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Article

Feasibility of dry canals in the Americas

Factibilidad de canales secos en el continente Americano

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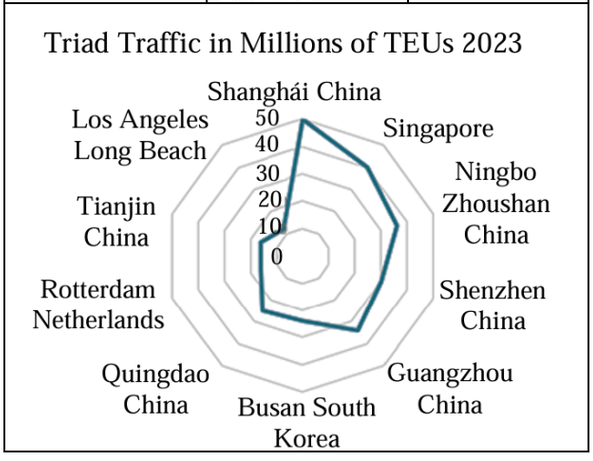
Abstract

The future of global maritime trade is being guided by the Triad generating uncontrollable infrastructure expansion. The objective of this research was to analyze the feasibility of dry canals in the American continent as sustainable development projects with fine relief from the Panama Canal. On the other hand, the success of a dry port depends on the preferences for use as a port route over its competitors. However, dry ports that are not competitive will be locally supplied. A mixed analysis was carried out to identify the feasibility criteria for dry canals, based on the quantification and estimation of statistical control variables, decision making, geopolitics and modernization. The characterization of data obtained from requirements so that a dry port can act as a detonator of sustainable and sustainable development in a cutting-edge environment. The identification of parameters of island-type port systems will be the subject of future work.

Objetives	Methodology	Contribution
The objective of this research was to analyze the feasibility of dry canals in the American continent as sustainable development projects with fine relief from the Panama Canal..	A mixed analysis was carried out to identify the feasibility criteria for dry canals, based on the quantification and estimation of statistical control variables, decision making, geopolitics and modernization.	The characterization of data obtained from requirements so that a dry port can act as a detonator of sustainable and sustainable development in a cutting-edge environment.

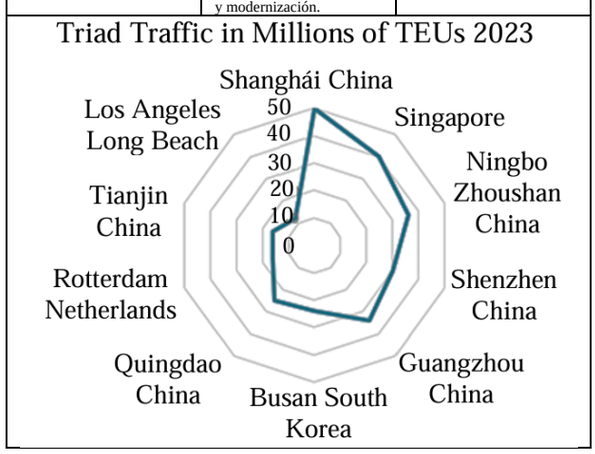


Dry port, inner port, Trunk port

Resumen

El futuro del comercio global marítimo está siendo guiado por la Triada generando una expansión de infraestructura incontrolable. El objetivo de esta investigación fue analizar la factibilidad de canales secos en el continente Americano como proyectos de desarrollo sustentable con fines desahogo del canal de Panamá. Por otro lado, El éxito de un puerto seco depende de las preferencias de utilización como ruta portuaria sobre sus competidores. Sin embargo, los puertos secos que no son competitivos serán de abastecimiento local. Un análisis mixto fue realizado para identificar los criterios de factibilidad de canales secos, basado en la cuantificación y estimación de variables de control estadísticas, toma de decisiones, geopolíticas y modernización. La caracterización de datos obtenidos de requerimientos para que un puerto seco pueda actuar como detonador de desarrollo sustentable y sostenible en un entorno vanguardista. La identificación de parámetros de sistemas portuarios tipo isla será motivo de trabajos futuros.

Objetivos	Metodología	Contribución
El objetivo de esta investigación fue analizar la factibilidad de canales secos en el continente Americano como proyectos de desarrollo sustentable con fines desahogo del canal de Panamá.	Un análisis mixto fue realizado para identificar los criterios de factibilidad de canales secos, basado en la cuantificación y estimación de variables de control estadísticas, toma de decisiones, geopolíticas y modernización.	La caracterización de datos obtenidos de requerimientos para que un puerto seco pueda actuar como detonador de desarrollo sustentable y sostenible en un entorno vanguardista.



