Identification and Analysis of Barriers that Impact the Sustainable Development of Brazilian Cabotage

Aldery Silveira Júnior * , Evanilton de Almeida Vivaldo , Fabio Enzio Moura Pereira Laune , Felipe Frutuoso Pereira , Matheus de Sousa Pereira , Michelly Karen Alves da Silva

Posted Date: 6 June 2024

doi: 10.20944/preprints202406.0081.v1

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Article

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Aldery Silveira Júnior [1,*], Evanilton de Almeida Vivaldo [1], Fabio Enzio Moura Pereira Laune [1], Felipe Frutuoso Pereira [1], Matheus de Sousa Pereira [1] and Michelly Karen Alves da Silva [1]

University of Brasilia, Faculty of Economics, Administration, Accounting and Public Policy Management, Department of Business Management, 70910-900 Campus Darcy Ribeiro, Brasilia, DF, Brazil

* Correspondence: aldery@unb.br

Abstract: Brazil has ideal conditions for the large-scale use of cabotage cargo transportation: a vast coastline with almost 7,400 km, approximately 70% of the population resident in a coastal range of up to 200 km from the coast and a strong concentration of activities economic along the coast. However, there is an absolute domain of road modal for the transportation of goods, and cabotage is underused. The purpose of the study was to raise the main barriers that negatively impact the performance of Brazilian cabotage. To this end, it was used to bibliographic and documentary research, based on studies already published in journals, doctoral theses, master's dissertations, congress annals, technical reports and research on government-related government agencies sites, navigation companies and entities related to cabotage. The main barriers that contribute to the low use of cabotage in Brazil were identified and analyzed, as well as possible alternatives of solution for sustainable development of this mode of transport. Such a study will certainly serve as subsidies for the definition of public policies aimed at better use of Brazilian cabotage, as well as to encourage navigation companies to invest more in the transport of goods by cabotage, in order to contribute to the reduction of trucks on highways Brazilian and for environmental preservation.

Keywords: cabotage; cargo transportation by cabotage; barriers that impact cabotage; sustainability; sustainable development

1. Introduction

Cabotage navigation is a mode of transport that involves cargo movement and passengers between ports of the same country, along the coast and rivers that flow into the sea. In the Brazilian context, cabotage takes advantage of the extensive network of ports distributed along the coastline and some rivers in the country to serve a wide variety of industrial and commercial sectors, including manufactured products, agricultural commodities, oil and derivatives, ores, chemicals, chemicals among others, and is an efficient and sustainable alternative to road transport, especially for long-range or large volume loads.

Cabotage offers a more economical transport option not subject to road traffic jams, and is more efficient in terms of fuel consumption compared to other modes, such as bus, rail and air. According to Cadore et al. [1], multimodal transport, combining road transport with cabotage, can reach an economy of up to 38% in transportation costs.

This mode of transport is a more sustainable option in terms of carbon emissions and environmental impact, compared to road, rail and air transport, which makes it an attractive choice for companies concerned with sustainability. On the other hand, cabotage can easily be integrated with other modes of transport through intermodal terminals, thereby promoting multimodality [2].

During the colonial period, cabotage was a common activity for the transport of goods among the various ports along the Brazilian coast. With economic growth and expansion of agricultural and industrial production in Brazil in the nineteenth century, cabotage has become even more important for the transportation of products between the various states and regions of the country. Steam ships were introduced, which increased the capacity and speed of travel. In the twentieth century,

 doi:10.20944/preprints202406.0081.v1

especially in the second and third quartis, there was a significant redirection of investments for terrestrial modes, such as rail and road, driven by technological advances in the auto industry [3].

From the last quartile of the twentieth century, several policies and specific regulations were established for the cabotage sector, aiming to promote the development of domestic maritime transport and ensure the safety of operations. This included legislation on vessel registration, licensing, maritime safety, among other aspects. There were significant investments in the modernization of the fleet and port infrastructure aimed at increasing efficiency and capacity for cabotage transport, as part of a broad effort of national integration [4].

Brazilian cabotage has undergone various phases of development, from its origins as an essential means of transport during the colonial period to the challenges and opportunities faced in contemporary. Despite the obstacles, cabotage continues to play a key role for the transportation of home load in Brazil, contributing to national integration, economic development and environmental sustainability [2].

However, this mode of transport could be much more developed in the country and occupy a prominent position in Brazilian logistics. Unfortunately, several factors limit their growth and efficiency, including: inadequate port infrastructure, bureaucracy and excessive regulation, unequal competition with road transport, advanced fleet age, high fuel cost (bunker), insufficient investments in the sector and unfavorable regulation to competition. Overcoming these challenges will require a comprehensive approach involving investments in infrastructure, simplification of bureaucratic processes, legislative reforms, tax incentives and public policies that promote the competitiveness and efficiency of cabotage maritime transport in Brazil.

This paper is the result of a study conducted to raise the main barriers that negatively impact efficiency and sustainable development of cargo transportation by cabotage in Brazil. To this end, it used a bibliographic and documentary research carried out in scientific and technical work, as well as consultations with government sites and organisms linked to the waterway modal.

2. Theoretical Reference

This item is structured in five topics: Cabotage: origins, concepts and definitions; Characteristics of cargo transportation by cabotage; Characterization of the cabotage sector in Brazil; Advantages of cabotage; and perspectives for Brazilian cabotage.

2.1. Cabotage: Origins, Concepts and Definitions

Fonseca [5] points out that there are two possible origins for the term cabotage: the first comes from the coastal transportation cable-cabo; The second, due to the Italian navigator Sebastião Caboto, which exploited new territories through the banks.

In Brazil, cabotage is defined by Law No. 9,432/97, as the type of navigation made between ports or points of the Brazilian territory, using the sea or the interior navigable roads [6].

Cabotage is a modal that is characterized by the transport of products on scale, due to the increase in cargo carried resulting in lower freight costs. This is due to the fact that water transport has a high fixed cost and a low variable cost - the higher the load volume transported, the cheaper the freight price tends to stay [4]. In addition, in long distance routes, cabotage becomes economically more advantageous compared to other modes.

In the international context, the name of cabotage differs from that used in Brazil. In the US, the Department of Transport uses the term Short Sea Shipping (SSS) to designate domestic waterfall [7]. Identic denomination is used in Europe, although on the European continent it is used to interconnect not only countries of the continent itself, but also countries with neighboring continents [8].

Cabotage covers various transportation services and represents an opportunity to mitigate the obstacles existing in the movement of goods that exist in the country [11]. This modal presents itself as a sustainable and efficient transport system, being an opportunity to boost the reduction of the country's logistics costs [9].

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2.2. Characteristics of Cargo Transportation by Cabotage

Cabotage stands out from other transport modes because it has greater load capacity, greater security for transported goods, lower pollutant emission, reduced operating cost and decreased risk of damage and technical problems during transportation [3,10].

According to Teixeira [11], cabotage is an intelligent option for cargo transportation, as the advantages of cabotage go beyond the reduction of transportation costs. This modality also contributes to the reduction of the emission of pollutants, since the movement of maritime goods is more sustainable than by rail or road transport.

On a thousand kilometers trip, a cabotage vessel consumes approximately four liters of fuel to carry a ton of load. Under the same conditions, rail transport consumes almost six liters, while road transport, which is the main means of transportation in Brazil, consumes more than 15 liters, which shows that cabotage navigation is more advantageous than these modes [11]. In Table 1, it is presented a comparison between these modes of transport.

Table 1. Comparison between the modes of transport cabotage, rail and road.

Indicator	Cabotage	Railway	Road
Equivalent units	**6,000 tons vessel.**	**2.9 hopper trains, 86 70 tons wagons**	**172 trailers with 35 tons**
Average fuel consumption to carry 1 ton/1,000 km	4.1	5.7	15.4
Gas emission (gCO/TKU)	20	23.3	101.2
Average transport cost, general load for 1,000 km (R $/t)	R$ 55,64	R$ 74,02	R$ 201,99

Source: [11].

In addition to the advantages perceived in Table 1, cabotage can help reduce traffic congestion and, consequently, improve vehicle traffic in Brazilian cities and roads [12].

Fostering cabotage is not just about reducing logistics costs, it also contributes to the improvement of transportation matrix sustainability, stimulates the country's social, business and economic development, generating jobs and income, and drives the national naval industry [13].

