BRAZILIAN LOGISTICS UNSUSTAINABILITY: A CONCEPTUAL REVISION APPLYING PHYSICAL INTERNET

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Abstract

Logistics in Brazil is very unsustainable, inefficient and precarious. Transport matrix, composed of 61% of highways, 21% of railroads and 14% of waterways, when at least 60% of this matrix should be anchored in railroads and waterways. Lack of investments in the logistics and multimodality network, as well as technological resources to facilitate the systematic arrangement among all the agents involved. The physical internet that adds concepts of an open global logistics system founded on physical, digital and operational interconnectivity through encapsulation, interfaces and protocols. The Physical Internet enables an efficient and sustainable Logistics Web that is adaptable, efficient, systemic and resilient. These features can answer for some Brazilian logistics problems. This paper reviews the main foundations and constituents of the physical internet theory in order to try to answer the main logistics problems that Brazil faces in trying to find possible solutions. In the end, it is concluded that, in fact, it is possible as long as the country creates investments for the infrastructure and technological resources, however, more studies can help in this matter.

1 INTRODUCTION

Brazil is known for its important role concerning the export of commodities. The main problem from a logistical point of view in Brazil is infrastructure. Just over 10% of our roads are paved, which amounts to less than 250,000 km. There is no point in trying to compare this situation with developed countries. Still, if we want to compare this situation with the other BRIC members, Brazil is far behind. Russia has more than 600,000 km of paved roads while China and India each have about 1.5 million km of paved roads (PUGA; PIMENTEL, 2016).
And it is worth remembering that the highways are our "strong point". Brazil has just 30,000 km of railways against 63,000 kilometers of India, 77,000 kilometers of China and 87,000 kilometers of Russia. Just to put these numbers in perspective, the US has more than 220,000 miles of rails. With regard to ships, the situation is no different. We have 14,000 km of waterways. Russia and China has more than 100,000 km each. In Brazilian ports, it is estimated that the handling cost per ton is US $ 13 while the world average is US $ 7. Transport matrix, composed of 61% of highways, 21% of railroads and 14% of waterways, when at least 60% of this matrix should be anchored in railroads and waterways.
Brazil loses the equivalent of US $ 83.2 billion per year with logistical costs due to problems ranging from high bureaucracy to the limited infrastructure of roads, railways, ports and airports. The loss represents around 5.6% of the Gross Domestic Product (GDP). Companies are now looking to offer their products and services quickly, cheaply and better than their competitors. For this, a good infrastructure of transport modes is required, since these are the ones that determine the time of delivery and even final cost differentials. The lack of infrastructure in Brazil is something that is visible. There is precarious equipment, roads, a shortage of skilled labor, and a lack of efficient public policies. Today, entrepreneurs already recognize logistics as one of the main factors of competitiveness, as many have lost space in the market due to lack of logistics efficiency.

Add to this the fact that highways are the main means of transportation in Brazil, and you have the revenue for an expensive, inefficient and inconsistent distribution. Brazilian products lose competitiveness and the consumer pays a high price. If the roads are not in good condition, it increases the cost of transportation, which is inevitably passed on to the consumer. Freight is one of the main components of logistics costs. Road transportation in Brazil corresponds to 58% of the national logistic system. However, according to the National Confederation of Transportation, 69% of the Brazilian roads are in bad conditions. The most damaged ones are those located in the North and Northeast of Brazil, preventing the economic development of these regions.