Puerto seco, puerto interior, Puertos troncales

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Introduction

Seaports are a spatial system that function as networks of logistics platforms that control cargo flows in supply chains that contribute to industrial development and global trade.

Ports interact with other nodes directly and indirectly, such as neighboring and overseas seaports, intermodal terminals and inland logistics platforms of different levels of connectivity. These form networks of sequential chains of transport flows, where the output of one node is the input of another (Bernacki, et. al. 2024).

Ports are nodes in a competitive system of complementary transactional networks. These use advantages such as location, cost and productivity to attract or retain service and shipping traffic. A range of ports may be located along the same coast and share inherent geographical, economic and functional characteristics (Li et al., 2024).

The Atlantic Ocean links South American ports, including those in Brazil, Argentina and Chile, with prominent European ports in countries such as Spain, Portugal, the United Kingdom and the Netherlands. The waterways on this route are the South Atlantic Ocean and the North Atlantic Ocean, relying on efficient logistics and infrastructure for reliable cargo flow and accurate supply chain management.

Supply chain logistics can be disrupted by primary choke points. These are crucial points in global trade. If they are interrupted, there are limited and unprofitable maritime transport alternatives. These bottlenecks are the Panama Canal, Suez Canal and the Strait of Malacca, key in world trade.

A clear example was the blockade of the Suez Canal in 2021, where this depends on the access granted to the Red Sea through the Bab el-Manded Strait. Secondary bottlenecks are those that connect to maritime dead ends with substantial resources and commercial potential, such as the Strait of Hormuz, which allows access to the Persian Gulf, and the Bosphorus Strait, which grants access to the Black Sea.

The Oresund Strait is the only access to the Baltic Sea and Russia's main ports. Closing these bottlenecks would force the use of alternative land routes that are unlikely to have the capacity to handle maritime load volumes. (Bartosiewicz et al., 2024, Bernacki, et. al. 2024 and Mechai & Wicaksono, 2024).

The aims of this research was to analyze the feasibility of dry canals in the American continent as sustainable development projects for the relief of the Panama Canal. The characterization of data obtained from requirements so that a dry port can act as a detonator of sustainable and sustainable development in a cutting-edge environment.

The evolution of maritime trade routes places all port systems that provide supply chain services in a committed competition to cover the parameters required by the port infrastructure trends of sustainable development, in an avant-garde environment, but How to achieve the success of a dry port? This depends on the preference for use as a port route over its competitors. The global port chain is migrating from a government sector to a private company sector, which makes it a transnational private capital company that is governed to a certain extent by the laws of the country of settlement and international laws, but business strategies and company laws are governed by the private company, as well as the profits among its shareholders. The feasibility of a dry port for any Latin American country must take into consideration that the top of the profit pyramid is occupied by the transnational, not the government of the country or the region of settlement.

The identification of parameters of island-type port systems will be the subject of future work.

International port trade

International trade occurs within economic trading blocs such as NAFTA in North America, the EU Single Market in Europe, ASEAN in Southeast Asia, MERCOSUR in South America, and ECOWAS in West Africa. (WTO) and the initiatives of organizations such as UNCTAD or the World Bank.

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The most important transpacific and transatlantic trade flows are 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 bottlenecks the transatlantic, transpacific and Asia-Europe routes. Shipping lines tend to organize their services to connect dominant trade flows directly and less dominant trade flows indirectly through transshipments (De Santa Marta, 2020) and (Mechai & Wicaksono, 2024).

International trade is centered on three exporting powers called the Triad made up of China-Singapore-Korea, with around 255 million TEUs, followed by the Netherlands with approximately 16 million TEUs and the United States with 13 million TEUs annually reported during 2023, you can see figure 3 (Li, L., et. al., 2024).

Box 1

Figure 3
International trade of the Triad in 2023

Throughout the world during 2022, the existence of 348 ports, with a mobility of around 500 million TEU's, were censused and reported in the Global Ranking of Container Ports. On the other hand, the Rankin of the American Continent of Ports reports the 33 ports with the highest activity with around 95.2 million TEU's, which represents that the American Continent imports 40% of the triad's global exports, of which North America imports 65.5% and 34.5% is distributed in Latin America. See table 1, (Cidell, 2024).

The successive stages of port development is called the port hierarchy, which ranges from small ports serving a niche market to large gateway ports serving a vast area made up of a wide range of economic activities. 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, turning them into a port system with national competition.

