estuary). Many sites have natural advantages, while others need to be improved with dredging and landfilling.

Although the port site is fixed in space, its location is relative to the main maritime routes and the interior, or to its proximity and interactions with cities or urban conurbations. “Governance and institutional environments” are property conditions, Treaties, agreements, laws, norms, institutional, between the public and private sectors at different levels (Sun, et. al. 2024).

Port functions are the range of services offered by the port, load handling, logistics and distribution, industry and maritime services.

They are subject to competitive pressures. Port logistics is one of the port functions classified within the dimensions of the port typology. Specialization in handled load, containers, conventional general, liquid bulk, dry bulk or rolling load, passenger traffic. Another subclassification refers to industries focused on ports, steel plants, energy, automotive, and chemical industries.

Logistics activities contribute significantly to port specialization. Port logistics must obey the typology of ports based on the dimensions of their scale, geographical attributes, governance - institutional environments, port functions and specialization. The latter being the one that determines the changing port capacities in the continuous optimization of maritime routes in a productive market in constant evolution (Liu, et. al. 2023 and Nicolet, et. al. 2023).

Evolution of port systems

Port functions have evolved, responding to technical, economic and social advances, giving rise to generations of port development. Traffic in seaports generates functions such as trade, distribution, industry, containerization, type diversification, load equipment, intermodal transportation and information technologies. Some ports have grown to become global manufacturing industrial complexes due to the strategic use of their port typology.

The 20 ports with the largest container movement represented 44% of total traffic, reflecting a well-established global hierarchy of ports with the greatest impact on GDP (Gross Domestic Product) in the economy of their countries of origin and in the global economy according to Global Transportation Practice; the container port, Performance Index 2022.

The Global Ranking of Container Ports designates 348 ports that in descending order of the first 20 ports globally were Yangshan, Salalah, Port Khalifa, Tangier-Mediterranean, Cartagena (Colombia), Tanjung Pelepas, Ningbo, Hamad, Guangzhou, Port Said, Hong Kong, Cai Mep, Shekou, Mawan, Yokohama, Algeciras, Port King Abdullah, Singapore, Posorja, Tianjin (Liu, et. al. 2023 and Oliveira, et. al. 2022).

This does not imply that small ports have limited importance for the economies they serve, because although they are not a means of generating economic resources for the passage of container ships that greatly impact the Gross Domestic Product of a Nation, however, it can present advantages such as having a means of access to global markets with its port infrastructure that allows them to import and export to satisfy the economies of the nation, transferring them to a port system with national or local competition.

From a supply chain perspective, seaports increasingly function not as individual locations handling ships but as revolving platforms of global supply chains and transportation networks.

The contemporary fourth-generation port is characterized by being a platform that controls load flows and requires knowledge-intensive coordination activities through specialized logistics.

A seaport is not autonomous, since port activities contribute to industrial and logistical development in port areas and their interior. Thus, ports act as service centers and logistics platforms for international trade and transportation (Noto, et. al. 2023).

In recent decades, ports have undergone a wave of reforms with a market-oriented business approach to port management. Ports have become independent commercial organizations whose focus is profitability, cost recovery and customer service.

These are part of a system with spatial and functional characteristics that support global logistics and transportation networks. They interact with other nodes, such as neighboring and overseas seaports, intermodal terminals and inland logistics platforms, being subject to three types of functional interdependencies with other nodes; “chain networks” ports are nodes that are part of a sequence of flows, the output of one is the input of another.

“Hierarchical networks” ports are nodes that are part of different levels of connectivity, which implies that they can be reached directly and indirectly.

“Transactional networks” ports are nodes in a system of commercial relationships where they can be competitive or complementary. They use advantages such as location, cost, and productivity to attract or retain shipping services and traffic (Noto, et. al. 2023).

Ports rarely operate in isolation from other ports, they are part of complex networks of interactions, grouping together adjacent container ports in the same region competing for the same port calls and inland multi-port gateways.

Interior nodes and feeder ports are considered part of the port system.

They are competing to attract economic activities associated with seaports, which leads to functional changes in the port system. These nodes can also cooperate and coordinate their development by pooling transport flows and offering land and infrastructure for development.

This provides economic activities such as manufacturing and logistics with a range of node location options suitable for operational and market access needs.

