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Truck-Sharing Constraints: Two Case Studies

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ABSTRACT

This study explores and describes the potential truck-sharing constraints (physical and behavioral) for container trucks travelling empty; such empty truck trips contribute to traffic congestion, carbon emissions and transport capacity shortages at the marine container terminals of the leading ports. In this study, two case studies are presented in order to investigate the range of constraints that are involved. The truck-sharing constraints for the port are co-ordination problems between the carriers, a competitive container transportation industry that is lacking in mutual trust, in addition to the absence of the deployment of a neutral subsidiary company to take over the responsibility for the issue of empty truck trips. The constraints for a load-matching company are the diversity of the truck dispatching systems of carriers, the lack of trust between carriers, cost barriers and the weight restrictions imposed by the Government. The results of the two case studies, which have been explored in this study, can be used to persuade port stakeholders to evaluate and overcome the challenges presented by the truck-sharing constraints in the effort to reduce the number of empty truck trips.

Keywords: *congestion, emission, supply chain collaboration, transport capacity, truck-sharing*

1. INTRODUCTION

Since long ago, ports have been constantly evolving to serve as points-of-transaction and transport communication between the countries of a region and, in particular, with the rest of the world, from the general perspective of their activities (Haynes *et al.*, 1997). The overall aim of a port is to ensure that worldwide transportation services are neither delayed nor interrupted. The importance of a port further increases when it starts to be used for the purpose of ensuring and supporting supply chain activities in the cargo distribution process. This is not the exception to what has already been stated, since many studies confirm that a port is an influential component for its supply chain management activities (Heaver, 2002, Bichou and Gray, 2005, Tongzon and Heng, 2005, Wang and Cullinane, 2006, Panayides and Song, 2008, Panayides and Song, 2009). To fully appreciate the importance of the role expectations of a port in its supply chain, sufficient facilities (such as inland transportation) and services are required to enhance its attractiveness and competitiveness (Carbone and De Martino, 2003). For similar reasons to these, but especially from the service perspective, the container terminal, which is regarded as a core part of a port, becomes a part of its supply chain to ensure the greatest level of service delivery to its final customers (Panayides and Song, 2008). In other words, this means that the importance of the container terminal has increased because of port containerization (De Souza *et al.*, 2003).

Although port containerization has many worthwhile benefits, it nevertheless brings disadvantages. One of those disadvantages is the limited capacity in many areas of the container terminal operation, which in turn affects the key factors that influence the operational capability of port dimensions. The magnitude of the capacity shortage problem at ports has been made clear in many studies (Paixão and Marlow, 2003, Steenken *et al.*, 2004, Pallis and de Langen, 2010, Chao and Lin, 2011, Maurer and Degain, 2012, Dekker *et al.*, 2013, Islam and Olsen, 2013a, Islam and Olsen, 2013b), and its different possible consequences can also be found in some other studies of maritime logistics (Park and Noh, 1987, e.g., Ircha, 2001, Baird, 2002, Steenken *et al.*, 2004, Dekker, 2005, Imai *et al.*, 2006, Grossmann, 2008, Henesey *et al.*, 2009, Islam and Olsen, 2011). However, this system-wide capacity shortage problem has profound and diverse effects on the

effectiveness and efficiency of containerized transportation. The effects of overall capacity shortage on containerized freight transportation are expected and are likely to occur since all port components are connected to each other (Cetin and Cerit, 2010).

However, in the long run, simply increasing the number of container trucks at the expense of local residents and the environment surrounding the port may not be a viable option to meet the demand for increased transport capacity. The reason for this is that many container terminals are located in densely populated areas and therefore, the surrounding environment may become increasingly less habitable. The utilization of unutilized transport capacity through truck-sharing is a feasible and sustainable option. However, the effectiveness of this preferred option largely depends on the degree of adoption of truck-sharing initiatives between road carriers, and the success of such initiatives and collaborations relies on the exploration of real-life truck-sharing constraints. Conversely, the existing literature on this issue is rather limited. A major conclusion that can be drawn from this literature is that the few identified and described truck-sharing constraints have been explored and synthesized from the perspective of the general truck industry (especially, the retail industry). Therefore, this study intends to contribute to this limited literature by looking specifically at container trucks, with emphasis on the perspectives of a leading port company, and an expanding load-matching company. The major contribution of this study is extended to the truck-sharing constraints faced by the third parties specifically involved. To sum up, in other words, based on a clear and justifiable rationale, this study offers insights into the truck-sharing constraints that influence the extent of collaboration amongst road carriers and hence their willingness to use the existing capacity of container trucks more efficiently.

Two exploratory case studies have been constructed from the content of face-to-face interviews. As stated before, one of the case studies in this research is a leading port company of the country. This port is continually suffering from capacity problems (e.g., transport capacity in particular). To overcome this problem, a key area of need is to move the port to a new transport process. This pioneering transport initiative has failed to deliver solutions to port's transport capacity crisis, but the failure reveals many interesting lessons for every port company to take advantage regarding truck-sharing constraints, worldwide. Apart from this case study concerning transport operations, another case study has also been reported in this study. In the second case study, it has been attempted to reveal what kinds of constraints the load-matching company are dealing with. Increasing their understanding of principles such as truck-sharing constraints, which help to identify the major constraints facing road carriers and shippers (e.g., importers and exporters), will help companies flourish and therefore improve the transport capacity of the road network.

The rest of the paper is organized as follows: the first section represents the background that provides a clear context for the study; the second section provides further details of the research methodology employed; this is followed by a discussion of the reviewed literature in the third section; the fourth section describes the case studies; the fifth section provides the managerial implications of this study, and the concluding section reviews the overall aspects of this research.

2. LITERATURE REVIEW

2.1 Background: Capacity Shortage at Ports

2.1.1 Port Containerization: Opportunities & Challenges

Shipping containers are industrially-manufactured standard boxes to be used for transporting cargoes in maritime logistics, and now, many years after their invention, shipping containers have been made popular; this was first instigated by the entrepreneur Malcom McLean in 1956 (Cudahy, 2006). The shipping container has been widely adopted by the business world in general as a promising transport tool and containerization is now used as an advanced method of efficient freight transportation because of the unique benefits provided, such as being a fast turn around and inexpensive cargo handling facility (Abrasheva *et al.*, 2012). However, this introduced facility that supports containerization has its limitations, most of which come in the form of "challenges" that are predominantly applicable to container terminals (Bandeira *et al.*, 2009). For example, in leading ports, new container terminals need to be built annually just to keep up with increasing demand, and in order to conform with rising expectations of offering better services to shippers who are considering moving freight from one country to another. The demand for making new container terminals brings the need for more berths and cranes to be provided to handle containers (Rashidi and Tsang, 2013).

These are not the only requirements that ports will need to meet in order to be able to offer the minimum amount of service to importers and exporters with the goal of being recognized as a leading port in the region in which they are is situated; ports are also required to invest in straddle carriers, terminal operators, and internal trucks. Such infrastructural facilities and services are just a few examples that need to be addressed and considered by a port authority when trying to develop operational capacity and capability. However, in the context of a container terminal, the development of increased capacity is a formidable task; such development may have negative consequences in terms of service quality and cost. Therefore, in identifying the consequences, the study by Wang and Cullinane (2006) suggested, *"... ports should ensure that existing infrastructure and equipment is utilized to maximum economic and technical efficiency in order to optimize the container production process"*. In support of this argument, on the other hand, ports often lack the necessary capacity to execute their internal terminal operations competently; such situations weaken the goal of supply chain integration with other members of the same network. Capacity shortage is one of the limiting problems currently facing many container terminals of the world (Paul and Maloni, 2010).

2.1.2 Reasons of Capacity Shortage at Container Terminals

The importance of container terminals as the means of providing containerized cargo transportation services by sea, rail and road has increased significantly, particularly in the last few years (Zhang *et al.*, 2009). Because of this, the problem that occurs is that many container terminals of the world are currently facing the problem of a shortage of

capacity (Paul and Maloni, 2010); this is due to several factors that influence the demand for container port capacity (Figure 1).