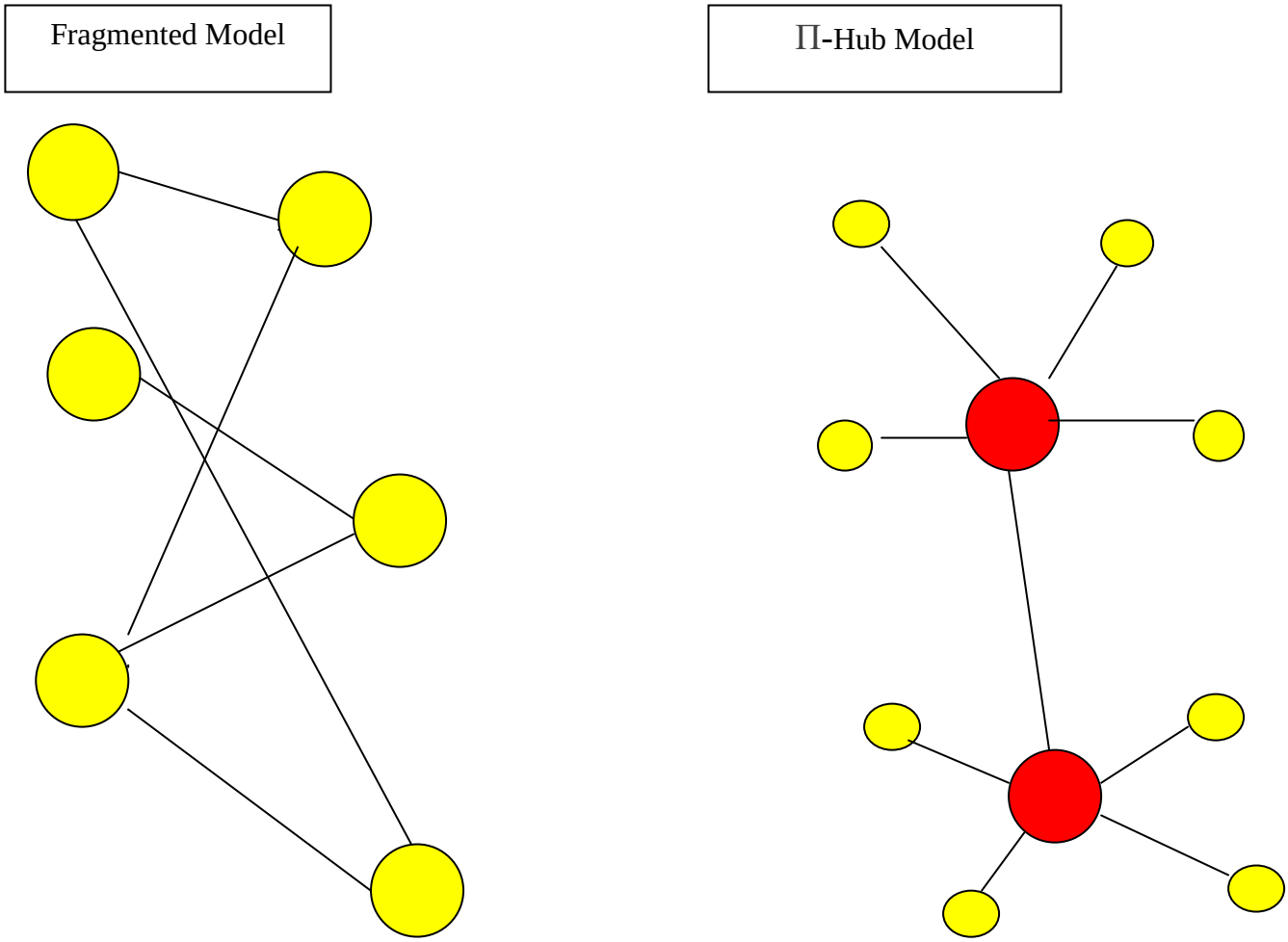
According to the CNI (Conselho Nacional da Indústria), productive sector spends R$ 108.4 billion annually with transportation costs - including freight, tolls, transhipment costs, terminals, port fees - which corresponds to 4.5% of the Product Gross Domestic Product (sum of the riches produced by the states of the region). According to the document, if the planned investments are not made, logistical costs can rise to R $ 162.8 billion in 2020.
Cargo theft is still a problem in Brazil. In 2009, more than 1 billion reais were recorded in theft losses. This cost is also passed on to the final consumer. Also, if companies do not manage demand properly, they end up with expensive, expensive stocks. With the amount of data available today it is possible to make an excellent forecast of demand, keeping inventory levels lower without causing breakages.
The low investment in logistics in Brazil is due to the difficulty of the government plan this sector, the need to improve the regulatory framework, the development of funds structures and the incentive of the private sector. One of the challenges is to think about the different

modalities of transportation in an integrated way to avoid costs in freight transport for which railroads are more efficient and sustainable. That is one of the possibilities of solution
In the current economic environment and technological development has increased sharply the importance of logistics. On the one hand the high financial cost, higher value-added production and the wide range of product types require the implementation and execution of streamlined inventory and distribution processes. On the other, the high fuel prices and the growing prospects of intermodality, lead to the search for more intelligent solutions in transportation.