2.3. Characterization of the Cabotage Sector in Brazil

Cabotage is a modal that is characterized by the transport of products on scale, due to the increase in cargo carried resulting in lower freight costs. This is due to the fact that water transport has a high fixed cost and a low variable cost - the higher the load volume transported, the cheaper the freight price tends to stay [4]. In addition, in long distance routes, cabotage becomes economically more advantageous compared to other modes.

Despite the beneficial potential of cabotage for the national logistics system, its use represents only about 10.43% of the total volume of cargo transported in Brazil [14]. This low adhesion is attributed to a number of problems faced by the modal, including the scarcity of regular routes, lack of adequate port infrastructure, long waiting periods for ships, tax complexities, technological lag and competition with other means of transport [11].

In addition to low use, cabotage faces a low investment in the sector, which reflects the lack of incentive to the use of the modal. According to a study by CNT [14], the Brazilian water sector received about 2% of the investment made by the Union and the state companies in 2022, totaling about R $ 197.18 million, which contrasts sharply with the R$ 6.434,71 million invested in the road modal. Despite receiving reduced investments and incentives, the rate of 10.43% of the volume of cargo transported in the country by cabotage shows a contribution of the much higher modal to the incentives it receives for cargo transportation.

The low investment received by modes waterway is one of the factors responsible for the lack of efficiency of Brazilian cabotage. A survey by Roberto et al [3] attested that compared to other

 doi:10.20944/preprints202406.0081.v1

countries of similar economic expression, Brazilian cabotage has low efficiency, although it has significant potential and may play a prominent role in cargo transportation. However, in order to become competitive compared to countries of similar economic situation, the country would need to triple the volume of cargo transported.

Despite having a significant potential, Brazilian cabotage faces a series of barriers that delay its development. It is essential to understand and overcome these obstacles to boost modal growth. This demands a focused effort on the elimination of existing barriers and a more robust investment in infrastructure, modernization and technology, with a view to making cabotage an efficient complement to other terrestrial modes [3].

On the other hand, it is noteworthy that the cargo transportation by cabotage has been growing in Brazil accelerated. According to the National Transport Confederation (CNT), Brazil moved 288.8 million tons of load in 2021, which represented an increase of 6.3% compared to 2020, and the previous year (2020 compared to 2019), the increase was 12%. [15]. The Chart 1 demonstrates the growth of load volume by cabotage from 2018 to 2021.

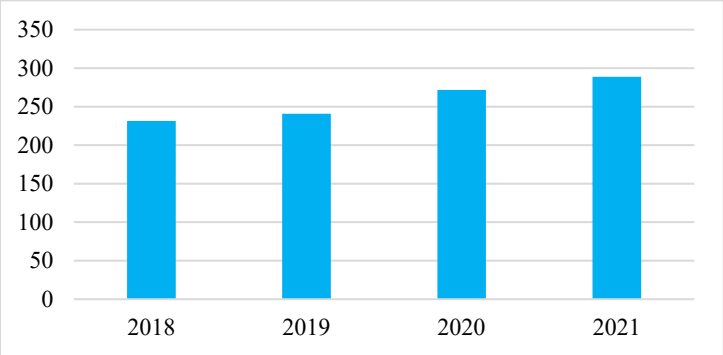

Chart 1. Load volume transported by cabotage from 2018 to 2021 (in tons). Source: [15].

Finally, it is emphasized that Brazil has intrinsic characteristics that privilege cabotage: about 7,400 km of coast and approximately 80% of the Brazilian population residing in cities up to 200 km from the coast [9].

2.4. Advantages of Cabotage

Cabotage has environmental and social advantages in relation to road transport, its main competitor. This is due to the fact that this modality pollutes considerably the environment, in relation to terrestrial motor vehicles, especially trucks, and contributes to the reduction of congestion and the number of accidents on the highways [16].

Cabotage is also competitive from an economic point of view. According to a study by Jurcovic et al. [17], this modality saves about 32,000 euros in the European industrial sector for each km traveled. In addition, the infrastructure created for cabotage support is 12,600 euros per km, which corresponds to 32,610 euros less than the structure required for road transport.

In a survey conducted by Kim and Wee [18], it was raised that intermodal transport, based on cabotage (since cabotage is a transport port - Porto, and needs auxiliary modes), can be exceptionally more economical when it comes to distances over 2,000 km of route.

In China, cabotage corresponds to 25% of its transport matrix, while another 23% are attributed to the waterway modal in lakes and rivers. On the other hand, both the European Union and Japan have an even more significant portion of cabotage -powered products in their transportation matrices, reaching 32% and 44%, respectively. These numbers indicate the considerable relevance of cabotage transport in these regions, highlighting the strategic importance of this mode of transport in their economies [19].

In addition to the perceived economic and social advantages, cabotage also stands out for the low rates of accidents in its operations and the high level of cargo safety in relation to theft, theft and damage [12].

 doi:10.20944/preprints202406.0081.v1

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2.5. Perspectives for Brazilian Cabotage

There are challenges that need to be overcome so that cabotage can achieve its full development in Brazil. Among these challenges are the lack of investments in port infrastructure and intermodality, as well as the need for regulatory and tax improvements to promote an environment favorable to the sector [5].

In the early 21st century, Brazil underwent significant changes in its governmental and macroeconomic scenario, and benefits from a favorable international context. These factors contributed to the country to gain greater political and economic relevance in the global scenario. Given this context, promising perspectives arise for the development of Brazilian cabotage, using opportunities and boosting the growth of this specific sector [5].

Investing in the expansion of cabotage and national infrastructure can be a significant momentum for Brazilian production and the economic development of the country. In the Brazilian context, cabotage has significant expansion potential, as the country has an extensive coastal coast and a high population concentration near the coast [20].

It is important to note that cabotage in Brazil is still in a relatively underdeveloped stage compared to road transport, even in the face of the extensive Brazilian coast and the potential that cabotage presents. In this sense, it is necessary to strengthen the sector and overcome existing challenges, such as the lack of investments and the improvement of regulations, in order to fully take advantage of the benefits of this modal transport and boost the national economy [21].

An promising perspective for cabotage is the BR do Mar program, launched by the Brazilian government in 2022, which aims to expand the availability of cabotage in Brazil, promoting a balance in the transport matrix by increasing the use of outcrops. It also aims to reduce costs and bureaucracy, while seeking to expand the supply of ships and foster competition in the sector [22].

Finally, it is noteworthy that the country's extensive sea coast and population distribution with high concentration on the sea coast configures a conducive scenario for the use of this modal. However, it is essential to improve infrastructure, invest in technology and promote policies that encourage and facilitate the use of cabotage, aiming to take advantage of the potential of this mode of transport for the cheap freight and reduction of the country's logistics costs.

3. Materials and Methods

The research carried out can be considered applied, with a qualitative approach of the descriptive type, carried out through bibliographic and documentary research, with transverse temporality. It is subsequently presented the classification of the research on the following aspects: source, nature, approaches, objectives technical procedures and temporality, and will be discussed about the method used.

3.1. Research Classification

The study was based exclusively on secondary sources, compiling previous research information about Brazilian cabotage, addressing its use, history and position in relation to other modes, without the need for new data, which characterizes it, according to Gil [23], as to the source, as secondary. The main sources used included government websites, official government portals, scientific articles published in congress journals, books, dissertations and theses of *stricto sensu* programs, governmental laws and databases.

As for nature, according to Gil [23], the research was applied, as it aimed to contribute to the theoretical understanding of the barriers incident about the cargo transportation by cabotage in Brazil. Its purpose was to understand and describe these barriers and discuss possible solutions to overcome the obstacles that negatively impact the sustainable development of Brazilian cabotage.

The approach adopted to achieve this objective was qualitative, since no statistical instruments were used [24], the central focus of the study being the survey and interpretation of available data.

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Regarding the objective, according to Gil [23], it was descriptive, as it was intended to describe the main barriers related to cargo transportation by cabotage in Brazil, describe its characteristics and establish relationships between the findings.

Regarding the technical procedures, according to Souza et al. [25], the research can be classified as bibliographic and documentary research, as it consisted of the investigation and improvement of knowledge through works already published. The research was conducted through the search, analysis and investigation of the problem, using common resources in bibliographic and documentary research.