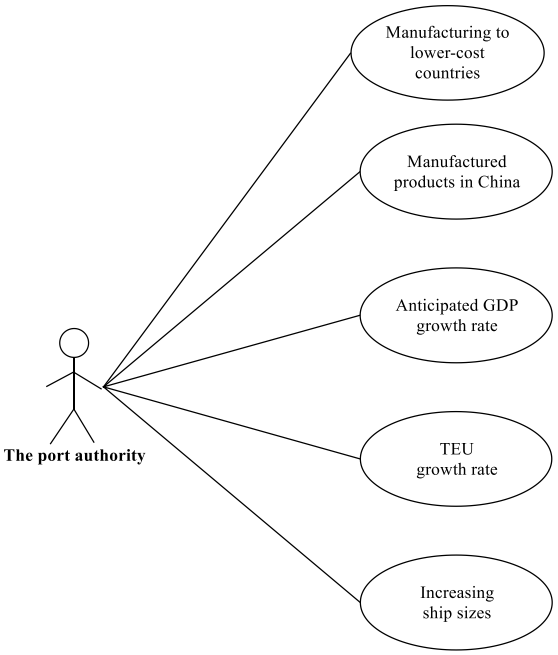

Figure 1 Top reasons for capacity shortage at container terminals

For example, in the 1980s, manufacturers replaced their production facilities and moved them to countries where production costs were comparatively lower; in addition, in the 1990s, and 2000s, Chinese manufacturers started exporting their products worldwide causing a major trade boom throughout the world (Pallis and de Langen, 2010). Secondly, the predictions for GDP (Gross Domestic Product) growth rates indicate a positive trend that will have an impact on worldwide trade volume in the future (Chin *et al.*, 2009). A positive economic relationship is expected between GDP growth rate and seaport demand development (Ocean Shipping Consultants Limited, 2009). Thirdly, the number of Twenty-foot Equivalent Unit (TEU) containers transported annually increased from 39 million to 356 million between the years of 1980 and 2004 with an annual growth rate of 10 percent; this increase is expected to continue until 2020 (David and Sichman, 2009). The growth rate is positive because of the TEU's unique advantages (cheaper and easier cargo handling facilities). Fourthly, shipping liner companies are increasing their ship size (Stopford, 2009); this is due to the fact that when ship sizes increase, unit transportation costs decrease. Although some ports adopt innovative ways to increase container terminal capacity, other ports are under pressure due to issues pertaining to capacity shortage (Chao and Lin, 2011).

2.1.3 Consequences of Capacity Shortage

The capacity shortage problem has compelled seaport authorities to build new facilities and infrastructure for their container terminals. For example, between the years 2007 to 2015, around 700 new container terminals will be required to be built in order to accommodate the growing number of containers in East Asian ports (UN and Korea Maritime Institute, 2007). The maritime transport industry is growing at a more rapid rate than the rate at which seaports are able to build sufficient facilities to smooth the flow of freight transportation (Pallis and de Langen, 2010); this is due to the fact that it takes many years (ranging from 2 to over 10) from decision making to the completion of changes to port infrastructure to increase capacity (Henesey, 2006). As many ports are exceeding capacity, seaports need to deal with the shortage problems (Figure 2).

Firstly, capacity shortage creates congestion problems in the container terminals and congestion has consequences for port users. For example, congestion accelerates during the delays that occur, and costs increase. Some typical examples of such delays are; missed feeders for shipping lines, yard congestion and re-handling for terminal operators, longer waiting times for trucking companies, and longer lead times for shippers (Park and Noh, 1987, David and Sichman, 2009). Thus, the parties involved in the supply chain face losses. Secondly, because of capacity problems and for economic reasons, the larger ships tend to visit a specific number of ports (Henesey *et al.*, 2009). For example, a mega ship that has a capacity of 18,154 TEU can cause capacity shortage in many ports (Grossmann, 2008). Hence, recently built deep-water ports are able to gain market share from the shallow-water ports (Baird, 2002). If an exporting country sends its containers to an importing country via a hub port, problems, such as the following, will occur: (1) the "transit time" will increase; (2) "cargo handling costs" and "risk of damaging the cargo" will increase due to multiple freight handling in each port during the course of transshipment**.** Thus, capacity shortage causes supply chains to be ineffective in many ways. Finally, capacity shortage causes a port to increase the price of its service. This, in turn, increases the transport cost for the use of some ports and, thus, other less congested ports look more attractive to shippers (Dekker, 2005).

2.1.4 Capacity Expansions for Container Terminals

All of the foregoing issues discussed that relate to capacity influencing factors and their individual or combined effects have resulted in capacity shortage in many container terminals of the world (Paul and Maloni, 2010), in addition to other related problems, such as, fostering congestion and increases in cargo handling cost (Islam and Olsen, 2011). Understanding and taking these consequences into account, and considering the need to minimize the capacity shortage problem, the majority of existing studies have suggested that the capacity problem in seaports can be solved by either finding a solution, which could be the implementation of "structural mechanisms" leading to facility expansion (McCalla, 1999), or, the creation of mechanisms ("non-structural mechanisms") that could assist in the improvement of the utilization of existing facilities (Dekker, 2005) with the aim of adopting more advanced technology (Ballis *et al.*, 1997), in the organization of work (Paixão and Marlow, 2003), and Business Process Re-engineering (BPR) (Islam *et al.*, 2013) or, in Business Process Improvement (BPI) (Islam and Ahmed, 2012). Each solution has its advantages and disadvantages (Figure 3), and each has its own cost profile. For example, structural mechanisms to improve port capacity may be expensive and lengthy to implement, but which, in practice, may have wide applicability. On the other hand, non-structural mechanisms to expand port capacity may be much cheaper and quicker to implement.

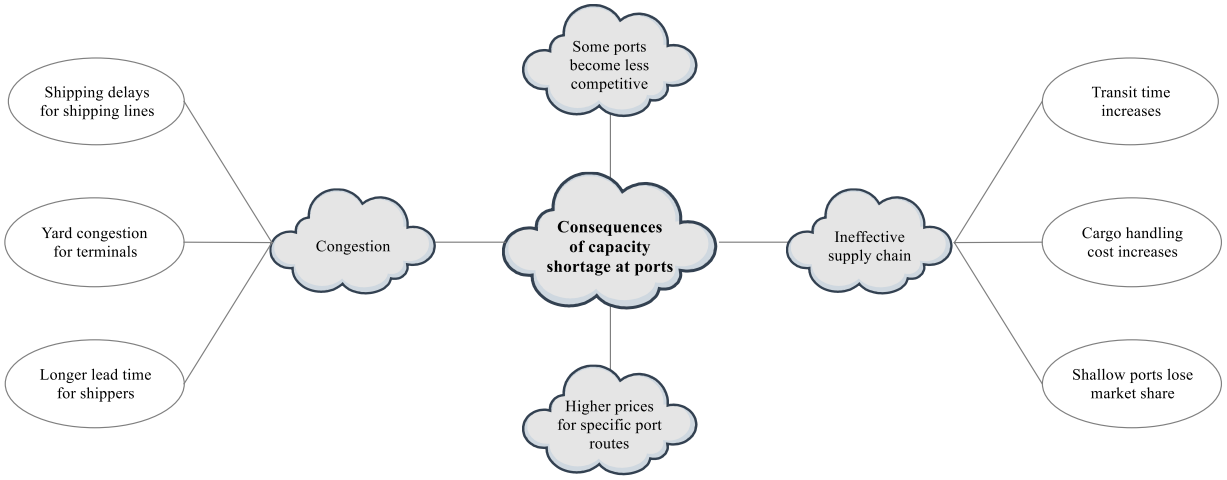

Figure 2 Most significant consequences of capacity shortage at container terminals.