2 Background

Nowadays, there is great communication between countries. The Internet has brought greater flexibility of relations, particularly with regard to free trade between countries. This change in business relationships brought an increased flow of products that are produced and shipped to final destination. The distribution, packaging, storage, transport were begun to grow with them. This fast growth has imposed a need to improve the distribution procedures.
As an alternative to solve this demand, rises The Phyical Internet (PI, π) that was presented by Montreuil as a response to the Global Logistics Sustainability Grand Challenge. It covered three aspects of sustainability: economic, environmental and social, using symptoms from today´s logistics system as evidence of unsustainability of our present system. The Physical Internet is defined as an open global logistics system founded on physical, digital and operational interconnectivity through encapsulation, interfaces and protocols. The Physical Internet enables an efficient and sustainable Logistics Web that is adaptable, efficient, systemic and resilient.
The goal of this grand challenge is to enable the global sustainability of physical object mobility (transportation, handling), storage, realization (production, assembly, finishing, refurbishing and recycling), supply and usage. From an economical perspective, the goal is to unlock highly significant gains in global logistics, production, transportation and business productivity. From an environmental perspective, the goal is to reduce by an order of magnitude the global energy consumption, direct and indirect pollution, including greenhouse gas emission, associated with logistics, production, transportation. From a societal perspective, the goal is to significantly increase the quality of life of the logistic, production and transportation workers, as well as of the overall population by making much more accessible across the world the objects and functionality they need and value.
The aim of a road-rail π-hub is to efficiently and sustainably transfer containers from trains from one line to trains from another line or from and to trucks. The basic idea of the road-rail π-hub is: 1) to never dismantle trains to avoid very strict safety constraints; 2) to enable a real network with many destinations available with short lead-times; 3) to smoothly interconnect with truck services.
To reach these goals, the mission of a road-rail π-hub is: 1) to receive trucks and handle their inbound π-containers so they can be loaded in time in their assigned train and railcar so as to move them to their next rail-based π-node; 2) to receive trains and handle their inbound π-containers so they can be loaded as pertinent either on a truck called to pick them up or on a subsequent train so as to move them to their next π-node or their final destination; 3) to handle and sort π-containers in connection with either a truck or another train.

