

COLLABORATION IN LOGISTICS FOR EMPTY CONTAINERS

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ABSTRACT

Between 2001 and 2011, the volume of seaborne container transit doubled, from 59 to 118 million TEU. Because not all import sites have the same level of demand for exporting containerized cargo, the need for empty container repositionings is also influenced by the demand for container transit. Empty containers must therefore be moved from areas with excess equipment to those with deficits. Approximately 25% of all containers that are shipped are empty, which cost USD 33 billion in 2011. Reducing those costs is essential for carriers because the industry's overcapacity has put pressure on margins and empty trips are sometimes not covered by the shipper.

While ideas linked to technology, price, and operations research have been widely adopted, cooperative solutions have not gotten much practical attention. According to the literature, this is because the advantages of this kind of approach are still being demonstrated.

According to the network model, we think that a carrier's equipment swapping between surplus and deficit locations will cut down on the number of empty transfers needed. The study, which is the first to empirically examine the possibilities of equipment interchange, will show that 5–10% of transfers can be avoided. As a case study, the analysis is based on real container movements that were gathered from nine international container carriers. By demonstrating the advantages of equipment interaction, we aim to encourage additional carrier collaboration.

1. INTRODUCTION

The number of containers transported by sea worldwide doubled from 59 million to 118 million TEU between 2001 and 2011 (Drewry Maritime Research, 2012; Global Insight, 2011). Shippers need empty equipment to do containerized transfers; if it is not accessible, it must be moved to the export location (Di Francesco, Crainic, and Zuddas, 2009, p.758). These repositionings move empty equipment from surplus to shortage zones, which helps to absorb the transport imbalances (Moon, Do Ngoc, and Konings, 2013, p.107). But there are a lot of empty repositionings: 40% of all equipment moved by land is empty, while every fifth container carried by water is empty (Konings et al., 2001, p.334, Karmelic, Dundovic, and Kolanovic, 2012, p.223). 82 million containers were loaded and unloaded in ports in 2005 alone (Vojdani and Lootz, 2011, p.2). In 2011, carriers alone incurred expenses of USD 33 billion due to empty logistics (Notteboom and Rodrigue, 2008, p.167; Vojdani and Lootz, 2011, p.2). This amounts to 7–10% of carriers' operating costs. Therefore, empty container logistics demands a lot of work from carriers and merits their consideration. The effectiveness of carriers' empty logistics is essential to their overall profitability due to their low earnings at the moment (Flämig, Wolff and Herz, 2011, p.5; Olivo, Zuddas, Di Francesco and Manca, 2005, p.367; Feng and Chang, 2008, p.470; Lam, Lee and Tang, 2007, p.265; Song and Carter, 2009, p.292).

There are several methods to achieve this efficiency. Logistics, technology, price, and management/organization are all factors that can lower the carrier's expenses while shipping empty containers. These levers can be divided into two categories: those that increase transport efficiency (for example, by enhancing network architecture) and those that decrease the number of necessary empty transports. Both internal and exterior (cooperative) strategies are used.

Managerial and organizational levers, particularly cooperative ones, are hardly applicable in practice despite having extensive theoretical study, whereas logistical, technological, and price levers have garnered substantial attention and are extensively used.

It is challenging to conduct equipment swapping or even sharing for a number of reasons. First, and possibly most importantly, literature suggests that switching equipment won't cut down on the number of empty repositionings needed if carriers have identical imbalances (Lun, Lai, and Cheng, 2010, p.161). "Future research could identify cost-saving opportunities from cooperation among carriers," according to Braekers, Janssens, and Caris (2011, p. 697). In order to eliminate one of the biggest obstacles to collaboration in empty container logistics, the upcoming chapters will attempt to provide an answer to this question.