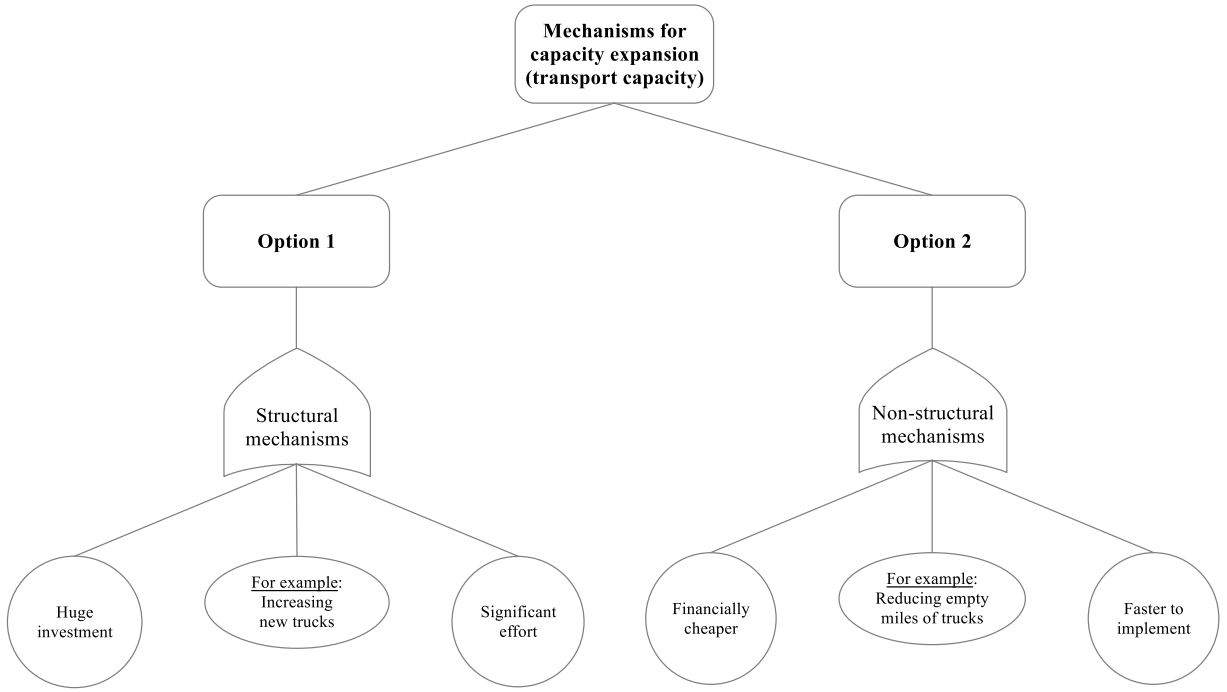

Figure 3 Key mechanisms available for a port to expand its capacity.

2.1.5 Importance of transport capacity expansion

A container distribution system is shaped by a series of capacity influencing components which are functionally interconnected to each other, meaning changes in any one part should affect other parts. Thus, the performance of each component determines the overall performance of the port (Cetin and Cerit, 2010). However, these components are influenced by many stakeholders, usually, these are, railway operators, terminal operators, shipping lines, road carriers and others. One common problem with such a distribution system is that each of these stakeholders may react to its own welfare and may not be concerned about the overall performance of the whole port (Dowd and Leschine, 1990). Hence the real value of increased efficiency is finally the contribution it makes to the port's overall capacity expansion potential (Dowd and Leschine, 1990). For example, during the 1990s, California updated its port capacity to handle bigger container ships without improving the transport facilities to connect the port to the hinterland; this created major bottlenecks (Auckland Regional Holdings, 2009). Hence, in order to improve the system-wide capacity shortage problem, it is vital to put emphasis on the improvement of transport capacity.

2.2 Related Works

2.2.1 Empty Truck Trips Problem

Apart from recommending the adoption of a planned approach in increasing containerized freight transportation facility at ports, finally, and perhaps most significantly, the study by Islam *et al.* (2013) highlights the importance of developing a deeper understanding of the interaction between the reduction of empty trips and transport capacity expansion at ports. The study also concludes that this prevailing situation, to a certain extent, represents an opportunity to solve the transport capacity shortage problem at container terminals. This concept is feasible for the reason that if the currently underutilized, empty space on travelling trucks is made available for use to carry a larger number of containers under the same conditions, those trucks would then be able to carry extra containers per

trip. This would increase the transport capacity of each truck on every trip and would affect the transport capacity of the existing carriers and the overall port region. Therefore, the fact that, for strict security reasons, only a certain number of port-registered container trucks are allowed to participate in port operations, potentially impacts on the efficiency and effectiveness of the truck transport capacity of a port and its surrounding area. Similar findings on the way in which proper utilization of the empty space available on trucks can contribute to increasing transport capacity, have also been reported from a collaborative standpoint. For example, see Islam *et al.* (2013).

2.2.2 The Economic Benefits of Reducing Empty Truck Trips

Many economic benefits are associated with empty trips reduction. These benefits go from supply chain efficiency and freight savings to important sustainability-related innovations and better operational performance from the shippers, road carriers, and port authorities. Some interesting examples can be provided to help distinguish the different issues involved by facilitating a sharing of resources (e.g., container trucks) between supply-chain members versus a non-collaborative transportation idea. For example, exporters pay a part of the total cost of the full container delivery service, since two exporters may share the same container truck. This increases supply chain efficiency, effectiveness and competitiveness, which helps reduce the costs of the final customers. It also does the environment a favor by reducing CO2 emissions, and fewer heavy vehicles on the road means less congestion and pollution. Apart from all these benefits, a driver will earn more money, since the cost will be shared among all of the parties. A detailed description of the economic benefits can be found in Islam *et al.* (2013).

2.2.3 Literature Related to the Empty Trips Problem

The empty trips problem is a topic of interest that has been addressed in scholarly literature from different points of view and for different purposes. One of those perspectives that exists in the literature is the backhauling problem (Vehicle Routing Problem with Backhauls-VRPB) that uses optimization algorithms to satisfy all constraints and serving the required demands for linehaul and backhaul customers (Potvin *et al.*, 1996, Toth and Vigo, 1999, Tavakkoli-Moghaddam *et al.*, 2006, Imai *et al.*, 2007, Anbuudayasankar *et al.*, 2012). Another research stream relevant to the empty trips problem is one that discusses co-ordination and co-operation problems in the hinterland (the region served by the port) transport chains (for examples, see Monios, 2011, Van den Berg and De Langen, 2011, van der Horst and van der Lugt, 2011). Finally, one of the key issues of the supply chain management also concerns the problem of empty running by trucks and their opportunities for full loading in the form of Collaborative Transportation Management (CTM) (for more clarification, see Esper and Williams, 2003, Tyan *et al.*, 2003, Li and Chan, 2012). However, a complete description of all of these studies from a variety of research domains is beyond the scope of this study. Interested readers are also referred to the recent short review by Islam *et al.* (2013) for additional discussion of the problem of empty truck trips.

2.2.4 Literature Related to Truck-Sharing Constraints

Many types of truck-sharing constraints have been previously reported and classified in the limited amount of literature that is available on the topic. Those few studies that have directly examined truck-sharing constraints as an explanation for scarce backloading opportunities have mainly focused on the type of freight trucks that are for general, rather than specific, use. General-purpose trucks are frequently used in the retail industry (more specifically, in the department store environment). For a review of the few studies available on truck-sharing constraints for general trucks, see McKinnon (1996), McKinnon and Ge (2006), McKinnon (2007) and McKinnon *et al.*, (2010). However, the only study specifically relevant to the topic (truck-sharing constraints for container trucks) of this research, reported in the literature, as far as the authors are concerned, is that by Islam and Olsen (2014), who identified four different types of truck-sharing constraint (Figure 4) that are explicitly applicable to container trucks:

Customer-related prohibiting factors: Customer-related factors may prevent access to truck-sharing opportunities. For example: (1) customers (exporters and importers) demand their freight be delivered or received as soon as possible without undue inconvenience or delay, although road carriers may also have their own priorities, for delivering or receiving freight (e.g., location of the customer and profitability of the job) (Arevalo-Ascanio *et al.*, 2024); (2) site limitations may be associated with container size, hazardous materials and height issues, such as limit access for vehicles to a customer's property; (3) distinct pickup locations as well as unique customer addresses can make it impossible for a vehicle to successfully pick up an extra container from another warehouse location (Saragih *et al.*, 2022); (4) weight of the total freight on a container truck can limit opportunities to take one or more containers on the same truck.

Carrier-related prohibiting factors: Road carriers may have to consider factors that may make successful truck-sharing difficult, including: (1) a high degree of competition between different road carriers providing the same level of transport service can limit the opportunities (Siluthanyi *et al.*, 2024) available to them for truck-sharing; (2) in the long run, a lack of clear communication and effective co-ordination in operations, decision-making, and mutual objectives (e.g., gaining market share versus increasing profit) between the various transport selling companies can make it difficult for truck-sharing to occur in the market; (3) in order to ensure safe or suitable working conditions for truck drivers in the course of regular driving, drivers are restricted to driving only a set number of hours per day (e.g., when they reach a 13 hour driving limit, they may be required by law to take a break of at least ten hours before driving again); (4) sufficient trust among road carriers, with whom truck data (e.g., routing and scheduling) would be shared, is essential for in truck-sharing business.

Seaport-related prohibiting factors: Efforts should concentrate on identifying the port-related variables that prohibit a truck-sharing operation, for example: (1) the presence of a truck appointments system at the port gate can prevent road carriers from truck-sharing. The reason for this is the tight schedules that dictate that truck drivers come to the port following a precise timing schedule after completing complex and variable loading and unloading tasks at the customer's location or in other place (e.g., traffic congestion); (2) another type of pressure is the port-

related charges that make truck-sharing difficult because of the inflexibility and complexity linked to maritime transportation; for example, the price-sensitive demurrage and detention charges (these may contribute to the final price of the product) are used by the port authority to automatically put pressure on road carriers and customers to manage empty and loaded containers more efficiently and effectively; (3) similar to these compelling reasons is the "export cut-off time", based on the expected arrival and departure time of container ships; these determine when an export container is estimated to arrive at the port; (4) finally, there is another reason that goes beyond all these factor, the hours of operation of a seaport, which also restrict the occurrence truck-sharing events. For example, some ports are available for transactions 24 hours a day and other ports are not.