The research, regarding temporality, was transverse, given that it was conducted in a period of time, March to June 2023, and the evaluations refer to the period in which it was held [26].

Following, the research methods will be discussed.

3.2. Research Methodology

To conduct the bibliographic research, the research argument with keywords related to the theme was initially defined: Cabotage, Brazilian Cabotage, Barriers, Cabotage Barriers, Sea Routes, Sea Roads, Cabotage, Brazilian Cabotage, Short-Sea Shipping, and Marine Highway Rounte.

Following, searches were performed on the following articles repositories: Web of Science, Scielo, Scopus, Spell and Google Academic. The selection of articles was guided by the prioritization of the journal's classification at Qualis Capes, in extract A1 to A4, followed by the date of publication, with emphasis on the latest years.

About 1,000 articles dealt with the research argument were found. From the realization of a textual and thematic analysis, with the objective of understanding the objectives of the authors and uniting their ideas through an interpretative analysis, fifty articles were selected.

In addition to the selected articles, searches were performed on government portals, in their official bodies, such as the National Waterway Transportation Agency (ANTAQ), which regulates the cabotage transport in Brazil, and the Brazilian Institute of Geography and Statistics, the main data provider from the country, in addition to union associations of the sector, such as the National Transport Confederation (CNT) and Brazilian Association of Cabotage Shipowners (ABAC).

Research in government portals of the Government was intended to select documents and data related to the barriers subject to the research, and dozens of document publications and official reports were identified, as well as a considerable volume of statistical data.

Following, textual and thematic analyzes were performed within the achievement of the objective of the work, from the understanding of the objectives of the findings and the union of their purposes through an interpretative analysis.

After reading, reviewing and analyzing the selected texts and documents, it went to the problematization, raising questions for discussion and reflection, in order to identify the main barriers that negatively impact the performance of Brazilian cabotage.

3. Results and Discussion

Bibliographic and documentary research resulted in the identification of several barriers that were synthesized in five groups:

- Barriers related to port infrastructure;
- Barriers related to bureaucracy;
- Barriers related to legislation;
- Cost-related barriers; and
- Barriers related to the low offering of ships.

The following will be presented the identified barriers and their dismemberments, followed by analyzes.

4.1. Port Infrastructure Related Barriers

Related to port infrastructure, the following barriers were identified:

- Inefficiency of highways and railways that connect ports to cities;

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- Obsolescence of port equipment;
- Dredging deficiency of port access channels; It is
- High costs of practice services.

The order schematized above represents the degree of importance of each barrier for the development of Brazilian cabotage. This categorization was through analysis of the researched material, identifying not only frequency of appearance of each barrier, but also the degree of sensitivity of each, measured by the qualitative impact of these barriers on the cargo transportation by cabotage.

Each of the raised barriers has distinct characteristics and peculiarities, as shown below.

4.1.1. Inefficiency of Highways and Railways that Connect Ports to Cities

The ports are points of entry and exit of goods, and rail and road connections allow efficient cargo transport between ports and production, distribution and consumption centers. This is essential for international trade and for the supply of local and regional markets.

The conditions of the railways that connect ports to shopping or production centers are not meeting the needs of cargo carriers by cabotage. For Fernandes [27], among the main barriers for cabotage growth is the ineffectiveness of rail connections (few train lines leading to ports) and lack of technological modernization and maintenance of the lines that exist. Already the highways that connect the ports to producing centers are mostly in deteriorated conditions, generating damage to vehicles, which increases the cost of transportation and makes the final value of goods carried by cabotage.

Although there are investments in the implementation of railroads and improvement of highways by the state, they are still in barriers that hinders the growth of cargo transportation by cabotage in Brazil.

4.1.2. Obsolescence of Port Equipment

Port equipment is directly related to port infrastructure and play a key role in the efficient functioning of the ports, ensuring agility and only the time required of the ship's permanence in the port, for loading and unloading.

Obsolete port equipment, such as cranes, forklifts and carriers, have low productivity and efficiency. This has been leading to longer waiting times for ship load and unloading, increasing operating costs and making cabotage less attractive compared to other transportation options.

Obsolete port equipment usually requires frequent and costly maintenance. This can increase operating costs for cabotage companies, making it less competitive than road or rail transportation.

The ship's permanence period in Porto, according to Müller [28], is configured as a limiting factor in the development of cabotage. For this author, the permanence for a long period of the ship in Porto compromises the port efficiency and, consequently, the entire logistics chain and, therefore, the Brazilian economy as a whole.

4.1.3. Dredging Deficiency of Port Access Channels

Dredging is an essential process in managing and maintaining ports and navigable pathways. It involves the removal of sediments, debris, sand, sludge and other water body life materials (such as rivers, canals, bays, ports and coastal areas) in order to maintain proper depth and ensure safe navigability for boats [29].

The dredging of port access channels is paramount to ensure the modernization of transportation, as it ensures the traffic of large vessels on the waterway [30]. Many ports in Brazil require regular dredging to maintain adequate depths to accommodate the silences of ships. Lack of investment in dredging and maintenance of access channels can limit the operational capacity of ports.

Some Brazilian ports do not have insufficient depths to accommodate large vessels, which limits the load capacity and size of ships that can operate in the cabotage. Dredging is required to increase the draft (submerged region of the ship) and allow larger ships to transport more goods.

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The dredging sector in Brazil is highly regulated, and there are a number of government agencies involved in the approval and regulation of dredging projects, including ANTAQ, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) and National Council Environment. This bureaucracy makes the process of licensing and execution of dredging more complex.

Dredging projects may involve investments in infrastructure such as dredgers, transportation equipment and port facilities, which increases port costs. Dredging is a time-consuming process that delays port activities. The costs associated with dredging are often passed on to coastal shipping operators, making coastal shipping more expensive and less competitive compared to road transport.

4.1.4. High Costs of Piloting Services

The piloting service consists of a set of activities aimed at advising the commander of a ship in port zones, with the objective of protecting the vessel from possible accidents [31]. The practical (the one who performs the piloting activities) has legal regulation and even if not part of the port infrastructure, this activity has a direct connection with the activities of the port and, consequently, influences its performance.

Hiring the practical is mandatory for most vessels that enter or leave Brazilian ports. The costs associated with these piloting services are passed on to the shipowners and, ultimately, to the prices of the transported goods. This makes cabotage less competitive than other forms of transport.

The practical hiring process in Brazil is complex and bureaucratic, which further increases the costs and time involved in the cabotage operation. This discourages potential operators to opt for cabotage. The cost of piloting service in Brazilian ports is extremely expensive, in addition to the deficiency of qualified labor, which makes it difficult to develop cabotage in the country.

The first three identified barriers have a common factor: they need, for improvement or solution, investment. Given that they are part of the structure of an organized port, these problems fall on government agencies or, depending on the contractual situation, about the private company that manages the port.

As for the piloting service, it is understood that there is room for the redefinition of your modus operandi in order to reduce the costs inherent in this service.

4.2. Bureaucracy-Related Barriers

The bureaucratic obstacles inherent to the Brazilian cabotage system were divided into three types:

- Excessive number of documents for transport operation;
- Low offer of qualified labor to operate ships; and
- Poor integration of road transport with cabotage.

3.2.1. Excessive Number of Documents for Transportation Operation

Cabotage transport in Brazil has been facing several adversities regarding its efficiency in general. One such deficiencies is the bureaucratic system, especially with regard to issuance of documentation. This deficiency directly impacts the punctuality and efficiency of transport, reducing the interest and proximity of the logistics market with cabotage.

In analyzing the tax and administrative requirements in the ports, it is clear that long-course cabotage and navigation are treated equivalently, which represents an obstacle to making cabotage attractive to the market. Compared to road transport, which deals with few bureaucratic barriers, watercraft transport loses in competitiveness and efficiency [32].

In addition, it is important to highlight that all ports operating in Brazil are customs places, which makes it even more difficult to release cargo release. Both the cabotage load and long-haul load are subject to the same customs procedures when they arrive in the port, depending on the type of load, the required documents can reach 44, whether tax or administrative [32]. All this regulation aims to ensure that companies that carry out load transport operations through the waterway modal comply with the current legal rules, as well as to facilitate customs control of cargo transported.