Maritime transport evolves “global maritime space” profile of continental masses, global shipping routes and choke points the logistics performance index is a combination of a country's rating according to seven criteria: customs clearance, logistics infrastructure, ease of shipping international logistics competency/internal skill sets and service providers, track and trace capabilities, domestic logistics costs and timeliness/consistency (Dong, et. al. 2020).

Cluster in global supply chains

Seaport logistics and its importance of integrating ports and terminals into supply chains has increased the value-added focus. Major seaports offer opportunities to improve value-added logistics services by integrating the production and distribution chain. Modern seaports logistics system centers called cluster in global supply chains

Port and route selection criteria are related to the entire network in which the port is only one node. The ports selected are those that will help minimize the sum of ocean, port and land costs, including inventory and carrier quality considerations.

Port choice becomes more a function of cost and overall network performance. A well-coordinated logistics and distribution function of seaports, with the cooperation of various service providers, facilitates the integration of ports into high-quality value-added advanced logistics and distribution networks.

Port clusters generate scale and scope advantages linked to physical load flows, “ecologies of scale” due to their spatial concentration, but they could also face challenges, mainly accessibility (congestion) and higher land costs. On the other hand, the concentration of activities opens more opportunities to group load flows through intermodal transport (short sea shipping, barge or rail) (Dong, et. al. 2020).

External logistics company with global management

Logistics operators are classified according to the logistics tasks they perform in the company. Party Logistics or PL is subclassified as; 1PL, 2PL, 3PL, 4PL, 5PL.

1PL (First Party Logistics); fleet agencies and drivers for freight transportation. Companies maintain control of warehouses. 2PL (Second Party Logistics); In addition to transportation, the logistics operator is also responsible for storage tasks and material flows. 3PL (Third Party Logistics); External logistics operators are responsible for transportation, storage, management and organization of activities. 4PL (Fourth Party Logistics).

They are logistics operators that act as consultants and auditors of 3PLs, to validate and optimize the activity.

They do not have a logistics infrastructure, they only advise. 5PL (Fifth Party Logistics); They carry out a total integration of the services offered by 3PLs and 4PLs, thanks to their size and experience (Chen, et. al. 2022 and Sheikh, et. al. 2023).

International trade in port centers is dependent on the growth of carriers, load owners, terminal operators, external 3PL (Third Party Logistics) logistics service providers, freight forwarders and insurers.

This is also known as third-party logistics and can entail some disadvantages associated with the limited control that companies exercise over logistics functions such as; price, rate (subject to the type of merchandise), shipping method (urgent or not) and its destination, scalability.

The ability of a logistics operator to efficiently respond to an increase in activity is key to sustainable business growth; Technology: logistics operators who, supported by technology and automation, carry out their processes; Reputation:; Your operator's references have to be excellent. Management in a 3PL warehouse requires the functionalities associated with traceability, stock management or location assignment, exhaustive logistics control, capable of working with different transportation agencies integrated into the software (Bernacki, et. al. 2024, Chen, et. al. 2022 and Sheikh, et. al. 2023).

Ship fleet transport logistics

TEU (twenty-foot equivalent unit) containerization of maritime trade is the name of a ship's container. The 20 most important categories of the Standard International Trade Classification indicate that maritime transport represents 70% of total trade and 66% of world trade in containers, which represented about \$54,000 per TEU in 2020.

Global trade takes place predominantly within Europe, North America and East Asia called the triad. The energy, minerals and agricultural trade has specialized transport networks and port facilities designed to handle bulk loads with hopper type (Tramp) ships, as well as oil, gas, chemicals and special fluids on tankers. On the other hand, for various products that can be packaged, they are transported in container ships (Dong, et. al. 2020).

Imbalances in trade flows are a topic of interest in port logistics due to everything it implies. China exports more than it import with partners such as the United States and the European Union.

This generates an imbalance in maritime flows for bulk and container trade that involves repositioning, representing around 20% of global movements, this makes the return trip of the hopper or container ship empty. In the case of tankers, these are specialized in the fluid or gas they transport and cannot have any other use, because they become contaminated, therefore their return empty is a given (Castrellon, et. al. 2023 and Farah, et. al. 2024).