Some other miscellaneous prohibiting factors: Apart from categorized variables, many other factors are responsible for the amount of truck-sharing usually carried out between road carriers and customers (exporters and importers), including Dangerous Goods (DG), truck capacity, container categories and empty depot location. For example: (1) due to the nature of some containerized freight, it is not always possible on every occasion for a container to be transported safely in close proximity with other containers carrying a diverse range of freight in the same truck or vessel; (2) different container trucks have differing capacities for dealing with the type and size of product they regularly carry; the lack of standard container trucks means that these trucks are often incapable of carrying other containerized freight simultaneously to the same destination; (3) for a similar reason, dissimilar types of containers, which are often carried by dedicated trucks, have the long-term effect of making truck-sharing difficult for the parties concerned; (4) empty depots that are available may be in distant locations, and the container-truck fleet may not be capable of picking up or dropping off containers from several distant locations on the same trip.

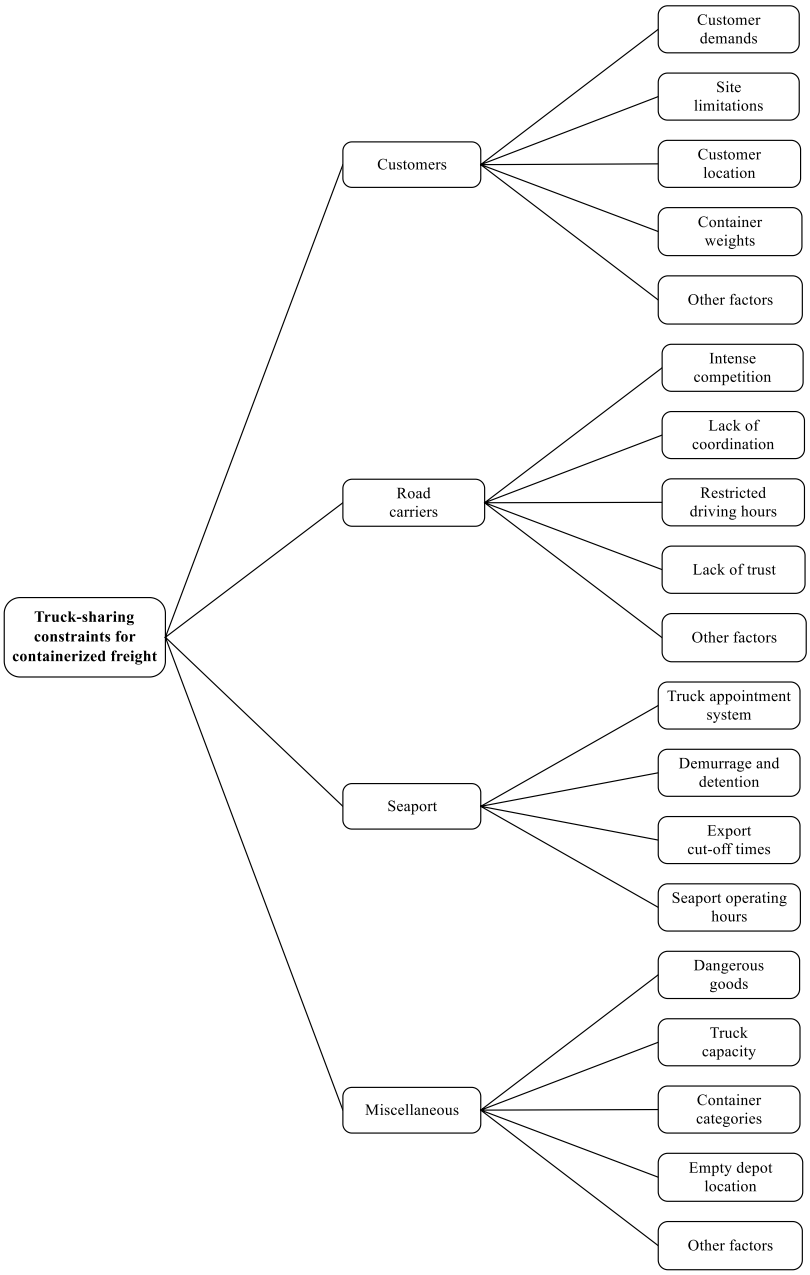

Figure 4 Major truck-sharing constraints for container trucks

2.3 Major Contributions of This Study

Based on earlier discussion, it is evident that the published reports on truck-sharing constraints that are currently available have been limited, to date, and most of this limited literature relates to general freight trucks. However, it is also important to note that general freight trucks are different from their counterpart container trucks in terms of physical configuration and operational applications (i.e., under the typical conditions generally assumed in maritime logistics for an export or import process). To elaborate on the reasons for dissimilar operational applications, a plausible explanation is that many steps are involved during the exporting process, and it is possible that a container truck may remain empty during any one of those steps (e.g., an empty container pickup or a full container delivery). On the other hand, as is dissimilar to container trucks in terms of operational requirements, a general truck typically remains empty after cargo delivery and during the equipment return phase.

Therefore, after taking those differences into account, and in order to successfully contribute to the filling of these research gaps, as stated earlier, the only study to have considered container truck-sharing constraints comprehensively is the work by Islam and Olsen (2014). The conclusions reached are likely to be correct for the circumstances of that particular study where the researchers interviewed a variety of container road carriers from the container transportation industry. However, in order to extend the earlier study by Islam and Olsen (2014) and their findings, in contrast with that study, respondents from two different organizations have been interviewed for the purposes of this study. These organizations are not directly involved with the container transportation industry but help other carriers to establish a mechanism to enable truck-sharing initiatives. The first of the two organizations is a local port company, and the second is an organization that facilitates the reduction of empty trips by advertising load-matching services on their website. In brief (Figure 5), therefore, this study extends the findings of earlier limited studies on truck-sharing constraints of container trucks from a different perspective (other members of the supply chain rather than the road carriers). Secondly, this study also contributes further to the overall literature on truck-sharing constraints, which consisted of studies relating to both general trucks and container trucks.

2.4 Research Question (RQ)

Taking into account the problem of transport capacity shortage in container terminals and its subsequent effect on congestion and bottleneck problems, as far as the authors can ascertain, the presence of services similar to those of truck-sharing initiatives are evident to a limited extent in the container transportation of the inland connections and their regions for a port. However, examples of collaborative challenges pertaining to truck-sharing constraints (usually explored for non-containerized freight transportation) are available in other areas of research. To cover that research gap, the research question to be answered in this study is: *"What are the truck-sharing challenges among road carriers to gain optimal container-truck utilization from the perspective of a leading port and a load-matching company?"* Collaboration among stakeholders is the key for scaling innovation in freight transportation and to effectively utilize existing underutilized transport capacity.