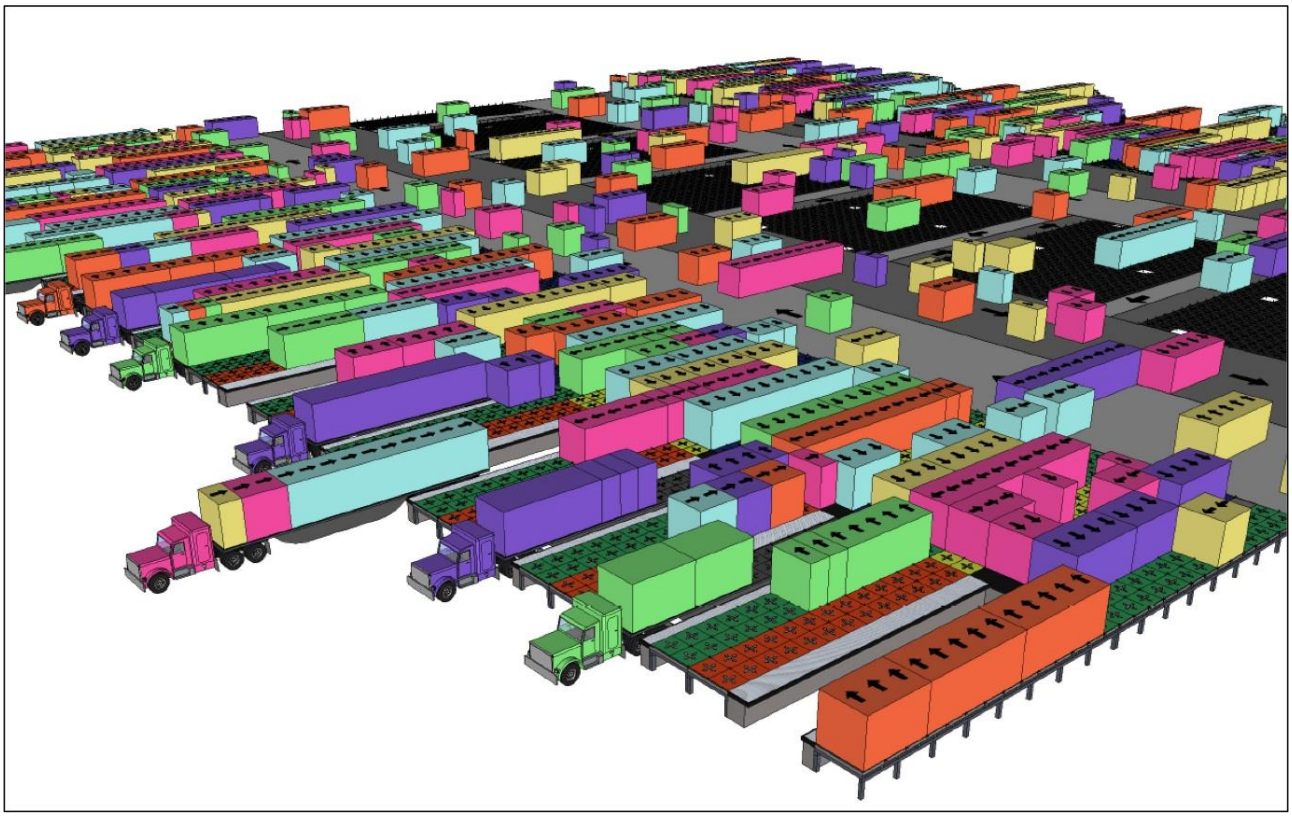
Figure 1 – Logistics Model



Source: by the author from Benoit (2011)

The fragmented model shows that the flow is ineficient and can spend more time that the π-hub model, that´s why the first one must be change for the hub model configuration. Each π -hub is a logistics platform and it can allow concentration of flows on each platform and can be sent to each location from the next available, located by the manager of each π -hub. If it is provided with terminals multimodal technologies could lead to transfer of cargo to railway wagons or for the which will carry out the more "legs" that connect the π-hubs.

Figure 1: Conceptual Drawing of Physical Internet Hub



Source: Kevin Gue (wordpress.com)

The global logistics sustainability grand challenge cannot be addressed through the same lenses that have created the situation. The current logistics paradigm must be replaced by a new paradigm enabling outside-the-box meta-systemic creative thinking.

From an economical perspective, the way goods are flowed is hugely costly. In most developed countries, it accounts for a significant fraction of the gross national product like in the U.S.A. provides a vivid example. Based on statistics from the 2009 Department of Transportation reports, transportation represents about 10% of the U.S. Gross Domestic Product, or roughly about 1.4 trillion. From an environmental perspective, the stakes are also high. Brazil doesn´t follow the same way.

Beyond such big-picture numbers, the societal, environmental and economical unsustainability of logistics across the planet can be grasped through numerous symptoms. Several of them are below. For each, goes with commentaries in relation to Brazil:

1. We are shipping air and packaging

Most of part, the products are in the Brazilian ports waiting for containers are full and then they will shipping. Sometimes, it takes from a month to four months until it´s happen.

1. Empty travel is the norm rather than the exception

Logistics in Brazil is non-systemic. There are logistics operators that works in a independent way for a specific industry or a group of them.

2. Truckers have become the modern cowboys

It can be said that in Brazil they end up assuming the same role. They are not integrated into a system and are limited to just driving a truck from one point to another, often in extended journeys, which leads to fatigue and in some cases, accidents

3. Products mostly sit idle, stored where unneeded, yet so often unavailable fast where needed

This is a constant in Brazil, since the logistics service always works independently and uniquely, without connecting with other products that are marketed by other companies. This lack of systemic communication leads to inefficient and expensive storage and mismatch between inventory and product delivery.

4. Production and storage facilities are poorly used

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5. So many products are never sold, never used

There are many cargo thefts in Brazil which further elevates this item. This leads to the contracting of cargo insurance, which raises the final price to the consumer.

6. Products do not reach those who need them the most

Failures in logistics infrastructure, misuse and underutilization of multimodality, and discontinuity of delivery generates inefficiencies as products that do not reach their destination in a timely manner.