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As evidenced by [33], bureaucratic processes involving multimodality (cargo transport using more than one modal) are more costly when it involves cabotage. These processes cover from the issuance of the invoice (NF) to the reimbursement of the additional to shipping to renewal of the Merchant Navy (AFRMM), being filled by the issuance of a series of documents, such as: electronic knowledge of transport (CT-e), knowledge of multimodal cargo transportation (CTMC), multimodal linked service (SVM), among many others, which vary according to the type of cargo transported.

It is noteworthy, as appropriate, that the federal government, through Law No. 14.206/2021, implemented a new documentary modality, the electronic transport document (DT-e), which aims to mitigate some obstacles to the integration of road transportation with water transport [34].

4.2.2. The Low Offer of Qualified Labor for the Operation of Ships

In addition to the bureaucratic obstacles related to the use of ships, there are also significant challenges with regard to labor. The standard of the Maritime Authority for Waterway (NORMAM 13/DPC) establishes rigorous regulations regarding labor inspection, risk and safety inspection issues, imposing the need to take specific preparatory courses and practical internships [35]. In addition, it requires the request for registration and issuance of the registration and registration book.

There are challenges related to the courses that prepare operators. As reported by the Special Secretariat of Ports of the Presidency of the Republic (SEP), there is a considerable scarcity of vacancies for the formation of this workforce, especially in the scope of the Internship Program [32]. This scarcity is due to the excess and informational complexity that the Brazilian Navy (DPC) ports and back board demands for the release of labor, making room for a bureaucratic excess to work on navigations and the removal of companies they offer the course by his cost.

4.2.3. Poor Integration of Road Transport with Cabotage

The audit carried out by the Federal Court of Audit, in 2020, highlights how the excess of bureaucracy discourages the integration of modes of transport in Brazil. This problem is evidenced by the need to fill information on various systems, print supervisory documents and carry it with goods, in addition to the obligation to store all this documentation later [33].

Despite the advances regarding the bureaucracy of transport, especially the implementation of electronic documents, Brazil still faces challenges for creating a unique transport platform or document. This is more complex when it comes to watercraft transportation, as this modal has its own systems, such as the merchant and port system without paper, and specific tax issues such as AFRMM [33].

The advance resulting from the implementation of electronic documents brought another bureaucratic complication: the lack of communication between government inspection systems, which results in the duplication of the same information in several different systems. This inefficiency and redundancy generate additional costs, making logistics operations more expensive, which negatively impacts multimodal transport, discouraging cabotage transport [33].

The federal government has been developing efforts to unify tax and administrative documents, such as the implementation of the Electronic Tax Document Manifesto (MDF-e) and the Electronic Transport Document (DT-e). These aim to centralize the registration of tax and administrative documents, and consolidate various information in one place [33]. Adoption of DT-e as an integrated and unique document offers the opportunity to eliminate duplications and give greater flexibility to multimodal transport operators.

Despite such advances, there are still obstacles and significant bureaucratic procedures that affect the companies that operate in cabotage, imposing them agility to synchronize the issuance deadlines of various documents, resulting in costly tasks and incorrect penalties.

The challenges faced by carrying cargo transportation, because of excess bureaucratic processes, compromise the efficiency of the modal and constitute obstacles to the conquest of space in the cabotage market, impacting not only the financial and economic perspective, but also generating obstacles logistics along the transport chain.

 doi:10.20944/preprints202406.0081.v1

4.3. Barriers Related to Legislation

The following barriers related to legislation that negatively impact the performance of Brazilian cabotage:

- Legislation that disciplines access to ports and terminals;
- Legislation that disciplines the entry of foreign companies in the Brazilian cabotage sector; It is
- Legislation affects the Brazilian port infrastructure.

Following, each of these barriers will be analyzed.

4.3.1. Legislation that Disciplines Access to Ports

The main law that addresses the limitations of access to ports and terminals in the context of cabotage in Brazil is Law No. 8.630/1993, known as the Port Modernization Law, establishes the general basis for the organization and exploitation of Brazilian ports [36]. Port legislation faces problems that impact cabotage in the country

In the 1990s, the Port Modernization Law brought structural and organizational changes to Brazilian ports, such as the creation of the Port Authority Councils, the extinction of the monopoly of port administrations and the establishment of the labor managing organ. These changes aimed to modernize port management, promote operational efficiency, increase competitiveness and facilitate integration into the global economy [37]. Still, the use of cabotage in Brazil remains relatively low. This suggests that port legislation did not effectively promote the expansion of cabotage in Brazil, even after changes in the 1990s.

Disorganization, excessive bureaucracy and lack of integration between port entities result in delays and inefficiencies in ports. In addition, the state-owned administrative structure negatively impacts the operation of ports due to labor and strike issues, affecting the regularity of port operations [37].

Legislation does not adequately address infrastructure deficiency for storage of agricultural products during crop periods that causes traffic jams, poor road conditions and the lack of port infrastructure that hinder product flow, especially from the Midwest. Continuous investments in infrastructure, modernization of bureaucratic processes and expansion of transportation capacity are fundamental to dealing with export growth and ensure an efficient and integrated logistics chain [37].

Lack of clarity or conflicts in the interpretation of laws, norms and regulations can lead to uncertainties and difficulties for economic agents, impairing the development and efficiency of the water and port transportation sector. Legal insecurity affects both those involved in the relationship between ship and port, and those subject to customs control performed by the IRS. This issue highlights the continuous need for regulatory framework and the search for solutions that promote greater security and predictability for those involved in the sector, thus encouraging investment, competitiveness and growth in water and ports in Brazil [38].

Investments in port modernization and dredging are necessary to improve infrastructure and reduce operating costs, as well as to promote port efficiency and cabotage cargo transportation, which could become more attractive and competitive.

4.3.2. Legislation that Disciplines the Entry of Foreign Companies in the Brazilian Cabotage Sector

The legislation requires that the cabotage be carried out only by Brazilian companies. This limitation creates a barrier to direct access of foreign companies to the market, limits foreign participation and prevents direct competition in the cabotage sector, negatively impacting the efficiency and development of this modal.

Such a legal restriction affects cabotage operations and inhibits competition, with possible negative effects on the sector's operational efficiency. In addition, the bureaucracy associated with the forecasting of foreign vessels by Brazilian companies may increase the operating and administrative costs of the cabotage sector.

The entry of foreign companies in the national cabotage sector is regulated by the Cabotage Law, in conjunction with other regulations related to foreign trade and maritime transport [6]. This law

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establishes that cabotage navigation in Brazil must be carried out by Brazilian companies, that is, by companies with headquarters and administration in the country. On the other hand, the Cabotage Law brought flexibility to the chain of foreign vessels in the cabotage navigation, allowing their use in cases of absence or unavailability of Brazilian flag ships.

One of the reasons for the low use of cabotage in Brazilian logistics is the presence of obstacles imposed by the country's legislation, which prioritize Brazilian flag ships. These restrictions are barriers that make it difficult to develop cabotage as a means of cargo transportation in the country, resulting in the scarcity of available vessels and low levels of services in general [4].

Thus, Law No. 9,432/1997 is one of the main statutes that regulate water transport in Brazil, and allows the opening of the national market for foreign vessels in cabotage activities only by facing a Brazilian navigation company authorized by ANTAQ to operate in the navigation sector. This guarantees the participation of foreign companies in the Brazilian market, while established requirements to protect national interests [39].

4.3.3. Legislation Affects the Brazilian Port Infrastructure

The port infrastructure refers to facilities, equipment and services that enable port operations, such as areas of attraction, storage and load systems. And it can be considered a barrier due to inadequate capacity, limitations on cargo handling, obsolete equipment and accessibility problems, affecting the efficiency of port operations.

The main law that addresses issues related to port infrastructure in Brazil is Law No. 12.815/2013, known as the Port of Ports [40], which established the new regulatory framework of the port sector. Such law allowed the increase in investments in private terminals and established guidelines to modernize and increase the capacity of port terminals, and imbued to ANTAQ the responsibility for the regulation and control of the port sector, encouraging competitiveness and controlling tariffs and freight [13].

Despite the importance of cabotage, the evolution of sector regulation from the issuance of the Cabotage Law in 1993, to the recent changes promoted by the ports, in 2013, this modal still faces challenges related to the port infrastructure, which remains inadequate [5], such as the absence of pier dedicated to cabotage.