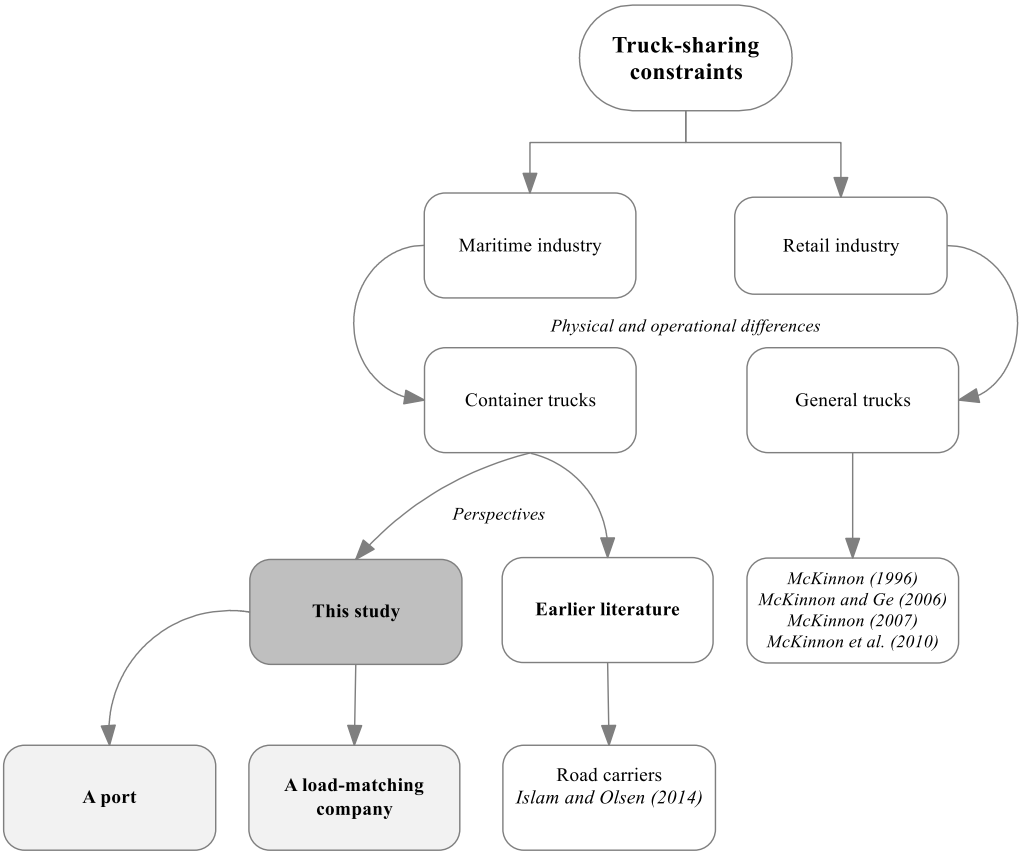

Figure 5 Major contributions of this study to the limited truck-sharing literature.

3. METHODOLOGY

3.1 Methodological Approach

The aim sought in this study is to explore potential truck-sharing constraints to minimize the number of empty truck trips at ports, alongside improving system-wide transport capacity by means of reducing empty mileage. A case study methodology has been chosen to satisfy the objectives of the study. Since the perspective of the research question is unique in its characteristics, and the findings reflect specific contextual conditions, a case study methodology is believed to be appropriate for this study, as suggested by Yin (2013). A case study is also appropriate when research questions have explanatory components (e.g., what are the truck-sharing constraints?) 2013). Therefore, excluding exceptions known to the authors, interest and research directed toward the application of a case study methodology are increasing in the logistics and supply chain management field. This is mainly due to the possibility of gaining important insights into a range of objectives; this might not be possible using a different research methodology. The rationale of this argument has been justified in many studies (Aramyan *et al.*, 2007, Lau and Wang, 2009, Khan *et al.*, 2012), and the advantages are also obvious: the purpose of the methodology is to ask descriptive questions such as "how?" or "why?" that are likely to elicit more than one-word answers.

Accordingly, taking into account all these possible issues, two different case study organizations have been investigated to answer the research questions of this study. Although the case study sample sizes are small, to reflect the generalization of the population (Merriam, 1985), this limitation can be overcome by selecting representative subjects (McCutcheon and Meredith, 1993, Lau and Wang, 2009). One of the two case studies, therefore, is one of country's leading port companies, and the second organization, which is the only company of its type in the country, provides a successful business-to-business (B2B) load-matching service to many road carriers. To perceive the operational similarity between the two organizations, it is clear that each of them works as a facilitator between carriers to ensure the underutilized capacity of empty truck trips is minimized.

3.2 Data Collection Approach

The rationale for selecting these two distinct case organizations, one being a port authority and the other a load-matching company—is grounded in the multi-actor dynamics of truck-sharing ecosystems. The port authority is a key infrastructure and policy actor directly impacted by the problem of empty truck trips and has the power to initiate or support collaborative solutions. The load-matching company, on the other hand, offers a technological and market-driven approach to truck-sharing facilitation. By including both perspectives, this study provides a more comprehensive understanding of truck-sharing constraints across both institutional and entrepreneurial settings.

Case study 1. In the instance of first case study, in order to draw the case study into wider discussion on the necessity for the implementation of a shared-transportation option, described here from the perspective of improving responsibility in the supply chain in particular (e.g., increasing container fleet carrying capacity by roads), the researchers have identified the necessary data requirement. Therefore, the researchers have deliberately used the data captured from reports published on the port and its region. A small part of the acquired information is based on transcriptions which resulted from previous interviews (i.e., exclusive interviews with the road carriers operating in the container transportation industry) in another study conducted by the same authors.

Apart from those interviews with the road carriers, another set of interviews was previously undertaken for the port case study. Those interviews were also part of a research project led by the same researchers who authored this study. In that simulation-based research project, in total, three interviews of varying duration were conducted with three selected participants from the port. Respondents were selected in a way that highlighted various aspects of the port's activities, including its transport strategies and policies. These respondents were well informed about truck operations because of the nature of tasks they perform. Therefore, the interviewees were the logistics manager, the operations manager, and the manager in charge of gate operations. A combination of structured and unstructured questions was asked. However, some interviews were not recorded because of the confidential nature of the information provided. Therefore, in brief, interviews from two different groups (i.e., from two different angles – road carriers and the port) are compared and contrasted with regard to the experience of a specific truck project (as explained in the case study section) initiated by the case study relating to the port authority on the reduction of empty truck trips. Since the port authority is responsible for coordinating terminal activities, they are an important part of the cargo delivery system, particularly in supply chains. On the other hand, road carriers are also part of the transport chain and are therefore under an obligation to develop efficient transport and logistic systems.

Case study 2. In the second case study, which relates to a load-matching company, a semi-structured face-to-face interview was conducted to answer questions about the way in which the company operates, and what the constraints are to the provision of load-matching solutions. The interviewee was selected in a way that ensured that interviewee was fully aware of the entire operational procedure of the company, and real-world working constraints of offering load-matching services. Therefore, the interviewee chosen was the co-founder of the company. The duration of the interview was approximately 30 minutes. Questions asked included specific operational aspects of the organization, such as: (a) a brief introduction to the company and its services; (b) the way the company provides its services to attain maximum profitability; and (c) the truck-sharing constraints the company faces in the provision of its services. The interview was tape-recorded and was later transcribed. Apart from the interview, another source of data collection was the company's proprietary information. Hence alternative data sources have been used to allow for the cross-reference of important information.

3.3 Data Analysis Approach

Interview results were categorized, reviewed and approved according to the identified themes that had been explored in the review of published literature discussed and

reported earlier. Along with the categorization and further classification of the interview answers, clarity and presentation of the interview responses relating to the study's research question of this study also played a decisive role in its development. For example, every truck-sharing constraint was identified, and therefore, isolated as a separate theme, before counting it as a unit of analysis that needed to be adequately described in the study. Therefore, the subtheme of each interview was in alignment with the requirements of the identified themes. Apart from all these required conditions, the researchers also employed the "back and forth" approach as suggested by the study of Fugate *et al.* (2009). This approach has been applied to this study to ensure that excess information is eliminated, and that additional information is included, whenever considered necessary, in the whole process of the revision and eventual amendment and presentation of interview results.

4. FINDINGS

4.1 Case Study 1: Discussion and Results

To strengthen the methodological rigor, more contextual details about the two case studies are now added. The first case involves a leading national port authority actively experimenting with reducing empty truck trips. The second case focuses on a pioneering digital truck load-matching platform. These cases were chosen to represent two complementary stakeholder perspectives, traditional infrastructure-based and technology-driven approaches to addressing truck-sharing constraints. Despite operating in different business sectors, both are unified by a shared goal of improving container truck utilization in the port logistics ecosystem. It is important to note that the number of load-matching companies globally, particularly those offering truck-sharing services, is quite limited. To maintain the anonymity of the case studies, we have made a conscious effort to include only the essential details necessary for understanding the context, while minimizing any information that could potentially reveal their identities.

This case study shows why the port, termed "the port" hereafter for brevity, needs to encourage and support active participation in the integration of the truck-sharing concept with its door-to-door container freight transportation. Because there are many empty trips, which offer improvement opportunities for its registered road carriers, only registered road carriers can make transactions within a port for many reasons, including those of port safety and security. This may help the port to achieve a competitive advantage for adapting its services, by increasing the port throughput of the container terminals and hence its hinterland reach (the region regularly served by the port), in response to the continuously changing environment in which the port is operating. In brief, this case study first discusses the background of system-wide capacity shortage issues (including the transport capacity problem). Second, a brief description is given of a measure taken to reduce the empty trips issue, and the reasons (e.g., truck-sharing constraints) for which the exercise failed.