A multiport is identified by the location relationship with nearby areas of identical hinterland traffic, criteria for grouping adjacent container ports in the same gateway region competing for the same port calls in the networks, and the hinterland connectivity profile. On the other hand, feeder ports or interior nodes can cooperate and coordinate by grouping transportation flows and land for development. Provides economic activities, manufacturing and logistics. These follow a macroeconomic and microeconomic analyst perspective, forming port clusters that offer scale, scope and environmental advantages, linked to the physical flows of cargo through intermodal transport (short sea shipping, barge or railway). Just as “ecologies of scale” due to their spatial concentration can face accessibility challenges (congestion) and higher costs of the surrounding land. (Li et al., 2024).

Specialized maritime transport

International trade and Maritime Transport Services covers cargo markets such as: Bulk; solid, liquid, and gaseous, Rolled Cargo; Ro-Ro, Containers; general, and refrigerated, Oversized and Passenger.

Container ships have evolved logarithmically in tandem with the growth of the global market transported by this means. World trade advances logarithmically with increases per decade of around 35%.

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The world's largest container ships reported until 2023 is 1st. MSC Irina, (2023, Liberia) with capacity 24, 346 TEU, length 400 m and beam 61 m. 2nd. MSC Loreto, (2023, Liberia) with capacity 24, 300 TEU, length 399.99 m and beam 61.3 m. 3rd. MSC Tessa, (2022, Liberia) with capacity 24, 116 TEU, length 399.99 and beam 61.56. 4th. Evergreen Ever A lot (2022), with a maximum capacity of 23,964 TEU, length 399.99 m and beam 61.50 m. 5th. HMM Algeciras (2020). Maximum TEU: 23,964. Length 400 m, beam 61 m and depth 33.20 m. maximum height point container ship 50 m. 6th. HMM Oslo (2020). Maximum TEU: 23,820, length 399.9 m and beam 61.5 m. 7th MSC Gülsün (2019). Maximum TEU: 23,756. 8th. MSC Mina (2019). Maximum TEU: 23,656 9no. CMA CGM Jacques Saadé (2020). Maximum TEU: 23, 112. 10th. OOCL Hong Kong (2017). Maximum TEU: 21,413.

During 2016, the modernization of the Panama Canal incorporated locks 427 m long, 55 m wide and 18.3 m deep in the port area. The depth of the locks is 25.9 m, because they contain fresh water and the draft of the ships depends on the density of the water, directly related to salinity and temperature. The Neopanamax vessels suitable for transit through the new locks are 49 m wide by 366 m long, draft of 15.2 m and maximum TEU: 14,000. Another classification of vessels was the so-called Panamax with a length of 294 m, beam of 32m, and 12 m., draft with a maximum capacity of 5000 TEU. These are suitable for passage through the old locks of the Panama Canal whose dimensions are 320m. long, 32 m. wide and 12 m. draft (PortalPortuario, 2023).

The diversity of tramp vessel marine service configurations is a general cargo market dealing with smaller shipments. Fractional loads can be sent. “Weekly services on fixed days” do not have a route, itinerary, or fixed schedule, allowing this system to be available to ship any cargo from any port.

Typology Dynamar services specific frequency operated with exclusive ships for that work, services that offer departures, implementing charter trips, operated under incentive, within the “Parcelization” commercial route, in which a ship is chartered.

The general cargo market includes specialized ships. Heavy cargo ships do not operate on fixed routes but are attracted to those areas where large investments are made in the oil and gas industry. The reefer ships high-value food products that require end-to-end refrigeration and atmosphere control service. Refrigerated transportation is a one-way business.

Global trade problems

90% of global trade is carried out through a port supply chain with management of critical routes that can supply the service with quality parameters, low cost and delivery time. The exports carried out by the triad require port infrastructure for their supply. However, this has been surpassed and the port necks represent a serious problem for current trade, and this will become more acute in the coming years (Wu, X. et. al., 2024).

An imbalance between exports and imports is what currently occurs in the multipoint and point-to-point port supply chain.

Eurasian trade to America requires a business plan capable of satisfying the critical routes of port trade. The American continent needs to promote critical trade routes. A proposal made to all Latin American countries that have transpacific crossing conditions is to carry out dry port projects, also called; dry channels, internal ports, interoceanic land bridges or trunks, which operate as complementary to the Panama Canal for the passage of TEUs (Bogataj et. al. 2022).