7. Fast and reliable intermodal transport is still a dream or a joke

Multimodality is not yet a reality in Brazil. Lack of investment and technological adequacy to have a logistical system that is economically and socially sustainable.

8. Getting products in, trough and out of cities is a nightmare

The more distant the product of the consumer, the more logistical resources must be used to guarantee the delivery of the product in perfect conditions in the shortest possible time. In Brazil, it happens all the time, specially, in extreme regions of the country.

9. Products unnecessarily move, crisscrossing the world

Logistic action that works in an unintegrated way can lead to unnecessary routes and could be better used if they were globally interconnected.

10. Networks are neither nor robust

Logistic networks in Brazil work in isolation with little connection to other modes. Freights are basically road freights with poorly maintained roads and holes.

11. Smart automation and technology are hard to justify

The Ministry of Transport of Brazil has a logistic development plan, but investments and studies that justify these investments are lacking. Companies have little interest in building partnerships for this.

12. Innovation is strangled

The lack of research and study investments to make efficient multimodal logistics economically sustainable leaves innovation more distant..

Based on these and other important points can be noted that the way physical objects are transported, handled, stored, produced, supplied, designed and used throughout the world is often not sustainable. Brazil mostly fits with the above assessment. A continental country where the logistic map could be efficient, fast and modern suffers from being essentially

reliant on a road transport infrastructure that is poorly distributed and maintained, with roads in precarious conditions, inducing the emission of gases harmful to both human health and the environment. Rail transport is insignificant. Transport by rivers with potential for navigation still needs more incentives for logistics development. For abroad trade, ports are misused and have an extremely precarious structure, focused in Port of Santos, the major Brazilian port. The Brazilian Ministry of Transport has a national logistics plan, but it is still in the implementation phase.

In recent years there has been growing concern about the environmental effects of global human activity. This explains the increased attention to the popular classes, in government appointments, in the academic literature and also the general public. Stakeholders including government agencies and society are increasingly aware and they pressure companies to take responsibility for any negative effects that their business activities may cause. The increasing attention to more sustainable solutions includes logistics. Indeed it plays a very important role since it is a major source of pollution and resource use.

3 RESEARCH METHOD

This paper was classified in Physical Internet Fundamentals and Constitutes topic and Sustainability research field. It aims to deepen theoretical knowledge regarding the Physical Internet and its application in the Brazilian logistics. It is not the object of this study to exhaust all the concepts and fundamentals of the physical internet but to relate the basic principles with the logistic problem with relevance to the question of sustainability, considering that the Brazilian logistics is extremely inefficient and not sustainable as pointed out previously.

Explanatory research records facts, analyzes them, interprets them, and identifies their causes. This practice aims to broaden generalizations, define broader laws, structure and define theoretical models, relate hypotheses to a more unitary view of the universe or productive scope in general, and generate hypotheses or ideas by virtue of logical deduction (LAKATOS; MARCONI, 2010).

Explanatory research requires greater investment in synthesis, theorization and reflection from the object of study. It aims to identify the factors that contribute to the occurrence of the phenomena or variables that affect the process. Explain why things and try to understand them. That is made during this study. The results can be discussed in a conclusion.

4 CONCLUSION

Based on the explicit theoretical framework, it can be seen that the Brazilian logistics presents serious problems of infrastructure, maintenance, management, investment, multimodality, sustainability, transport, handle, storage, realized and supplied. All these problems are involved in the concepts of Physical Internet.

Brazil is among the leading developing countries with the highest growth potential in the world. It is currently among the twenty largest exporters in the world and only does not perform better due to lack of physical infrastructure. In this sense, the great brake of growth is the lack of quality of transport modes. The country has a good infrastructure of information, but it does not want to be in the physical infrastructure, especially with regard to the railway, road and maritime system.

The current framework of the country's cargo transportation structure has presented many limitations to the expansion of economic growth. With an existing transportation problem, the country is wasting billions of reais, with cargo thefts, operational inefficiencies, resulting in a significant loss of competitiveness. The inappropriate use of the modalities ended up generating a great dependence on the modal road, due to the low prices of the freights. Despite the huge coast and navigable rivers, the highways have a prominent role. According to the Transport Mystery, about 60% of national cargo is transported by highways.