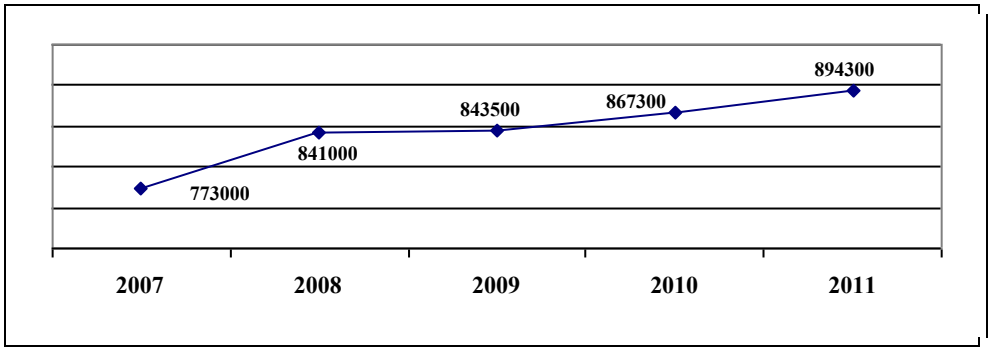

Figure 6 The port's container annual throughput (approximate)

4.1.1 The Port

This is a leading port company in the country due to its annual volume of import and export throughput. For example, the financial value of the amount of trade volume the port handles per year is more than 10% of the country's GDP. This is not considered to be exceptional in the maritime industry, as the port handles around 890,000 TEU (Twenty-foot Equivalent Units, a standard unit) per annum.

4.1.2 Transport Capacity Shortage Problem

Nowadays, many leading port companies around the world face the same problem: a system-wide capacity shortage. To some extent, the system-wide capacity shortage problem is facilitated by the fact that external forces are in play in the global environment, which has made the existing situation worse than it was previously. For some typical reasons for the capacity shortage that are frequently mentioned in the literature, see the subsection on *"reasons of capacity shortage at container terminals"* However, apart from the causes provided in the literature, to provide more case-related reasons for the capacity shortage problem, it is evident that the, approximately six percent, growth rate that has occurred over time (Figure 6) looks alarming for the long-term strategic planning, sustainable management and smooth operation of the port. This alarming situation comes to light largely due to the capacity shortage problem, bringing about many negative consequences for a port. These negative consequences in the form of common challenges and potential barriers to the success of a port's competitiveness and profitability may also bring additional complexities, and hence vulnerabilities and costs for their supply chains.

The most common examples of the negative consequences of the system-wide capacity shortage problem include the following: (1) capacity shortage accelerates congestion in ports and increases costs and delays for shipping lines, terminal operators, trucking companies and shippers (Park and Noh, 1987); (2) due to the problem of capacity shortage, large container ships can

only visit a limited number of ports (Henesey *et al.*, 2009); (3) the capacity shortage issue increases the transport costs of specific port routes and thus other, less congested, ports become more attractive to users, such as exporters and importers (Dekker, 2005). However, it is interesting to note that, in a container terminal especially, all port components (e.g., gate, yard and storage) are connected to each other, and a performance bottleneck in one component is likely to affect the entire system throughput (e.g., for the port); that is, the total number of containers handled per year. In other words, a bottleneck in one port component means that every other component connected to the system cannot perform as it should do, or in the way in which it has been designed to perform. Therefore, the idea of "*system-wide synchronization and the uniform connection of port components"* has been well accepted in the port community and is cited in the literature (for some examples, see Dowd and Leschine, 1990, Huang *et al.*, 2008, Cetin and Cerit, 2010).

As a result, based on the same assumption, it can be further asserted that, depending upon the extent of the system-wide capacity shortage problem, it will have an impact on the required transport capacity of container trucks. Such a result is also expected for the case study port, especially when 87% of land-side cargo haulage is transported by road because of the door-to-door service capability of container trucks. Therefore, the hinterland influences the establishment and management of transport connections between the port and its region, and for which the port provides its services to its customers. A well-established connection with a port hinterland, that has sufficient capacity and is of such quality, is important for a port from a marketing, and hence a competitiveness, perspective. These expectations are quite reasonable, as the shipping lines prefer (among other important factors) ports and container terminals with good hinterland connections (Wiegmans *et al.*, 2008). From the perspective of the cost of shipping, apart from the reasons for the switching behavior practiced by shipping lines, which influences the final price of the product, hinterland connections are crucial, since hinterland transport costs are usually higher than maritime transport costs (Notteboom, 2009). Hence, along with other components, in order to alleviate the system-wide capacity shortage problem, to avoid disappointment with the overall port performance, it is important to place emphasis on the improvement of transport capacity as well.

4.1.3 Transport Capacity Expansion Alternatives

Struggling to cope with the transport capacity shortage problem by simply increasing the number of container trucks is not a promising solution for the development of a sustainable freight transport process at the port gates. One of the reasons for this is obvious: with the port typically generating around 3,000 truck trips per day, the possibility of road carriers adding more container trucks is limited by the specific constraints imposed by the port's prime geographic location, which has been developed because of its proximity to the city center. Therefore, coupled with both private and public transportation, along with the location of the truck routes leading to and from the port, the transport situation in the port region has become less sustainable in recent times. This is evident from a case study conducted in the port region which revealed that, between 2006 and 2007, the level of congestion of the roads increased from 0.48 minutes of delay per kilometer to 0.55 minutes of delay per kilometer. That same rate of delay per kilometer was still in evidence up to 2009 and the same situation prevails. Such heavy congestion discourages the port authority from further increasing the number of container trucks around the port territory.

On the other hand, among the members of the port community, the limited popularity of other modes of transportation, such as Short Sea Shipping (SSS) or rail transport, allows only restricted options (for many reasons, e.g., some modes are slow) as alternative transport modes. Therefore, in this research, in the search for better alternatives to achieve increased transport capacity, it has been found that only 25-30% of trucks servicing the port carry containers both in and out on the same trip. This means that between 70%-80% of the trucks visiting the port have the opportunity to carry more cargo. This represents an opportunity for the application of the concept of truck-sharing at the port in order to increase the port's freight transport capacity with the help of existing road carriers whilst at the same time minimizing the burden on already congested truck routes.

4.1.4 The Implemented Collaboration Mechanism

Taking all these important issues into account and, in particular, to enhance the port's competitiveness at a regional level and take the full advantage of container trucks running empty, the authority of the case study has found a possible solution. The port authorities, through their subsidiary trucking company, suggested that if any external road carrier took a full container into the port but did not have a full container to bring out, the subsidiary trucking company would pay "a certain amount of money" to bring an empty container back to the dry port (the dry port helps to connect the port with its hinterland via high-speed rail connections). The port's subsidiary company trialed the scheme several years ago, without success, however the outcome of this transport project can perhaps be best understood from a comment by one of the port interviewees, *"So we've tried it a couple of times and every time it just falls over within a couple of months."* Due to the confidential nature of the implemented transport project and the case study port, any detailed description of the project such as its implementation strategies, or the major parties involved, are out of the scope of this study,

4.1.5 Identified Truck-Sharing Constraints

Many truck-sharing constraints (Figure 7) have been explored in this case study. As the interview results have revealed and suggested, one of the reasons for the project failure was that independent carriers had no desire to work for one another, due to a lack of co-ordination in operations and decision-making. However, this situation is not considered to be exceptional in the road carrier industry. As reported in earlier supply chain collaboration studies, that an absence of working together and problems with co-operation exist among the supply chain parties concerned (e.g., Lee *et al.*, 1997). More specifically, the nature and extent of the co-operation problems in the transport industry has also been captured by maritime logistics studies (for an example, see van der Horst and van der Lugt, 2011). The reasons for the problems that exist can be explained by other factors, for example, competition.

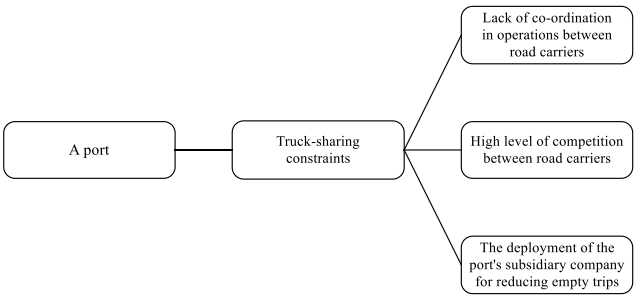

Figure 7 Key truck-sharing constraints for a port

Therefore, another potential contributory factor to the unsuccessful execution of empty trips reduction goals is the high level of competition among road carriers interested in improving their individual profitability and sustainability, without addressing the benefits to the entire supply chain. The respondents were asked to indicate the extent of competition in the transport industry, and one of the respondents (a road carrier) commented on the reasons for the non-cooperative behavior of the road carriers towards each other on a practical level, *"...what they think is that you're trying to take their customers away from you."* The same idea is reflected in an interview with port staff member, *"The trucking company saw, even though they were getting revenue and two-way running, they said 'oh, I don't want to help them out. I'm helping them get their business and they steal my customers'."* As is similar to the interview results identified, the same ideas are also supported in the literature: that an effective implementation of a collaborative solution is influenced by the degree and nature of competition existing within an industry (e.g., McKinnon *et al.*, 2010). This happens because of the trust issue, which has further been elaborated upon in a statement by another port interviewee, *"We've tried to do some of these things before, and it works for a couple of weeks and then, you know, then people say 'oh no, I don't trust the port,' or, 'I don't trust this trucking company, or I don't trust this person.' It all comes down to trust. No one trusts each other in the trucking companies, so none of them want to work together."*