4.4. Cost - Related Barriers

Four cost -related barriers that directly affect the performance and efficiency of Brazilian cabotage were identified:

- Barriers related to the costs of depreciation and fleet renewal;
- Barriers related to operating costs;
- Barriers related to the costs associated with the load capacity of the vessels and the initial kilometer; and
- Barriers related to intermodality costs.

Such costs will be analyzed below.

4.4.1. Barriers Related to the Costs of Depreciation and Fleet Renewal

The periodic need to replace ships to maintain operation underway, especially in the face of market growth, represents a significant challenge for cabotage, due to the high costs associated with the acquisition of new vessels.

There is a cyclic need to reserve a significant volume of capital for fleet renewal. According to the Planning and Logistics Company (EPL), the average age of the boat fleet by granting Brazilian Navigation Company (BNC) was 15.4 years in 2020 [41].

If the demand for vessels is supplied, the operating costs will grow so that “the modal may decline against competition with the terrestrial modalities” [5, p. 32]. Thus, the sustainability of the modal depends on timely replacement and investment in ships to improve efficiency and meet demand.

 doi:10.20944/preprints202406.0081.v1

Ship depreciation is an important factor to be calculated and monitored, in order to ensure the sustainability of operations of corporate companies. In addition, “the main vessels used in cabotage navigation are large and their construction cost is high” [42, p. 431].

To Cruz et al. [44], fleet renewal is a relevant factor for calculating cabotage freight costs, so that added to other costs, may reflect strongly on the decision to choose the modal of transport. Given this, it is evident that the cost of fleet renewal represents an important barrier for the development of cabotage in the country. Fleet renewal needs substantial investment capacity, restricting the market to few players that have sufficient management and investment capacity to support periodic ships.

The continuity of the cabotage operation is affected by the evaluation of the cost of depreciation and renewal of the fleet. These aspects require detailed analysis, especially considering the nature of the company's main activity. In scenarios where transport is restricted to short distances, analysis needs to be deepened. There is a high probability of financial unfeasibility, where costs can overcome the benefits of cabotage, resulting in excessively narrow margin operations.

On the other hand, despite the expressiveness of these costs, they are not recurring. This means that in high demand logistics operations with maximum capacity of ships and, especially, in long distance displacements, the use of cabotage modal becomes an attractive alternative.

In this context, it is clear that the choice of cabotage modal transcends a simple logistical decision, must consider the entire conjuncture of the market. To make an effective logistics decision, it is essential to understand the operation as a whole. This involves from financial demands, investment availability and cash flow to analyzing the logistics needs of the business in relation to the market in which it operates.

A recommended strategy for companies that opt for cabotage is to calculate the depreciation of their assets and plan the fleet renewal based on the estimation of ships life, together with the study and analysis of demand through supplier data means. This process allows the creation of a long-term financial and budgetary plan, integrated into the company's accounts plan, which periodically reserves a percentage of revenue for planned investments over time, aiming at the renewal of the fleet.

Considering the average for the renewal of vessel fleets, planning is suggested for a period of 15 years. This allows the full fleet to renew in a planned way, preventing it from becoming an insurmountable obstacle to the operator.

4.4.2. Barriers Related to Operating Costs

The investments required to establish and operate with cabotage is not limited to the high cost of vessel acquisition, they also include a “high operating cost with crew, licensing, maintenance and repairs and administration, among others” [42], [p. 425]. These costs, added to the know-how needed to operate in the sector, are a significant barrier to the development of cabotage in the country.

The costs associated with the transhipment process are closely linked to the cargo movement in the ports of origin and destination of vessels [44]. They involve expenses with labor, loading and unloading equipment, as well as product storage costs at the ports. In addition, modernization of transhipment operations requires increasingly sophisticated facilities, which involves an increase in costs related to cargo movement at ports and terminals [45].

The hiring of professionals specialized in naval and overflow operations highlights the need for an organizational and procedural structure appropriate to the sector's operational model. This requires investment in professionals trained to deal with heavy and high -added equipment, requiring training and hiring qualified individuals to perform these functions.

The cost of labor in companies that operate with cabotage is considered the second most significant, immediately after fuel cost [46]. This is justified by the importance of qualifying the professionals involved in operations. In this way, investing in personnel hiring and training strategies becomes essential for business viability and sustainability.

In this sense, it is essential that cabotage companies include in their strategic planning not only the costs of equipment, depreciation, storage and overflow, but also the payroll, hiring and maintenance costs of a team capable of meeting the company's needs.

 doi:10.20944/preprints202406.0081.v1

4.4.3. Barriers Related to the Charge Capacity Costs of the Vessels and the Cost of the Initial Kilometer

The restrictions of cargo capacity imposed by the characteristics of the route show as a significant barrier on cabotage transport. This is because the costs associated with types of vessels tend to increase as operation expands on scale. Waterway particularities may require appropriate vessels for the route, which can determine the load capacity and make transportation cost.

According to Bender and Fernando [44], these limitations have a direct impact on the costs of the operation and should be taken into account in an economic analysis of water transport, especially in choosing the most appropriate vessel for the route.

The cost of waterway transport varies not only due to the volume transported, but is also influenced by the distance traveled. Compared to other modes, the cost of the initial kilometer in waterway transportation tends to be higher [47], making cargo transportation more costly for short distances.

In view of the amount of load supported by each modal, waterway transport is the lowest cost-kilometer cost. However, to achieve this benefit requires sufficient capacity volume due to the high fixed navigation costs (infrastructure and vessel), which makes the operation of low load amount unfeasible [47].

Logistic operators who are dedicated to cabotage need to perform route planning and seek, with regulatory agencies, the establishment of profitable and effective maritime routes. In doing so, they can ensure predictability in the routes, making them accessible to those seeking reduction in freight costs.

4.4.4. Barriers Related to Intermodality Costs

Competition with terrestrial modes, especially road transport, emerges as one of the main challenges for cabotage. This limitation is due to the inability of maritime transportation to carry out door to door, unlike road modal, which allows you to collect products at the point of origin and deliver them directly to the final destination [21]. However, cabotage can be used jointly with road transport, seeking cost reduction. In this context, cargo departs from regions near the trucks, heading to the vessel ports and are sent to the final destinations by trucks.

By choosing the combination of terrestrial and cabotage modes, aiming to use them as complementary modes, Brazil can reduce the costs of cargo transportation. However, this alternative faces challenges related to transhipment costs, coupled with transfer costs between different modes. These costs stand out as a significant factor in the decision to adopt intermodality, representing a barrier to cabotage.

Considering that Brazil has a continental territorial extension, in certain regions, the use of cabotage can only be accessory through intermodality. However, if the cost of cabotage freight is considerably high, so that complementarity generates a higher value than ground-to-door transport, the operation becomes unfeasible, reducing the need for cabotage transport.

Ultimately, it is noteworthy that the impossibility of delivering point-to-point products proves to be an important weakness for cabotage, which reinforces the need to plan the costs related to the transhipment of product handling and storage during the exchange between exchanges Modal. This fragility, added to other barriers, negatively impacts the choice of cabotage as a transport modal.

4.5. Barriers Related to the Low Offering of Ships for the Cabotage

The low offer of ships for cabotage is directly impacted by much of the barriers already analyzed and were grouped into three topics:

- Barriers related to operating costs;
- Barriers related to legal or regulatory aspects; and
- Barriers related to shipbuilding.

 doi:10.20944/preprints202406.0081.v1

This classification allows a deeper understanding of the obstacles faced by the offering of ships for cabotage, providing insights for future discussions and strategies. Next, an analysis of each group of barriers identified.

4.5.1. Operating Cost Barriers

Cabotage operating costs include: taxes, fuel, crew, maintenance, administrative, safe and others, which weigh greatly in the calculation of freight of cargo transported by cabotage.

Brazil's high tax burdens emerge as one of the main obstacles to the scarcity of ships in cabotage, contributing significantly to the reduction of the participation of this modal in the transport matrix. Cabotage, in turn, is under a substantial tax burden, covering taxes on services, goods, fuels and freight, making it difficult to operate this modal.