The competition to present projects for interoceanic dry crossings from the Atlantic to the Pacific by the developing countries of Latin America with commercial alliances to the Triad countries and independently has not been long in coming. The participating countries due to their geopolitical conditions that make them suitable are Mexico, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Venezuela and Colombia. The country of Costa Rica is the only one that proclaims itself out of the competition, because it prefers to bet on the conservation of its ecosystems as a means of sustainable development. However, you could become interested in the projects and change your mind (Anbleyth-Evans, 2023 and Chou et. Al. 2021).

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Previous evaluations place them as the most suitable countries due to their geopolitical conditions and previous infrastructure already built in their territories, leaving Nicaragua, Mexico and Colombia as participants with interest in carrying out the three projects to compete simultaneously. But this does not exclude the other participating countries.

The draft conditions of ports in Latin America range between 10 and 15 m. at most. The port infrastructure in the Air draft parameter in unloading gantries ranges around 35m.

Nicaragua, together with a Chinese businessman, planned to build the Nicaragua Canal that would measure 278 kilometers long, between 230 to 520 meters wide, and up to 30 meters deep. However, in 2021 it was canceled, and the dreams of the canal fell apart, leaving only a dry port. It currently has the advantage of road infrastructure with expansion projects.

Mexico will rehabilitate a 200 km railway system in the Isthmus of Tehuantepec, with connection to the ports of Coatzacoalcos and Salina Cruz Oaxaca, which could be an alternative to alleviate the high demand in the passage of containers. With the advantage that this step already exists and is only being adapted.

Colombia's project is the so-called dry canal, which would be 220 kilometers long and would go from the Pacific to a city that would be built near Cartagena de Indias. Having the advantage of its port network of great global impact with proximity to the Panama Canal.

It is worth mentioning that Latin American countries compete to host either a wet canal or a dry canal in their territory and this will depend largely on foreign investors from the Triad and G7 countries. On the other hand, it is clear that the construction of a wet canal in Latin America similar to the Suez Canal could leave the dry canals disabled and out of competition. However, if they are not built, the dry canals will be trunks supporting the Panama Canal in the coming decades. A revaluation of built projects will emerge and place their impact on international trade on a higher scale (Li et al., 2024 and Wu et al., 2024).

The melting of ice in the Arctic ice cap caused by global climate change has made new transpolar routes possible, shortening the distances between Asia and Europe and between Asia and North America. Some studies have illustrated the logistics cost advantages of these new routes, comparing them with the dominant Panama Canal and Suez Canal routes (Mechai et. al. 2024).

Transportation cost strategies and risks in shipping companies

Mixed containerization is a strategy of shipping companies to prorate transportation costs, because the charges for perishable products yield greater profits that balance the costs of non-perishable products. However, refrigerated products also face higher charges in every sense such as tariffs, port handling, customs, tracking, storage insurance, etc. The client will have to pay all of these to the shipping company that, together with its logistics manager services, will carry out total or partial monitoring depending on the client's requirement from point to point or in multipoint trunk services (Bogataj et al., 2022).

Port terminals require infrastructure for loading and unloading, because a container ship can hold 1 to 5% of its total cargo of refrigerated containers and these require manual connection and disconnection conditions by port terminal operators, and a refrigerated contact transfer infrastructure through electric power generating plants that supply the chassis of trucks or trains that will carry out the transfer. In addition to special care, the fact that the containers are not airtight, generating condensation during their transfer, requires logistics accompanied by a very complete and expensive infrastructure to be able to supply the timely transfer of the containers. Most container ships carry mixed loads of standard and refrigerated container ships, so thinking about only supplying standard container ships greatly reduces the possibility of supplying the port central, being competitive with port customs at an international level in a network of supply criticizes that under the concept of logistics, quality and delivery time it will always look for port areas that offer lower costs, times and port tariffs, with logistics that ensure protection at all times in the event of any situation that puts the integrity of the container at risk. (De Santa Marta, 2020 and Fazi et al., 2020).

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The security factor having a very important value in the supply chain (De Santa Marta, 2020 and Fazi et al., 2020).

Commercial agriculture must be competitive and depends on crop specialization to achieve economies of global scale, it implies greater dependence on technology. About 37% of the world's land area is devoted to agriculture, of which 68% is devoted to pasture and 32% to cropland. About 10% of the value of world trade refers to agricultural products food distribution.

As an economy becomes increasingly urbanized, it must rely on food distribution systems beyond its region to meet demand. Long-distance food distribution systems make it possible to establish a constant supply between regions of the world at different stages of their harvest cycles. The term food mile factor of weight-distance relationship in food distribution. The higher it is, the more energy needs to be expended to maintain the food supply. Many food products, cereals, are massively transported by grain elevators and bulk vessels such as railways and ships bulk foods main markets, are processed into primary foods. Therefore, agricultural production levels, regulates and maintains port systems in their different scales and classifications in a competitive state. However, limited production of these products in developing countries that lack technological exports can mark competitiveness in the balance of imports and exports.