The third and final factor is the deployment of the port's own subsidiary transport company, which competes in the same container transportation industry, in an effort to resolve the empty trips issue. In order to overcome the limitations of the port authority's implemented system, which is perceived to be biased (e.g., to provide additional special benefits to the subsidiary carrier, such as an EDI link from the subsidiary's operations system to the port system) towards its own road carrier according to the interviewees' answers. Hence one of the road carriers suggested the establishment of a neutral third-party authority, *"It's good to have different thinking and we're quite happy to have someone independent looking at it."* However, there was one interviewee from the subsidiary trucking company who perceived that the phenomenon of import-export imbalance is the main reason for the crisis, "*But at the moment that's not working that way because like there is the imbalance of imports and exports or empties. It's really hard one to get that balance right of imports and exports at the moment."*

4.2 Case Study 2: Discussion and Results

The second case study shows the way in which the given load-sharing company continually provides its services whilst observing the port's truck-sharing constraints; this company will have to overcome these constraints in order to successfully fulfil its mission of achieving maximum load-matching capability. To date, this is the only company in the country to provide Business-to-Business (B2B) load-sharing services through its official website at a regional level, and it is gaining popularity within the transport industry. Hereafter, for brevity, the company will be termed "the load-sharing company". The load-sharing company supports loads for many different types of truck (B-train, Truck-trailer, 40-foot unit, Swinglift, 8-wheeler, 6-wheeler, 4-wheeler, Vehicle carrier, and Livestock carrier); loads range from general freight and containers to bulk shipping. Currently, the company has a 40% growth rate and provides services for around 250 road carriers with an approximate number of 650 registered users to list loads on the website. On average, the company connects 200 loads and carriers in every single month. The services offered by the load-sharing company are based on some important benefits that road carriers and load posters (e.g., shipping lines or freight forwarders) should be able to experience: (1) the elimination of empty truck running; (2) improvement in freight efficiency; (3) reduction of unnecessary vehicle emissions; (4) fewer trucks on the road; (5) increase in profits for transport operators; and (6) reduction in the final price of the product sold in the market; in other words, with implementation of load sharing, there is likely to be increased capacity utilization through the reduction in the benefits of empty driving for; manufacturers, suppliers, wholesalers, importers, exporters and many transport companies.

4.2.1 Operational Procedure of the Company

The concept behind the business model of the load-matching company is to provide online services for linking up empty trucks (Table 1) with available loads (Table 2). Therefore, this is an online marketplace that assists in the provision of one off-loads, short-term contracts using the company website. The procedure involves road carriers tendering for the advertised loads. This on-line marketplace works in another way as well; road carriers advertise their available transport capacity, and those advertised capacities are accessed by a group of businesses requiring transportation for their goods. To satisfy the functions required, this online marketplace has dedicated sections for both road carriers and load posters. Registration for the online marketplace is free, there is also no charge for posting loads (to be line hauled across the country) and empty trucks for road carriers and load posters. Another attractive feature of the web-based company is that it allows a high volume freight movers (e.g., shipping lines and freight forwarders) with multiple loads to either tender their total load or to split it into smaller loads at a fixed price. By integrating all these important features, the website is able to showcase an easy-to-use navigation system that keeps users up-to-date with information relating to the latest loads and capacities that are available.

To further elaborate more on the process by which this online market place works: all load posters upload their jobs online. Information entered creates an anonymous

listing detailing pickup, delivery and load requirements. Therefore, any offers submitted remain confidential, and can only be seen by the load poster. The reason for this is that privacy is of paramount important in this transport business. This private, but useful information is then anonymously circulated across registered transport operators that have interests in those regions; operators are asked to either accept a fixed price for cartage or to make an offer on the listed load. If a carrier becomes interested in a particular load, the carrier can privately ask for the price from the load poster. Or, in another case, as stated previously, a load poster can offer a fixed price to the online marketplace for the transportation of a specific load. In both cases, if the road carrier accepts a price, then the transaction takes place between the carrier and the load poster. Once an offer or fixed price is accepted, both parties receive contact details in order to arrange transport, billing, and insurance. Therefore, the carrier receives the exact address of the load poster once a transaction is accepted. The load-shaing system also allows flexibility between both parties. For example, it allows carriers to compare cartage conditions when quoting a job, such as selecting the best possible date and time for transporting goods to complete a job. An acceptance fee is only charged at the point of transaction. Therefore, a load poster in the form of transport user pays commission on top of the quoted transportation price.

Table 1 Available truck capacities

	Available truck capacities								
	Leaving	**Arriving**	**Pickup**	**Delivery**	**Space available**	**Space**	**Weight**	**Type**	**Description**
#000	Location AA	Location BB	24/05/2014	27/05/2014	Empty	100m^3	20 tonne		
#001	Location X	Location Y	29/09/2012	31/12/2016	Empty	30m^3	8 tonne	4-Wheeler, Curtain	4 axle meat rail semi trailer
#200	Location A	Location B	3/04/2013	31/12/2014	Empty	70m^3	20 tonne	Truck – Tailer, Refrigerated	
#300	Location C	Location D	14/07/2013	15/07/2014	Empty	45m^3	27 tonne		
#330	Location XX	Location YY	29/01/2014	30/03/2014	Partially Empty	20m^3	8 tonne		

Table 2 Available loads

	Available loads				
	Leaving	**Arriving**	**Pickup**	**Delivery**	**Load**
#000	Location AA	Location BB	13/01/2014, 12 pm	31/03/2014, 12 pm	Multiple loads
#001	Location X	Location Y	20/01/2014, 12 pm	31/01/2015, 12 pm	Full load
#200	Location A	Location B	10/03/2014, 12 pm	28/03/2014, 12 pm	Full load
#300	Location C	Location D	17/03/2014, 12 pm	15/04/2014, 12 pm	Partially load
#330	Location XX	Location YY	24/03/2014, 12 pm	25/04/2014, 12 pm	Partially load

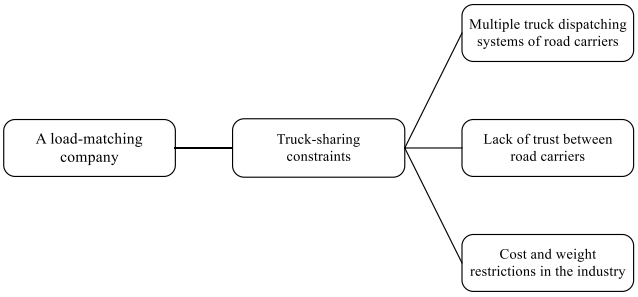

Figure 8 Key truck-sharing constraints for a load-matching company

4.2.2 Constraints of Offering Load-Matching Services

Many interesting constraints (Figure 8) have been explored in this case study in relation to offering load-matching services to customers. One of these constraints is to find ways to best manage technological differences (e.g., multiple dispatch systems) across carriers. For example, a problem may arise in communicating load-matching jobs to those seeking loads, because many of the carriers have dissimilar dispatch software programmes and processes for receiving and handling customers' jobs. Some carriers may not even have a truck dispatching system. One such example came from one of the interviewees (a road carrier) who commented, *"Like all the different carriers they got their own systems."* All these problems lead to the need for developing a sophisticated system for transport planning and the automated management of all transport operations, to track all related activities, from load pickup to delivery at the required destination. Another important technological challenge is to educate carriers and load posters on the use of the load-matching website; an example of this might be, giving instructions for advertising a load on the website.

Another important challenge is the process of establishing a relationship of trust between carriers; this is due to the fact that there are many privacy issues. The interviewee explained further, *"…there are obviously a lot of privacy issues with transport companies not wanting other carriers to have an opportunity to cart for their customers, but realistically they know it's more efficient to sub some loads out."* To overcome the problem, the load-sharing company appointed a Transport Development Manager to talk to potential customers (both carriers and load posters) and to explain the load-matching benefits in a way that can be both compelling and easy to understand; in addition, the Transport Development Manager is able to explain the outcome of a case and the standard procedure involved. Since the load-match company is an independent entity, it is much easier for the company to communicate with carriers, and carriers tend to support the business model more readily than in other instances (i.e., case study port). The interviewee further explained, *"So some people do it with trusted carriers and that's something we're trying to push because we're independent, and then it provides that trust for the carries, but it's a very slow uptake."* In some other circumstances, to manage the privacy issues

surrounding the use of extra transport capacity, the load-sharing company suggests delivery from depot to depot, rather than delivery from the depot to the customer; this is to ensure that the customer is unaware of the identity of the person/company to whom the job is billed.