The logistical problems are mainly concentrated in a discontinuous, disintegrated system with few technological resources. The concept of Physical Internet seems to address the key points of Brazilian logistics problems because in logistics, Physical Internet is an open global logistics system founded on physical, digital, and operational interconnectivity, trough encapsulation, interfaces and protocols. The Physical Internet does not manipulate physical goods directly, whether they are materials, parts, merchandises or yet products. It manipulates exclusively containers that are explicitly designed for the Physical Internet and that encapsulate physical goods within them.

It was aimed that the road-rail π-hub is to efficiently and sustainably transfer containers from trains from one line to trains from another line or from and to trucks. The basic idea showed of the road-rail π-hub is: 1) to never dismantle trains to avoid very strict safety constraints; 2) to enable a real network with many destinations available with short lead-times; 3) to smoothly interconnect with truck services.

The term, Physical Internet, employs a metaphor taken from the Digital Internet, which is based on routers, all transmitting standard packets of data under the TCP-IP protocol. A core enabling technology to make the PI a reality exploit is the encapsulation of goods in modular, re-usable and smart containers. This will make it possible for any company to handle any company’s products because they will not be handling products per se and its make sense for commercial products in Brazil. Instead they will be handling standardized modular containers, just as the Digital Internet transmits data packets rather than information/files. Modulars Brazilian containers can be provide for this specific purpose.

Another enabling technology of the Physical Internet is an open standard set of collaborative and routing protocols. Modularized containers are much easier to route through transport networks as individual “black-box” loads instead of heterogeneous loads of different sized cases and pallets that are used today in Brazil. But the efficient routing of modular containers over a collaborative network can only be realized if there is a standard set of routing and digital protocols, as well as business and legal conventions that apply across a community of users. Scale gains can be achieved when the standardized container containers dispatch products in a continuous flow without the need to stand in the port waiting for release for shipment. In Brazil, this wait can reach 120 days, which will burden the logistics process as a whole.

Beyond of handling and digital interfaces are needed to ensure reliability, security, and transparency as well as that the quality of the product being handled is not compromised through its movements. These interfaces cannot be proscribed, but the functional requirements need to be so that innovative interfaces may be developed.

Conception like the vision of the Physical Internet involves encapsulating goods in smart, ecofriendly and modular containers ranging from the size of a maritime container to the size of a small box would be good for Brazil. It thus generalizes the maritime container that succeeded to support globalization and shaped ships and ports, and extends containerization to logistics services in general. The other like the Physical Internet moves the border of the private space to be inside of the container instead of the warehouse or the truck is good too.

These modular containers would be continuously monitored and routed, exploiting their digital interconnection through the Internet of Things.

Although this is a compelling vision for the future of logistics, there are any reasons that some ponderations should be done to deploy the Physical Internet today, specially in Brazil, where there are some infrastructure and financial obstacles to implement some improvement in some specific sector. First, there is no agreed-upon standard for various container sizes outside of the international shipping containers. This, and the lack of standard contracts and other operational issues, mean that collaborative distribution is difficult to initiate and maintain. And expanding collaborative distribution is limited by the fact that there is not a centralized exchange for freight based on a standardized specification of a load, with the lack of standardized specification of a load due to the lack of standard containers. Other circular arguments on the use of the rail system, due to the currently time-inefficient design of switch yards, the lack of innovation due to the difficulty in justifying innovation when what is handled is so diverse, and the inability to construct facilities that will act as the backbone of the PI until there are users of the PI, all mean that there are a number of research questions and business issues that must be addressed before the Physical Internet is to become a reality.

Considering the following Brazilian logistic characteristics:

1. Increased level of transport service;

2. Expansion of the railway network, deteriorated during the period of public monopoly;

3. Increase the capacity and efficiency of port terminals;

4. Accessibility to Ports;

5. Expansion of the storage system, including for stock control purposes;

6. Expansion of waterway and pipeline activities (for ethanol, mainly);

7. Balancing the transport matrix;

8. Balance when assessing the environmental impacts resulting from logistical interventions

It is observed that the Physical Internet concepts are applicable to the Brazilian logistic context, either in the need to enable the transport of products, or in the standardization of modular containers, in multimodality, or in sustainability, which is intrinsic to the proposed model.

Studies can be done to raise the main deficiency points of the logistic system and apply the physical internet based on simulations that indicate results that can be applied by the main Brazilian stakeholders.

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