Cold chains handle about 70% of all food consumed in the United States. In China, less than 25% of meat and about 5% of fruits and vegetables. The United States imports about 30% of all its fruits and vegetables, and 20% of its food exports, about 25% of all Food products transported in the cold chain are wasted every year between 50 and 60% of all production, due to integrity violations, resulting in temperature fluctuations and product degradation.

The efficiency and reliability of temperature-controlled transportation has reached a point that allows the food industry to take advantage of global seasonal variations. Emerging vulnerabilities in global food systems cause international organizations to generate market mechanisms that create incentives to distribute food.

Port systems are affected in the supply chain network by technological risks, sociopolitical risks; conflicts, corruption, theft, commercial restrictions, lack of reliability in the government, operation of criminal groups, social instability, marginalization, areas of poverty, lack of energy, urban infrastructure, services, customs fraud, floor collection and geopolitics among others , since these mechanisms generate instability in the attraction of investment that has an impact on economic volatility and price supply and demand shocks that generate unrest and demonstrations by social groups. The influence of these risks on the supply chain means that market prices could be lower than the cost of production and distribution. A simple integration measure relates to customs delays, a major trade impediment, adding uncertainty to supply chain management. For regulators, trade facilitation improves their effectiveness and reduces the risk of customs duty evasion.

The geography of ports takes shape at different scales, from the port and its terminals at the local level to the global maritime transport system. Sites can be modified by adding infrastructure such as docks, docks, breakwaters, forming a port, geography is the core of the added value that maritime transport provides, and ports are the places that generate this value.

Ports depend on geographical limitations, changes in commercial and technical aspects of maritime transport, changes in logistics, geography of ports, development of transport terminals, supply of infrastructure, anticipated transport demand. On the other hand, the presence of infrastructure does not guarantee traffic, because shipping lines can reassign the sequence of the ports they serve as business opportunities change. The growth of port traffic implies improvements in spaces, maritime profiles, increased stowage, and an increase in the number and length of docks. As maritime traffic grows, port terminals and activities tend to expand in a valorization process from their original sites to locations with better maritime and land access in an unsustainable race with a sequential perspective to satisfy the demand of supply chains.

The creation of dry canals with internal port infrastructure must be extensive and focused on serving shipping interests, otherwise no advantageous ocean location will overcome the peripheral land disadvantage.

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Competitiveness, peripheral ports must be more proactive than ports centrally close to maritime networks or large internal markets, proximity to a circular route and have good facilities and connections.

Advantages can be found in a better-performing inland transportation network, personalized customer focus, flexible business environment, and increased reliability that comes from certain asset availability.

Connectivity to maritime transport networks makes it possible to identify critical routes that involve less port navigation time. The availability of storage in the terminal's stacking yard functions as a buffer and temporary storage area between offshore operations and land transportation.

The space consumed by container terminals increases space requirements, changing the geography of ports and has promoted the migration of terminals to new peripheral sites. It is recommended that in the layout of internal ports, large spaces be considered for the yards that will support TEU mobility and port revenue. The interior of the port is a strategic market area to interact and compete in the creation of interior freight corridors and centers.

The development of intermodal corridors and inland terminals allowed deep penetration into the country's interior via shuttle trains and barges. The rise of intermodalism and transportation corridors influenced the inland reach of seaports. Intermodalism has not only given ports incentives to expand their reach inland, but has also become more discontinuous, especially beyond the port's immediate hinterland. Such a process may even lead to the formation of “islands” in the distant hinterland for which the cargo hub achieves a comparative advantage in costs and services over rival seaports. Conventional market perspectives based on the decline of distance are not adequate to address this new reality. High-volume intermodal corridors typically offer a more favorable relationship between transportation price, delivery time and distance than conventional, continuous inland transportation coverage (Chou et al., 2021).

The hinterland of a port consists of overlapping service areas of individual hinterland terminals and available modal options and the size of each area depends on the service frequency and rates. The foreland is a maritime space over which a port has commercial relations; maritime transport networks are a common representation of the foreland concept. For successful integration, ports seek balance in import services; however, when it decreases, they turn inward to promote exports. This balancing logistics achieves a successful balance.

Inward movements generate low-paid activities such as repositioning of empty units, fixed delivery schedules, waiting for an available docking bay at a distribution center, network control and tracking.