A detailed analysis of cabotage operating costs points out that the price of bunker is one of the most costly components, representing more than 30% of the operating costs of a ship [48]. Cabotage bunker has a cost of approximately 30% higher than the fuel used in road transport and 37% higher compared to long -haul navigation. If the amounts charged were the same, it is estimated a 6% reduction in relation to the current cabotage costs [41,49]. This cost is considerably aggravated by tax incidence, notably ICMS, with an increase of 12% to 17% in fuel costs, depending on the state of the federation [50]. ICMS taxes do not focus on the bunker used by long -haul navigation.

A study by EPL [41] showed that the operating costs of the cabotage covers several categories, the fuel being the most significant, followed by the taxes, as shown below:

- Fuel - 44%
- Taxes - 20%
- Maintenance - 8%
- Administrative - 7%
- Crew - 5%
- Insurance - 3%
- Other - 13%

In Brazil, the high cost of freight represents one of the barriers that inhibit the use of cabotage. This cost is expanded by the high costs involved with the operation of the modal, indicated above.

Silveira Jr. [4] highlights other taxes and fees that affect cabotage, such as the additional to freight for merchant navy (AFRMM), which corresponds to 10% of the freight value; The Merchant Use Fee (MUF), charged for every knowledge that is launched in the merchant system; and taxation on the acquisition of foreign vessels, which is around 40% of the value of the vessel.

4.5.2. Barriers Related to Legal and Regulatory Aspects

The low use of cabotage in Brazil is widely attributed to issues of legislation and politics, adding to the lack of tax incentives for cabotage. The customs system that does not differentiate between cabotage and long -haul transportation, the high import taxes for new vessels, the obstacles to the multimodality that affect the cabotage, and the lack of updated or specific public policies for this sector, are additional factors that contribute for this scenario [51].

Cabotage regulation imposes several taxes on the sector, such as the addition of PIS, COFINS and ICMS on the value of freight, ranging from 14.5% to 19.8% according to the region, in return, sectors such as road transport and Long -course navigation enjoy tax incentives, such as tax exemptions, making cabotage transport less attractive to cargo carriers [52].

In addition, the collection of AFRMM, which is applied to companies operating in Brazil, with 25% rates for long-course navigation, 10% for cabotage and 40% in river and lake navigation. Taxation also reaches imports, with the Industrialized Products Tax (IPI) for ships and components, adding to indirect taxes on national inputs in shipbuilding [48].

Brazilian law also imposes several restrictions on national flag ships, limiting the availability of vessels. Law No. 9,432/97 also establishes limitations to BNC for the forecasting of foreign vessels for cabotage, creating a market reserve that can discourage the modal [53].

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The regulation of cabotage navigation is intrinsically linked to the policy of promoting the national naval industry. The absence of this policy results in costs and restrictions on the availability of transport for cabotage [53]. Despite the subsidies granted by BNDES and the adoption of AFRMM, its effectiveness is questionable, given the lack of economic and technological competitiveness of the Brazilian naval industry [54].

In assessing the amount of projects completed with financial support AFRMM, in the last 14 years, the Brazilian naval industry has delivered only 30 ships for cabotage. Representing only 3.3% of the total projects delivered [53].

To face these legislative challenges, Bill No. 4199/2020, popularly known as BR do Mar, was presented. In order to encourage cabotage in Brazil, foster the naval industry, increase competition, reduce logistics costs, expand navigable routes, Balance the transportation matrix, reduce shipping costs, increase the supply of cabotage ships and improve port infrastructure [52].

However, the implementation of the *BR do Mar* faces challenges, such as the high operating cost of Brazilian flag ships, the need for infrastructure investments, difficulties in renewing and expanding the fleet due to the high costs of financing and the delay for approval of the approval contracts by BNDES. Such aspects, combined with the low offer of Brazilian crew and the need for training by the Navy, high operating costs, the lack of regulatory frameworks and the long or incomplete regulations contribute to the low offering of ships for cabotage [41].

Finally, it is noteworthy that according to a study by EPL [41], the expansion of the fleet for cabotage through the BR Program of the sea has the potential to reduce costs and simplify procedures, thus boosting the cabotage and the naval industry in Brazil. It is estimated that the implementation of the BR Bill of the Sea will result in a reduction of more than 15% in cabotage operating costs. It is important to highlight that cabotage transport does not occur in isolation, it is complemented by road transport, which will continue to meet the demand, conducting goods from origin to port and later from Porto to the end consumer.

4.5.3. Naval Construction Barriers

Naval construction in Brazil faces significant legislative barriers, which include restrictions on vessel financing due to strict BNDES requirements. For financing, the navigation company needs to submit a net equity equivalent to 130% of the requested loan amount, and there is a 30% charge as a guarantee of production, acting as a warranty insurance.

Given this scenario, many shipowners choose to import vessels, although this choice is sometimes unfeasible, due to the high fiscal charges applied to imported ships, exceeding 51% of the value of the vessel, reaching the following percentages [48]:

- ICMS - 18%
- TEC - 14%
- PIS/COFINS - 9.25%
- IPI - 10%
- Total - 51.25%

As a way of circumventing the high price of the acquisition of a vessel, the chartering of vessels, in some cases, can be a compensating alternative, because it offers lower and more attractive costs to users of this modality. Brazilian law allows for the forecasting of vessels by BNC [53].

To face the need for specific and in large volume products for shipbuilding, Brazilian industry faces an urgent demand for modernization of its steelmakers to meet market demands and monitor the constant increase in sector demand. Approximately 30% of the total vessel building costs are directly linked to the cost of steel, while equipment represents 38.6% of total ships. In Brazil, about 44% of the equipment used in shipbuilding is imported, resulting in additional costs due to lack of investment [54].

High tax cargo also represent barriers to the competitive development of the shipbuilding industry. The cost of labor in Brazil is eleven times higher than that practiced in China and five times higher than in South Korea. This cost of labor can reach 40% of the total cost of building a ship,

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discouraging National competitiveness and resulting in a significant reduction in the acquisition of national flag vessels [55].

The regulation of cabotage navigation is intrinsically linked to the industrial policy of promoting the national naval industry and supporting the construction of ships by Brazilian shipyards. The absence of this policy creates restrictions on cabotage [54].

The low use of cabotage in Brazil is widely attributed to issues of legislation and politics. The lack of regulation for the promotion of the national naval industry, along with the absence of public policies that favor the growth of both parties, imposes restrictions on the development of cabotage [53], which directly impacts the low offering of ships for this mode of transport.

Finally, it is noteworthy that the Brazilian naval industry faces significant challenges related to resources for the acquisition or chartering of vessels, factors that contribute significantly to the low supply of ships for Brazilian cabotage.

5. Conclusions

The study approached the main barriers that negatively impact the cargo transportation sector by cabotage in Brazil, more specifically those related to port infrastructure, the bureaucracy that reigns in the sector, the operating costs, the low supply of ships to the modal, The legislation to unfavorable legislation and the deficiency of investments in the sector. Such barriers, among others, if treated with the seriousness that the cabotage sector complains, will certainly contribute to the efficiency of Brazilian logistics and the reduction of Brazil cost.

Some Brazilian ports do not have sufficient capacity to deal with the growing volume of load and the demand for cabotage services. Some ports have obsolete load handling equipment, such as cranes and forklifts, which compromise the efficiency of port operations; They face siltation problems and lack of depth in navigation channels, which restricts access to larger and more loaded ships and limits the ability of ports to receive larger ships; They do not perform adequate maintenance of port infrastructure can lead to problems such as quay wear, deterioration of attraction systems and lack of conservation in general; Inadequate logistical installations such as warehouses and container terminals, which storage and efficient load transfer; and low multimodal connectivity, which is essential for the efficiency of the transport system as a whole.

Bureaucracy and excessive regulation are responsible for a series of complex administrative procedures, from obtaining licenses and authorizations to compliance with environmental, labor and security regulations; Navigation companies need to obtain a variety of licenses and authorizations to operate in cabotage, including environmental licenses, cargo transportation authorizations, mooring permits and customs authorizations, whose respective obtaining processes are time consuming and complicated; Such companies are subject to a series of labor and environmental regulations that increase operating and administrative costs; The lack of standardization and automation of process - related processes increase the likelihood of errors and delays, as well as hindering the integration of systems between different government agencies; And the time and resources needed to deal with bureaucracy and excessive regulation can represent a significant burden on navigation companies, especially for small and medium, which impairs the competitiveness of the cabotage sector, discouraging investments and innovation, and limit market growth.