Transatlantic trade flows are considered the most frequent, they occur between Asia and North America (especially the United States), between Europe and North America and between Europe and Asia. The sea routes pass critical points such as the Strait of Malacca (30%), the Suez Canal (15%), the Strait of Gibraltar and the Panama Canal (5%). These routes can represent the largest number of bottlenecks in transatlantic trade so shipping lines tend to organize their services to connect the dominant trade flows directly and the less dominant trade flows indirectly through transshipments.

Very large Capesize ships will first call at a deep-water island port to unload part of the load and then proceed to the second port of call with lesser nautical access to unload the remainder.

Another practice consists of lightening deep-water ships in the current, whereby floating cranes unload part of the load onto barges, given the ship's increasingly shallow draft, but there will never be talk of total unloading of the ship to a means of transport. trunk. Bulk ships are smaller, so operators have a wider range of potential ports of call. They follow patterns determined by factors such as proximity to the market, specificities of the distribution network in the number of load lots and the need for silo-type infrastructure (Wang, et. al. 2023).

The characteristics of intraregional maritime services in the segment RORO (Roll On-Roll Off), ropax (ferries), Lo-Lo (Lift On-Lift Off) and Ro-Lo (a hybrid of Ro-Ro and container ships) are ships that They transport rolled load i.e. vehicles via ramps or cranes, combined with container ships, passengers, these are typical of the end-to-end type with shipping services following fixed schedules with medium to high frequencies.

Ferry capacity tends to vary depending on load density on the route and distance. Deepwater and short sea vehicle transportation is another submarket of the RORO market. On intercontinental routes, operators use Pure Car and Truck Carriers (PCTC) with capacities of up to 8,000 TEU, cost savings shipping lines aim for short port time and face a shortfall in the number of ports that have the infrastructure to accommodate large quantities of new cars.

Rail and barges play an increasingly important role in ensuring inland access to automobile ports as safe trunk transportation. On the other hand, the Dynamar typology is based on services of a specific frequency operated with exclusive ships for that task, implementing charter trips, within a defined commercial route "Parcelization", such as vagabondage, a process in which a ship (Witte, et. al. 2020).

Reefer ships primarily transport high-value food and pharmaceutical products that require refrigeration and atmospheric control in an end-to-end service. Refrigerated shipping is a one-way business.

The refrigerated transport sector is increasingly under pressure from container transport.

Therefore, shipping lines design the networks that they consider convenient to offer, but they are obliged to provide the services that their customers want in terms of frequency, direct accessibility and transit times.

Shipping productivity has improved using larger post-Panamax ships with lower fuel consumption and the design of new operating patterns and cooperation between shipping lines, resulting in a reduction in the cost per TEU of capacity provided.

Supply chains are highly dynamic as they react to patterns in global trade and information technology. The coordination and management of a complex network of activities that deliver a finished product to end users or customers.

The process includes supply of raw materials, parts, manufacturing and assembly of products, storage, entry and tracking of orders, distribution through the different channels and, finally, delivery to the customer.

Logistics services that still offer value can suffer degradation and become basic services called physical value added. Average product life cycles and global supply chain cycles, such as delivery time, have decreased. A series of indicators can be evaluated, such as the Logistics Performance Index developed by the World Bank (Dong, et. al. 2020).

Global logistics in one-stop shops

Intellectual property intensive activities focus on developing a brand, key in the business model of multinational companies with a focus on customers and product innovation, while production and logistics providers are outsourced to a network of suppliers, adopting flexible multi-company organizational structures on a global scale.

However, very few of the world's largest multinational companies operate globally, they rely regionally on the breadth and depth of their market coverage on a sustainable basis and their sales are situated within their local branch of the "triad".

Global logistics expenses represent around 10 to 15% of GDP and 20 to 50% of its total finished product costs. Logistics costs reveal that transportation costs are increasing relative to inventory holding costs, indicative of more inventory in circulation rather than held in distribution centers (Bernacki, et. al. 2024).

Technological innovation. of supply chains through customization and standardization using advances in data analysis and visibility "plug-and-play supply chains" (Agile Supply Chains). Logistics service providers external to the company control the supply chain supported by ICT (Information and Communications Technologies) systems; they are increasingly more efficient, sustainable, profitable, circular and establish Green Supply Chain Management strategies.