Terminalization encourages the establishment of a hierarchy of flows along a transport chain where terminals act as important regulators, either as bottlenecks or as buffers. Transshipment hubs tend to be deeper to accommodate container ship drafts, which puts them at a technical advantage and encourages feeder hub services and interline relay configurations between mainline vessels.

Railway dry ports are found throughout Europe, often linked to the development of logistics zones. Depending on the European country considered, these logistics zones receive different names, such as “platformes logistiques” in France, “GVZ” in Germany, “Interporti” in Italy, “Freight Villages” in the United Kingdom, “Transport Centers” in Denmark, and “ZAL” in Spain. The largest railway facilities have packages of up to 10 tracks with a maximum length of 800 meters per track. Rail hubs are typically equipped to allow simultaneous lot exchanges (direct transshipment) using rail-mounted gantry cranes (Bartulović et al., 2023).

Kansas City can be considered the most advanced inland port initiative in North America. There are four railway lines with private capital that compete to provide better service to the intermodal system. All nations in the world are thinking about the generation of multi-member projects and foreign investments.

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In North America they take advantage of the planning and establishment of a new intermodal rail terminal carried out at the same time as a logistics zone project. Compared to Europe, North American dry ports tend to be larger and cover a much more substantial market area. Although the main disadvantage is the seasonal snowfall (Bu et. al., 2023) and (Cidell, 2024).

In Asia, indoor terminals are much more recent. Satellite facilities near port terminals accommodate activities that decongest port operations. Metropolitan inland facilities to provide better connectivity to port terminals along the coast, as well as to support the logistics of a growing domestic consumer market. Major dry port development is underway on the Yangtze River, up to the upper reaches near Chongqing, about 2,400 km upstream from Shanghai. Intermodal rail development addresses the importance of the existing rail network for passengers and dry bulk goods. Intermodal rail and barge traffic is increasing, as is the use of inland ports (Bernacki et. al., 2024).

Methodology

This research had a mixed approach, applying both quantitative and qualitative technologies, using systematic processes, as well as records and estimated data. The objective of this research was to analyze the feasibility of dry canals in the American continent as sustainable development projects for the relief of the Panama Canal. 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 modernization. The characterization of data obtained from requirements so that a dry port can act as a detonator of sustainable and sustainable development in a cutting-edge environment.

Records of results obtained by different port companies, governments of different countries and previous studies of dry ports that iterate in the global port supply chain network, were considered as the application of the qualitative method that allowed the possibility of obtaining results from 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 dry port conditions adapt depending on their geopolitics, infrastructure, quality of service in a continuous reduction of costs and delivery times, among other. Finally, using the mixed method, an analysis of the control variables that allow involvement in the evolution of maritime trade routes places all port systems that provide supply chain services in a committed competition to cover the parameters required by the port infrastructure trends of sustainable development, in an avant-garde environment, but How to achieve the success of a dry port? This depends on the preference for use as a port route over its competitors. The global port chain is migrating from a government sector to a private company sector, which makes it a transnational private capital company that is governed to a certain extent by the laws of the country of settlement and international laws, but business strategies and company laws are governed by the private company, as well as the profits among its shareholders. The feasibility of a dry port for any Latin American country must take into consideration that the top of the profit pyramid is occupied by the transnational, not the government of the country or the region of settlement.

Results

The excessive number of dry ports as transport infrastructure generates the possibility of overinvestment, duplication since many inland places would like to claim a participation in global value chains. Case in Western Europe, abundance of inland terminals, Rhine-Scheldt delta, underlines the excessively competitive environment and waste of resources. North America, different ownership and governance structure, the establishment of an inland port, the intermodal terminal component is mainly in the hands of railway operators. Furthermore, local governments can devise the development of inland ports with the expectation of dry port development an emerging functional relationship between port terminals and their hinterland. Dry ports assume various functions with collocation with logistics zones, a dominant development paradigm based on their regional configuration.

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The size of each inland port area depends on the frequency and rates of intermodal transport services by rail or barge, which acts efficiently presenting an environmental benefit with CO_2 emissions approximately 25% lower than they would normally be (Chou et al., 2021).

When using dry ports, there are some challenges is the increase in the volume of cargo transported by rail. The current railway and road infrastructure is not sufficiently developed to be able to withstand the increasing loads. Some countries have insufficient railways to quickly transport the goods that arrive at them. Localized seaports sometimes offer strong competition that undermines the ability to be the most economical option (Centurião et al., 2024 and Wu et al., 2024).