The competition with road cargo transport becomes uneven due to a number of aspects: trucks can reach remote locations and provide door-to-door services, while cabotage often requires additional transhipment operations and depends on port availability ; On some routes, road transport can offer shorter traffic times than cabotage, especially for short-range loads or for poor ports; Shipping costs in road transport may be competitive compared to cabotage, especially in short-range routes or when considering total transportation costs, including port rates, storage costs and other costs associated with cabotage; The existence of an extensive network of highways, while the port and maritime transport infrastructure is not always so well developed; And the regulation and taxes on road transport are more attractive, since policies of subsidies or tax incentives are usually more directed to road transport.

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The average age of ships that operate Brazilian cabotage is relatively high, which compromises operational efficiency, as older ships tend to be less efficient in terms of fuel consumption and operational performance; They require more maintenance and may be subject to more frequent mechanical problems, which increases operating costs and reduces the reliability of operations; They may have difficulty complying with more recent environmental and security regulations, which may result in additional costs for updates and modifications necessary to maintain compliance; They usually have smaller load capabilities and may be less suitable for dealing with certain types of loads or operating on more challenging routes; And they convey an image of lack of modernity and reliability to customers and business partners, which can affect the reputation of navigation companies and compromise the ability to attract customers.

The high cost of bunker is a concern that plagues Brazilian cabotage because it affects the sector's competitiveness in relation to other forms of transport, such as the road; Bunker prices are subject to significant fluctuations due to a number of factors, including changes in oil prices, global demand for maritime transport and geopolitical events, making it difficult for navigation companies to predict and manage operating costs, creating uncertainties Financial and leading navigation companies to increase freight prices to compensate for possible losses, which can negatively impact customers and reduce the demand for cabotage services; Due to the weight of bunker costs, there is constant pressure on navigation companies to improve the energy efficiency of their ships, which involves investments in more efficient technologies such as low fuel consumption engines, hybrid or electric propulsion systems and operational practices aimed at reducing fuel consumption.

The insufficiency of investments in the cabotage sector is largely responsible for the previously related barriers, since: many Brazilian ports face lack of investments in modernization, expansion and maintenance, which limits the capacity of care and the efficiency of operations of operations Cabotage, resulting in congestion, delays in operations and additional costs for navigation companies; Investments in fleet renewal have been limited, which impairs operational efficiency, safety and sector competitiveness; Research and development investments, technology and innovation are essential to improve operational efficiency, reduce costs and promote sustainable development of the cabotage sector; Multimodal infrastructure investments are necessary to promote connectivity between different modes of transport, such as railways, highways and waterways, to facilitate the integration of cabotage operations with other transport modes and promotes the efficiency of the transport system as a whole ; And the lack of tax incentives and financing for the cabotage sector limits the capacity of navigation companies to invest in fleet renewal, infrastructure modernization and adoption of more efficient technologies. Public and private investments are essential to promote sustainable development of the cabotage sector.

Ultimately, it is noteworthy that full development of Brazilian cabotage requires investments in port infrastructure, simplification of bureaucratic processes, legislative reforms, tax incentives and public policies that promote the competitiveness and efficiency of the modal. These measurements, if combined, tend to create a more favorable environment for the development of cabotage transport in Brazil and to promote the competitiveness, efficiency and sustainable growth of the modal. However, in order for such initiatives to achieve the desired success, it is necessary to be coordinated and implemented in a comprehensive way, involving cooperation between the government, the private sector and other relevant stakeholders, among which the political power, represented by National Congress.

For future studies, the installed capacity of the national cabotage system is raised in order to verify the increase in the load transport demand that the system can support.

Author Contributions: Conceptualization, A.S.J.; methodology, A.S.J.; validation, A.S.J.; formal analysis, A.S.J.; investigation, E.A.V., F.E.M.P.L., F.F.P., M.S.P., and M.K.A.S.; resources, E.A.V., F.E.M.P.L., F.F.P., M.S.P., and M.K.A.S.; data curation, E.A.V., F.E.M.P.L., F.F.P., M.S.P., and M.K.A.S.; writing—original draft preparation, X.X.; writing—review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript.
Funding: Please add: This research was funded by University of Brasilia, and the APC was funded by University of Brasilia.

 doi:10.20944/preprints202406.0081.v1

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

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

 doi:10.20944/preprints202406.0081.v1

References

1. Cadore, K. R.; Reck, P.; Fischer, A. Complementação da cabotagem com o modal rodoviário para transporte de maçãs do Sul ao Norte e Nordeste do Brasil. *Revista Gestão Organizacional,* Chapecó, v. 12, n. 1, p. 39-59, jan./abr. 2019. DOI: 10.22478/rgo.v12i1.383.
2. ABAC. Associação Brasileira dos Armadores de Cabotagem. *A cabotagem no Brasil*. Abac: Rio de Janeiro, 2021.
3. Roberto, E. G.; Matos, F. J.; Gavião, L. O. Kostin, S. Comércio marítimo brasileiro: Busca de países referência para desenvolver a navegação de cabotagem. *Revista Eletrônica de Estratégia & Negócios,* Florianópolis, v.13, n.2, pp. 239-267, 2020. DOI: 10.19177/reen.v13e22020238-267.
4. Silveira Junior., A. *Cabotagem brasileira: Uma abordagem multicritério*. Appris: Curitiba, 2018.
5. Fonseca, R. O. A navegação de cabotagem de carga no Brasil. *Mercator*, v.14, n. 1, pp 21-46, 2015. DOI: 10.4215/RM2015.1401.0002.
6. Brazil. *Lei nº 9.432, de 08/01/1997: Dispõe sobre a ordenação do transporte aquaviário e dá outras providências*. Casa Civil: Brasília, 1997.
7. UNCTAD. United Nations Conference on Trade and Development. *Transport and trade facilitation: Rethinking maritime cabotage for improved connectivity*. UNCTAD: New York, 2017. Available in: https://unctad.org/en/PublicationsLibrary/ dtltlb2017d1_en.pdf, accessed in 12 mar 2023.
8. Valois, N. *Requisitos para o modelo de operação da cabotagem de cargas conteinerizadas no Brasil: A utilização de terminais rápidos*. Tese (Doutorado em Engenharia Naval e Oceânica). Escola Politécnica da Universidade de São Paulo. USP: São Paulo, 2014.
9. Silveira Junior, A.; Nunes, R. R. Assessment of the satisfaction level of users of Brazilian cabotage – containerized cargo segment. *Sustainability*, 2022, 14,12177. DOI: https://doi.org/10.3390/ su141912177.
10. Assis, M. F.; Silva, T. A. *Cabotagem: Custos adicionais em uma operação de transporte: Estudo de caso de uma empresa do ramo*. Trabalho de conclusão de curso (Tecnologia em Logística). Faculdade de Tecnologia de Americana. FTA: Americana, 2020.
11. Teixeira, C. A. N. Navegação de cabotagem brasileira. *Produção BNDES - Artigos*, Rio de Janeiro, v.25, n.52, pp. 432-435, 2018.
12. Silveira Jr., A.; Jesus, B. S.: Santos, E. L. P.; Arcanjo, J. V.; Santos, J. V.; Santos, N. G.; Nunes, R. R. *Cabotagem brasileira: Avaliação multicritério do segmento de carga conteinerizada*. Atena: Ponta Grossa, 2023.
13. Coelho, R. J. *Em busca da eficiência na cabotagem brasileira: Análise da percepção dos operadores das cargas conteinerizadas*. Dissertação (Mestrado). Universidade Federal de Santa Catarina, UFSC: Florianópolis, 2017.
14. CNT. Confederação Nacional do Transporte. *Boletins técnicos CNT – outubro de 2023*. CNT, Brasília, 2023.
15. CNT. Confederação Nacional do Transporte. *Anuário CNT do transporte*. CNT: Brasília, 2022.
16. Comi, A.; Polimeni, A. Assessing the Potential of Short Sea Shipping and the Benefits in Terms of External Costs: Application to the Mediterranean Basin. *Sustainability*, Basel, v. 12, n. 5383, p. 1-17, 2020.
17. Jurcovic, M.; Karina, T.; Morvai, K.; Hudcovsky, M.; Gorzelanczyk, P. Impacts of water transport development on the economy and society. *Transportation Research Procedia*, v.55, pp. 244-251, 2019.
18. Kim, N.; Wee, B. The relative importance of factors that influence the break-even distance of intermodal freight transport systems. *Journal of Transport Geography*. Nova York: V.19, pp. 859 - 875, 2011.
19. Schoner, K. *Cabotagem: Caminho sustentável para o crescimento do transporte de cargas no Brasil*. Portos e Navios: Rio de Janeiro, 2023.
20. Fonseca, R. O. A navegação de cabotagem no Brasil: Uma análise geográfica da conjuntura do modal no início do século XXI. *Revista Transporte y Territorio*, Aracaju, n. 20, p. 3-32, 2019. DOI: 10.34096/rtt.i20.6382.
21. Felipe Junior, N. F. A dinâmica recente do transporte marítimo de cabotagem e longo curso no Brasil. *Revista Transporte y Territorio*, n. 20, p. 33-65. DOI: 10.34096/rtt.i20.6383. 2019.
22. Brasil. Senado Federal. *Proposta que pretende beneficiar setor de navegação de cabotagem*. Senado Federal: Brasília, 2022. Available in: https://www12.senado.leg.br/noticias/materias/2022/11/18/proposta-pretende-beneficiar-setor-de-navegacao-de-cabotagem, accessed in 20 de feb de 2023.
23. Gil, A. C. *Métodos e técnicas de pesquisa social*. 6.ed. Atlas: São Paulo, 2008.
24. Zanella, L. C. H. *Metodologia de estudo e de pesquisa em administração*. Capes/UAB: Brasília, 2009.
25. Sousa, A. S.; Oliveira, G. S.; Alves, L. H. A pesquisa bibliográfica: Princípios e fundamentos. *Cadernos da Fucamp*, v. 20, n. 43, pp. 64-83, 2021.
26. Richardson, R. *Pesquisa social: Métodos e técnicas*. Atlas: São Paulo, 2002.
27. Fernandes, N. A dinâmica recente do transporte marítimo de cabotagem e de longo curso no Brasil. *Revista Transporte y Território*, vol. 20, p. 33 – 65, 2019. DOI: 10.34096/rtt.i20.6383.
28. Müller, S. M. *Cabotagem Brasileira - BR do Mar: Preço de combustível, competição e multimodalismo no projeto de Lei no 4.199/2020*. Fórum: Belo Horizonte, 2022.
29. Alfredini, P; Arasaki, E. *Engenharia portuária*. Blucher: São Paulo, 2013.