The other two truck-sharing constraints are cost and the weight restrictions of trucks. For example, sometimes a carrier will reject a delivery because the offered price is too low to justify the cost of delivering the required load. The other problem is the weight restriction imposed by the Government. The interviewee confirmed this limitation relating to truck-sharing, *"At this stage you can only get permits for heavier trucks, even though those trucks are equipped to take larger volumes we're limited by the government rules on the weights."*

4.3 Cross-Case Comparisons & Findings

The comparative analysis of the two case studies reveals both overlapping and context-specific barriers that hinder the implementation of truck-sharing initiatives in the container transportation ecosystem. A common set of constraints, namely, a pervasive lack of trust among stakeholders, limited coordination mechanisms, and technological fragmentation, emerged across both cases. These shared challenges or difficulties point to broader systemic issues that transcend organizational type or market position. However, the unique or distinct institutional settings of the port authority and the load-matching company give rise to exceptional operational challenges that warrant targeted strategic responses and interventions.

In the case of the port authority, truck-sharing initiatives were undermined by behavioral and structural challenges. Primary among these were the absence of a neutral coordinating body and the deployment of the port's own subsidiary carrier, which created perceived biases and competitive distrust among independent carriers. This lack of institutional neutrality, coupled with inter-carrier rivalry and limited willingness to collaborate, restricted the feasibility of sustained joint operations.

In contrast, the load-matching company faced a different set of operational barriers. While it benefited from its role as an independent digital facilitator, it encountered challenges related to system interoperability across diverse dispatch platforms, technological literacy gaps among users, cost sensitivity, and regulatory restrictions, particularly weight limitations imposed by government policy. Nevertheless, the load-matching company demonstrated a more scalable and adaptive model, supported by transparent mechanisms and market-based incentives that fostered gradual trust-building and engagement among carriers. Its digital approach allowed for a degree of anonymity and flexibility in interactions that reduced barriers associated with competition and confidentiality, making it comparatively more effective and efficient in enabling partial collaboration.

What distinguishes the two cases is not only the nature of the constraints but also the underlying organizational logics that shape stakeholder behavior. The port authority represents a traditional, infrastructure-driven institution with embedded hierarchies and limited flexibility. In contrast, the load-matching firm embodies a decentralized, technology-driven approach with built-in flexibility and lower barriers to entry. These differences illustrate that while both models seek to reduce empty truck trips and improve transport capacity utilization, their success depends on context-sensitive execution strategies. The load-matching company's success lies in its ability to act as a neutral platform that leverages technology to bridge gaps in coordination, whereas the port's hierarchical governance model struggles to foster trusts for inter-firm collaboration.

Furthermore, the cross-case synthesis highlights the important role of incentives, governance structures, and stakeholder alignment in shaping the outcomes of truck-sharing initiatives. For instance, financial incentives alone, without addressing the foundational issues of trust and neutrality, are insufficient to overcome competitive tensions in institutional settings. Similarly, technological solutions must be accompanied by user education, interoperability protocols, and regulatory adaptability to support partnership. This implies that technical efficiency must be embedded within a broader socio-organizational framework.

From a practical standpoint, these findings suggest that hybrid models integrating both institutional authority and digital facilitation, such as a port-supported but independently governed platform, may offer a promising path forward. Such models could leverage the legitimacy and infrastructure of port authorities while benefiting from the flexibility, trust-building features, and transparency of digital platforms. Moreover, policy support will be essential to standardize data-sharing practices.

In conclusion, an effective truck-sharing framework requires more than technological platforms or financial incentives; it demands the institutional legitimacy of a neutral coordinating agent, robust inter-organizational trust, and standardization of communication and dispatch systems. The synthesis of findings across these two cases thus contributes to a nuanced understanding of how behavioral, structural, and technological barriers interact differently across institutional and entrepreneurial settings. These interesting insights offer a strong foundation for guiding policymakers and practitioners in designing tailored interventions that support the development of collaborative, sustainable freight-sharing ecosystems.

4.4 Managerial Implications

In order to focus on the severity of the empty container repositioning difficulty (similar to the empty truck trips problem, which to a considerable extent, also generates unproductive empty vehicle miles). The study by Mittal (2008) described the situation, *"This has created longer trips for the truckers every time they haul the empty container to-and-from the regional customers to the depots, resulting in excessive empty vehicle miles travelled, congestion and pollution in the port area."* It is important to address all of these socio-economic issues (e.g., vehicle miles travel, congestion and pollution) in order to make a specific and pragmatic contribution to the supply chain domain. Hence, to further innovatively contribute in this supply chain field by introducing progressive ideas, and to assist practitioners in the adoption of the truck-sharing concept in order to reduce the chances of incurring empty trips by container trucks, this research paper aims to analyze the pros and cons of sharing a container truck by identifying its most important characteristics, such as the constraints of the concept. At this point of the summarized

discussion, in order to fill the research gap in truck-sharing constraints on the current crucial topic of freight transportation of the supply chain, it is vital to evaluate the issues that similar to this one be addressed, including the implications for qualified practitioners. The port's failed pilot highlights the importance of neutral coordination mechanisms, while the success of the load-matching company illustrates the effectiveness of independent facilitation and transparent platforms. These insights provide practical guidance for practitioners seeking to develop collaborative freight-sharing systems.

5. CONCLUSIONS

The expected role of a port in its supply chain is in question in today's rapidly changing business environment because a system-wide capacity shortage problem is an emerging issue for the major ports of the world. Among the problems arising, which are evident because of capacity shortage issues, there is an increased necessity for transport capacity for containerized goods; this is one of the most important issues to be addressed. Following the relative importance of increasing transport capacity, an important opportunity worthy of consideration is the huge number of empty truck trips that occur in a port. Financially unproductive, and thus wasted, empty trips represent an opportunity for the capacity needs of all shippers, and thus, the improvement of supply chain outcomes.

Paying attention to all the limitations of the published studies, and in order to fill the gaps in the literature in this regard, it is worth noting that the empty trips problem is also to a certain extent, addressed in other research domains. To take a closer look into this little-researched phenomenon of empty truck trips and to evaluate the potential of truck-sharing ideas from a real-life perspective, this research explores the truck-sharing constraints using two case studies. Therefore, in this current study, a new insight has been pursued in relation to the empty trips problem, and the exploration of truck-sharing constraints in a way that is dissimilar to that of previous studies (in which truck-sharing constraints were explored from the perspectives of container road carriers). For example, in one of those two case studies, the study includes the data provided by a prominent local port to explore truck-sharing constraints, and in another case, the study analyses the data provided by a leading load-matching company. The combined results of those two case studies contribute to the use of truck-sharing initiatives for leading high-volume container terminals, where, among many other factors, transport capacity shortage is a continually growing concern.

As a result, in brief, the truck-sharing constraints identified for the perspective of a port are: coordination problems between the carriers, a competitive container transportation industry that lacks mutual trust, and the lack of the deployment of a neutral subsidiary company to oversee the empty trips issue. The truck-sharing constraints for the load-matching company are: the diverse truck dispatching systems of the carriers, a lack of trust between carriers, cost barriers and the weight restrictions imposed by the Government. Based on these interesting results, it can be further argued that the port case study results failed to reveal significant differences with the goal of helping road carriers in the reduction of the number of empty truck trips by offering a mutually acceptable approach to the transportation industry. Conversely, the load-matching company's case study shows the effectiveness of a collaborative approach in addressing the same empty trips issue. By highlighting the behavioral, structural, and technological barriers observed in both institutional and entrepreneurial settings, this study advances the discourse on truck-sharing in port logistics. The comparative nature of the findings adds depth to an area with limited empirical evidence and demonstrates that addressing trust, neutrality, and compatibility is vital for implementation success.

As a future research direction, efforts should be made to gain further clarity to determine the nature of the difficulties that road carriers and shippers experience in the sharing of containerized freight transportation. Through further investigation, it would also be important to note the differences between the maritime and non-maritime industry, and to take into consideration the features of the maritime industry, for instance, the configuration of a type of truck may vary from industry to industry.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to this research.

DATA AVAILABILITY STATEMENTS

The data supporting the findings of this study cannot be shared publicly in order to protect the anonymity and confidentiality of the interviewees.

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