Dry canals can be sustainable, sustainable development and circular economy projects in the optimization of export and import routes. One of the largest inland ports in the world is in Duisburg, Germany. More than three million maritime containers and 130 million tons of goods arrive at this dry port every year. The location makes it one of the main crossings of the Silk Road. One of the most advanced and developed dry ports in all of Asia is in Lat Krabang, Thailand. On the outskirts of Bangkok, capacity to process half a million shipping containers, but has a record of having handled 1.7 million in 2008 (Irawan et al., 2024).

Discussion of results

A dry port in areas of extreme poverty and with a lack of infrastructure can detonate as an area of sustainable development, but to do so it will have to go through several stages of adaptation such as the creation of promising infrastructure that invites businessmen to invest in the purchase of large areas of land that have previously been changed from agricultural, mining, agricultural, tourism or settlements of demographics adhered to a culture to industrial type use with port activity. The placement of railway and port infrastructure requires large investments, which are obtained by revaluing the land that was initially dedicated to primary activities and by changing its land use to industrial, the value of the surrounding land will increase, which governments use to reinvest in technologies, port, railway and road transport infrastructure.

This predisposition of an initial infrastructure will trigger progress in the region with demographic, cultural, social displacements and the arrival of industrial and port infrastructure. However, this does not ensure the feasibility and sustainability of the industrial and port development project, since this system will become a new member of the competition in the port routes but its impact and development depend on the competition and continuous adaptation of its development plan. Business and its global competitiveness to attract port clients due to the transfer advantages it offers based on continuous reinvestment in infrastructure and technologies to be competitive in the hierarchy of dry ports (Asadi Dalivand et al., 2024 and Centurião et al., 2024).

In China's strategy to evade the Panama Canal, and to reduce customs costs for its products to be a more competitive power, there is the possibility of building a wet canal (that has similarities to the Suez Canal) by agreement with one of the countries. Latin Americans, where they can have control of passage at least for the next century. And to generate a business strategy where Latin American countries that have interoceanic crossings from the Atlantic to the Pacific Ocean generate dry channels that serve as trunks to the Panama Canal for the passage of goods (Anbleyth-Evans, 2023).

After evaluating various possibilities of dry canals in all cases and due to the existing conditions in countries with these characteristics, a project to build a wet canal breaks with the budgets of any nation, in addition to the fact that the construction of the canal would be in alliance with another nation, for this reason the construction of dry canals, although requiring less investment, represents codependency of several nations that, in the end, together with the negotiations, can represent a proximity in the long run to customs tariffs similar to those paid to the United States. And in any case, the transport of a large quantity of products must face trunk channels with the risks they represent. China proposes a new, easier, more economical, viable and less ecological impact possibility to bring its industrial products to the United States. This strategy is to build companies in the border area with Mexico and, through trains, transport products to the countries of the United States and Canada (Zhou, 2023).

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In a business strategy, China could prefer to build island-type ports in the northeastern area of the Gulf of Mexico and enable the port of Tamaulipas as an internal port to manufacture products in the border area with Mexico. In addition to having the proximity to the Ports; New York, New Jersey, Virginia, Georgia, Houston, South Carolina, Miami that communicate directly to the Atlantic Ocean. And although this does not resolve the customs taxes with the United States for the entry into its territory of products of Asian origin, it does represent an alternative in transportation time, in situations of saturation of the Panama Canal and in a balance in the lissing process of gray containers (Bu et al., 2023).

The ideology of sustainable and sustainable development of power countries such as China, fight in a commitment that goes hand in hand with green technologies in their productive development chains. For this reason, the development of dry canals in any of the Latin American countries for the passage of electric cars and other goods by port fleets seeking decarbonization is not an alternative that they can charge in exchange for exports through the passage of a canal," NO" for China its culture, ideologies and its technologies. Powerful manufacturing countries are developing technological and development strategies in conjunction with other nations and even offshore manufacturing so that these leading countries in the world can indicate that their manufacturing is green with measurable indices between powers that make the difference between these to be classified as one of the most powerful in the leadership of sustainable development technologies (Zhou, 2023).

Therefore, they could make channel development agreements through third parties, but never through governments, that is, development agreements that impact the environment are developed through private entrepreneurs of different nationalities, but not directly linked to governments or companies that seek to develop products with green chains through technologies. Environmentally responsible companies cannot be generated when in the chain of design, logistics, production, marketing, circular economy and sustainability of the technological development chain that commit in any of these processes to a direct or indirect attack on sustainable development (Asadi Dalivand et al., 2024).