 doi:10.20944/preprints202406.0081.v1

30. Oliveira, G; Correia, R. A necessidade da dragagem no porto de Santos. *FATECLOG*. v.10, pp.12-26, 2019.
31. Brazil. *Decreto nº 97.026, de 01 de novembro de 1988: Aprova o Regulamento Geral dos Serviços de Praticagem*. Casa Civil: Brasília, 1988.
32. SEP/IDOM. Secretaria de Portos da Presidência da República. Estudo para o desenvolvimento do setor de cabotagem no Brasil. *IDOM consulting*, v.1, n.1, pp. 1-411, 2015.
33. ANTAQ. Agência Nacional de Transportes Aquaviários. *Obstáculos regulatórios ao transporte multimodal.* Antaq: Brasília, 2022.
34. Brazil. *Lei nº 14.206, de 27/09/2021: Dispões sobre o documento eletrônico de transporte (DE-e).* Casa Civil: Brasília, 2021.
35. DPC. Diretoria de Portos e Costas da Marinha do Brasil. *Normas da Autoridade Marítima para Aquaviários – NORMAN-13*. DPC: Rio de Janeiro, 2003.
36. Brazil. *Lei nº 8.630, de 25/02/1993: Dispõe sobre o regime jurídico de exploração dos portos organizados e das instalações portuários*. Casa Civil: Brasília, 1997.
37. Perez, O. C.; Santos, V. H. A. Logística e comércio exterior: Dificuldades no porto de santos. *Revista Desenvolvimento Social*, v.11, n.1, pp. 33-42, 2014.
38. Collyer, W. O. A importância do direito marítimo e da regulação dos transportes e portos para o desenvolvimento da logística. *Journal of Transport Literature*, Manaus, v.7, n. 1, p. 194-201, 2013.
39. Ribeiro, P. V. C. O transporte marítimo de carga e proteção da bandeira brasileira. *Revista Científica Multidisciplinar Núcleo do Conhecimento*, v.11, n.03, pp. 05-13, 2020.
40. Brazil. *Lei nº 12.815, de 05/06/2013: Dispõe sobre a exploração direta e indireta pela união de portos e instalações portuárias e sobre as atividades desempenhadas pelos operadores portuários*. Casa Civil: Brasília, 2013.
41. EPL. Empresa de Planejamento e Logística. *Boletim de Logística – Cabotagem: A importância para o transporte brasileiro e as medidas de estímulo do Br do Mar*. EPL: Brasília, 2021.
42. Teixeira, C. A. N.; Rocio, M. A. R.; Mendes, A. P. A.; Oliveira, L. A. S. Navegação de cabotagem brasileira. *BNDES Setorial*, v.47, n.1, pp. 391-436, 2018.
43. Cruz, S. M. L.; Araújo, M. C. B. De; Alencar, L. H. Transporte de cabotagem no porto de Suape, Pernambuco: Uma pesquisa exploratória. *Production*, v. 25, n. 3, p. 560–570, 2015.
44. Bender, L. E.; Fernando, F. D. Transporte hidroviário de cargas: Proposta de modelo de estimativa de custos de linha na navegação interior brasileira. *Revista Eletrônica de Estratégia & Negócios*, Florianópolis, v. 11, n. esp. 2, p. 21-35, ago. 2018. DOI: 10.1590/1982-8432/reen.v11n2p21-35.
45. Pompermayer, F. M.; Campos, C. A. S.; Paula, J. M. P. *Hidrovias no Brasil: Perspectiva histórica, custos e institucionalidade*. Texto para discussão | Instituto de Pesquisa Econômica Aplicada. Ipea: Rio de Janeiro, 2014.
46. CNT. Confederação Nacional do Transporte. *Pesquisa CNT do transporte aquaviário.* CNT, Brasília, 2013.
47. CNT. Confederação Nacional do Transporte. *Anuário CNT do transporte*. CNT, Brasília, 2019.
48. Soares, J. A. B. *Cabotagem como complemento na matriz de transportes: Uma análise dos desafios para seu crescimento no sistema de transportes brasileiro no século 21*. Dissertação de mestrado do Instituto Universitário de Lisboa. IUL: Lisboa, 2019.
49. Carvalho, M. A. *Navegação de cabotagem para o transporte de cargas: História, desafios, regulação e futuro.* TCU: Brasília, 2023. Available in: https://portal.tcu.gov.br/biblioteca-digital/navegacao-de-cabotagem-para-o-transporte-de-cargas-historia-desafios-regulacao-e-futuro.htm, accessed in 12 mar 2023.
50. Granemann, S. R. *Modelo de comparação entre os modos de transporte rodoviário e de cabotagem no Brasil*. Trabalho de Conclusão de Curso (Bacharelado em Engenharia de Produção). Universidade de Brasília. UnB: Brasília, 2021.
51. Almeida, R. B. *Principais entraves de infraestrutura e legislação na cabotagem brasileira*. Trabalho de conclusão de curso. Universidade Federal da Bahia. UFBA: Salvador, 2015.
52. Santos, F. A. B. *Navegação de cabotagem no Brasil: Como o Programa BR do Mar pode contribuir para o desenvolvimento do Brasil em um cenário pós pandemia de Coronavírus*. Monografia. Escola Superior de Guerra. ESG: Rio de Janeiro, 2021.
53. EPL. Empresa de Planejamento e Logística. *Boletim de Logística: Desmistificando a Cabotagem e o Programa Br do Mar*. EPL: Brasília, 2022.
54. IPEA. Instituto de Pesquisa Econômica Aplicada. *Ressurgimento da Indústria Naval no Brasil (2000-2013).* Ipea: Brasília, 2014.
55. ABIMAQ – Associação Brasileira da Indústria de Máquinas e Equipamentos. *A nacionalização racional das navipeças: A importância da inovação na cadeia de suprimentos.* Abimaq: São Paulo, 2011.

 doi:10.20944/preprints202406.0081.v1

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