This involves reducing environmental impacts by focusing on supply chain strategies known as the five "Rs"; Reduce, Reuse, Recycle, Remanufacture and Reverse Logistics. Supply chain visibility results in efficient planning and lower operating costs. Logistics service providers could use low-cost outsourcing to reduce their cost base versus vertical integration.

This strategy is not free of risks and could subcontract activities that are not recognized as generating value. The use of real-time digital tools update data automatically, providing supply chain managers with updated and relevant information in decision-making for regulation, automation and optimization as a niche opportunity.

However, a low-price advantage is a challenge and cost leadership is very difficult to achieve, but it generates competitiveness and sustainable differentiation (through I+D, marketing and competitions), among companies of maritime-port logistics throughout the value chain (Bernacki, et. al. 2024, Yang, et. al. 2024, and Zhang, et. al. 2024).

Manufacturers are looking for global logistics packages rather than just shipping or reshipping. Global logistics (megacARRIER) is the dominant paradigm to which most transportation chains have responded by providing new value-added services in an integrated package along supply chains. Global logistics companies in intermodal integration and synchro modality share the ambition of becoming “one-stop shops” in overlapping distribution networks.

Point-to-point logistics with online sales channels

The rise of 4PL the electronic commerce environment at the company-company, company-consumer levels. The quality of the information system, the quality of the service and the satisfaction of users offers more opportunities to reach customers around the world and eliminate unnecessary intermediate links, reducing the cost price.

This is particularly the case for the spot business and basic port-to-port transportation, which are entry points for electronic forwarding, shippers gain better information using Big Data and electronic markets, greater rate transparency and visibility into shipping schedules. line services. Intermediary freight forwarders are most at risk from new technology providers or business models unless they adapt, offering supply chain visibility.

Carriers are challenged to opt for technology-driven collaborative networks, they must recruit new talent from outside the logistics sector with new perspectives and continually feedback their logistics flexibly with cutting-edge perspectives.

Customer profiling and market segmentation will be the core of the business model of these online sales channels. This practice will be available to many at a lower transaction cost and with more flexibility using customized electronic tools.

The use of larger ships (threshold of 12,000 TEU) generates great advantages such as the design of new operating patterns, cooperation between shipping lines of larger ships (post-Panamax) with lower fuel consumption, improvement of the container fleet, reduction of unit costs, access to more loops or services with relatively low cost implications, sharing of terminals, cooperating in areas at sea and on land, operating on multiport itineraries, calling at a limited number of ports, circulation of traffic through a network of specific nodes and lower costs of time slots.

The effort to prepare ports and terminals for increasingly larger ships is growing disproportionately. Supply chain risks with larger container ships could increase. Therefore, it is becoming increasingly difficult to generate profits for shipping lines, ports/terminals and carriers.

The digitalization of smart containers makes it possible to make additional information available to carriers, terminal operators and load owners. This information is related to container identification, location, geofences, and physical characteristics throughout the transportation chain. Information on temperature, humidity and pressure are relevant for reefer containers and cold chain logistics. Refrigerated containers require more detailed monitoring such as impact detection, disconnection of the cold chain, etc.

This allows for clearer identification of liability in the event of theft, damage or breach of container integrity. In 2018, 2.9 million reefer TEUs were used, approximately 5% of global container capacity. A normal 40-foot container costs around \$5,000, while a reefer container of the same size costs around \$30,000. The logistics of relocating empty refrigerated container ships is a need that worries the maritime transport sector, due to their exclusive use or disinfection as appropriate for new use (Castrellon, et. al. 2023 and Yang, et. al. 2024).

Container offloading logistics covers the container market chassis fleets required to transport containers by road within terminals. to store containers in terminals and distribution centers. It is called wheeled operations. For road transport of a refrigerator, a clip-on generator (called a Genset; it is attached to the upper front end of a refrigerator) or a suspended generator (it is attached under the chassis of a container) is used.

For maritime and rail transport, the capacity of the energy system determines the number of refrigerated containers that can be transported. Some ships have up to 25% of their spaces dedicated to refrigerated load. Power is provided by the ship's generator.

For rail movements, diesel generators are used to provide power to about 8 reefer containers. It is important to emphasize that refrigeration units are designed to maintain the temperature within a preset range, not to cool it.

Means that the shipment must reach the required temperature before being loaded into a reefer container. Refrigerated terminal facilities The growth of cold chain logistics has required transportation terminals and ports to dedicate a portion of their storage yards to refrigerated containers. represents between 1% and 5% of the total capacity.