Conclusions

The existence of dry channels in Europe, Asia and North America are the basis of their feasibility as part of the network structure of the global port supply chain. These have specific characteristics that support mobility, making it more efficient and reducing the pollution of polluting gases emitted into the atmosphere. Dry ports have limitations in infrastructure such as draft and loading and unloading height. However, they serve as perfect trunks for island-type ports, being able to receive the largest ships in the world today. Dry ports have their scale and competition within the port supply chain, being feasible at this level, but it is not possible that they can compete with deep-draft ports or interoceanic canals. These may be in a regionalization of internal ports to supply a nearby major port, making them compete for services, quality, price and time, which will reduce their profit margin, making some unprofitable because they are not the optimal option for the company route logistics of the shipping companies, but they balance the lack of import services with exports of agro-industrial products from the region. The dry canals in Latin America as trunk projects to the Panama Canal are feasible as development projects for what they are designed and the purposes they pursue such as buffering of loading-unloading and relocation of containers, being key in the coming years in the network of the international port supply chain. However, all will be continually re-evaluated to remain competitive in the global port supply network in an evolutionary process of continuous reinvestment. On the other hand, there are factors that can collapse any dry port project and they are insecurity, ecological impact, discontent due to social displacement when they realize that they are not at the top of the pyramid in the profits generated by the dry canal, because this This position is occupied by shipping companies and, most importantly, the limited service and lack of export products from the region makes them an easy target for crime, further losing confidence in the route.

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.

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Author contribution

Castillo-Aguirre, Alfredo Humberto: Contributed to the project idea, research method and technique, about to develop all the project.

Cruz-Gomez, Marco Antonio: Apported the studies, and bases in the área of railway systems, and also engeneering port.

Mejia-Perez, José Alfredo: Apported with traffic logistics, and ambiental engeneering.

Espinosa-Carrasco, María Del Rosario: Contributed withe the economic factor, and situation with the relation China/Latam, and economic factor in ports of Europe.

Availability of data and materials

The data obtained, it´s about the capacity of each port in America, showing that if it's factible for a dry canal, or another project:

Box 2

Table 1

Ranking 2023. Americas Top 33 ports

Núm.	Port/terminal	Country	Throughput, in millions of TEU's
1	Port of Los Angeles, California	USA	9.9
2	Port of New York and New Jersey	USA	9.4
3	Port of Long Beach, California	USA	9.1
4	Port of Savannah, Georgia	USA	5.8
5	Panama Caribbean (Colon area)	Panama	4.8
6	Santos	Brazil	4.2
7	Port of Houston, Texas	USA	3.9
8	Manzanillo	México	3.6
9	Port of Virginia	USA	3.6
10	Port of Vancouver, British Columbia	Canada	3.6
11	Port of Seattle and Tacoma, Washington	USA	3.3
12	Panama Pacific	Panama	3.3
13	Cartagena Bay	Colombia	3.2
14	Port of Charleston, South Carolina	USA	2.8
15	El Callao (all terminals)	Peru	2.7
16	Port of Oakland, California	USA	2.3
17	Guayaquil (all terminals)	Ecuador	2.2
18	Port of Halifax, Nova Scotia	Canada	2.1
19	Lázaro Cárdenas	Mexico	1.8
20	San Antonio	Chile	1.5
21	Moin/Limon complex	Costa Rica	1.3
22	Buenos Aires, Metropolitan area	Argentina	1.2
23	Itajaí-Navegantes	Brazil	1.2
24	Port of Miami, Florida	USA	1.1
25	Paranaguá	Brazil	1.1
26	Veracruz	Mexico Gulf	1.1
27	Montevideo	Uruguay	1.1
28	São Francisco do Sul, Itapoá	Brazil	1.0
29	Port of Montreal, Quebec	Canada	1.0
30	Buenaventura (all terminals)	Colombia	1.0
31	Altamira, Tampico	Mexico	0.8
32	Valparaiso	Chile	0.7
33	Puerto Cortés	Honduras	0.7

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Abbreviations

ASEAN	Association of Southeast Asian Nations
ECOWAS	Economic Community of West African States

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EU	The European Union
GVZ	Güterverkehrszentren
MERCOSUR	Mercado Común del Sur
MSC	Mediterranean Shipping Company
NAFTA	North American Free Trade Agreement
Ro-Ro	Roll on Roll Off
TEU	Twenty-foot equivalent unit
UNCTAD	United Nations Conference on Trade and Development
WTO	The World Trade Organization
ZAL	Logistics Activities Zones

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