Results Discussion

Continuous investment in infrastructure in a race against the requirements of the modernization of port areas is a crucial logistics factor that will allow the competitiveness of port customs at an international level in a critical supply network that under the concept of logistics, quality and delivery time will always look for port areas that offer lower costs, times and port tariffs, with monitored logistics of the passage of products that ensure their protection at all times in the event of any situation that puts the integrity of the container ship transfer service at risk.

For the export supply network through shipping companies to be profitable, the load on container ships must be mixed, that is, standard containers for the transfer of non-perishable products and refrigerated TEUs for perishable products.

The transfer of goods via port can occur within the same country, but many times it occurs in an external country, which is defined as offshoring. The term can be further qualified with the concepts of nearshoring and farshoring which imply a level of proximity. Types of corporations by multinational expansion strategy (Silva, et. al. 2024 and Xie, et. al. 2022).

“Platform companies” actively took advantage of the “China effect” manufacturing industry activities. This underlines that location decisions are continually re-evaluated, considering changes in global input costs, regulations and geopolitics. Furthermore, public policy attention is shifting from promoting competitiveness to developing capabilities. The main reason is that competitiveness tends to focus on decreasing input costs, while capabilities focus on increasing the added value provided by the manufacturing sector.

Results

Value chains are therefore a sequential process used by corporations within a production system to gather resources, transform them into parts and products, and finally distribute manufactured goods to markets. Backward participation. When one stage of a value chain produces products created by previous stages. This usually takes place in the later stages of a value chain. Forward participation. When one stage of a value chain produces products that will be used in later stages to create a final good. This usually takes place in the early stages of a value.

An environment in which just-in-time (JIT) and synchronized flows have become the norm in production and distribution systems. International transportation is changing to meet the growing needs to organize and manage its flows through logistics. Containerization is adaptable enough to address a variety of time and load constraints (Ji, 2024 and Lai, et. al. 2024).

Conclusions

The layout of critical routes around the circum-equatorial belt and the passage that involves the main global communication channels; English Channel, Strait of Malacca, Strait of Hormuz, Suez Canal and Panama Canal have generated bottlenecks in the maritime transport of goods, impacting the global economy (offshoring, nearshoring and farshoring). However, the evolution of global logistics to management of the global port supply chain as a single window has involved global logistics management specialized in technical characteristics of means of transport, port infrastructure that depend on geopolitical factors, adherence to clusters, quality in the service in a continuous reduction of costs and delivery times.

Online commerce and customs processes as a sustainable, sustainable and circular development system, use as a preferential transport system the services of interconnected avant-garde port networks that have single window shipments whose services cover offshore and onshore areas. with trunk or internal ports.

Port systems are increasingly opening their range of opportunities to a line of business with private investors as majority capitalist partners while investment and dependence on countries and governments is reduced (due to the large magnitude of continuous investment that they require to be competitive by committing the public finances of the country) to compliance with regulations and payment of taxes, reducing the impact on the GDP (Gross Domestic Product) of the host country.

Declarations

Conflict of interest

The authors declare no interest conflict. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Cruz-Ramirez, Christian: Contributed to the project idea, research method and technique, for develop the project.

Cruz-Gómez, Marco Antonio: Contributed to analyze the evolution of global logistics.

Espinosa-Carrasco, María del Rosario: Apported investigation about geopolitics and infrestructure.

Mejía-Perez, José Alfredo: Researched papers and references about the topic.

Availability of data and materials

The data obtained focus on the analysis of global logistics and port supply chain management. This includes statistical control, decisions related to geopolitics, and aspects of modernization and sustainability in port logistics.

The materials used in this research comprise experimental protocols and analytical models employed to evaluate the evolution of port logistics and the transformation of ports into single windows.

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Abbreviations

COVID-19	Coronavirus disease 2019
GDP	Gross Domestic Product
ICT	Information and Communications Technologies
JIT	just-in-time
Lo-Lo	Litf On-Lift Off
PCTC	Pure Car and Truck Carriers
PL	Party Logistics
Ro-Lo	hybrid of Ro-Ro and container ships
RORO	Roll On-Roll Off
St.	Street
TEU	Twenty-foot Equivalent Unit
US	United States

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