2. PROBLEM DESCRIPTION

Root causes for empty container logistics

Transporting containerized shipping requires empty equipment. Transport cannot take place if the shipper is unable to fill a container with empty equipment. Therefore, in the event that supply is insufficient empty containers must be moved to an export site. The four main root causes of empty container logistics are the large number of equipment owners, equipment type imbalances, seasonal transportation demand, and structural trade imbalances (Song and Dong, 2011, p.92; Olivo et al., 2005, p.4).

Empty container transportation is mostly caused by imbalances in regional and global trade. A region is automatically underbalanced in terms of containers if its containerized exports exceed its imports (Boile, Theofanis and Mittal, 2004, p.3; Hüttmann, 2013, p.31; Pawlik, 1999, p.119; Bandeira, Becker and Borenstein, 2009, p.383). This phenomena causes imbalances around the world. Every trade, such as transportation between two regions, might be unbalanced in addition to the regional imbalance, necessitating empty repositionings even in regions that are generally balanced (Brito and Konings, 2011, p.1; Diaz, Talley, and Tulpule, 2011, p.218).

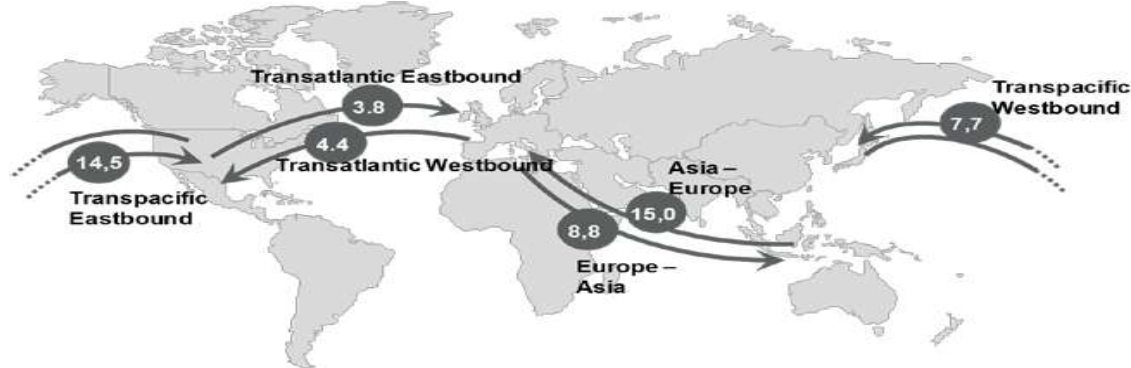


Fig. 1: Container flows 2012 in million TEU (Drewry Maritime Research, 2012)

The transpacific trade and the commerce between Europe and Far East Asia are the most significant examples of global imbalances. In both situations, the imbalance is brought on by Far East Asia's export surplus. The Far East and North America are connected by the Transpacific trade. There was a 6.8 million TEU trade imbalance (and hence a need for empty repositioning) in 2012, as 14.5 million TEU were shipped toward the east and only 7.7 million TEU were shipped in the opposite direction. The trade differences between Europe and the Far East is comparable. According to Braekers, Janssens, and Caris (2011), p.681, empty repositionings also take place inside an area. Whereas industrial centers frequently export more cargo than they import, necessitating the relocation of more empty containers, urban regions typically import more cargo, resulting in a surplus of empty containers. Additionally contributing to trade imbalances are weight disparities among the export cargoes of the regions (Konings, 2005, p.224; Olivo et al., 2005, p.204; Hüttmann, 2013, p.35).

Temporary imbalances can still be seen in a trade that is balanced over a year. These "temporal imbalances" are caused by seasonal cargo flows. Seasonal products (fruits and vegetables) or special occasions, like the Chinese New Year, are usually the cause of such flows. Between Northern Africa and Europe, as well as between Latin America and Europe, there are significant seasonal transports in trade (Lei and Church, 2011, p.754; Braekers, Janssens, and Caris, 2011, p.681; Olivo et al., 2005, p.204; Hüttmann, 2013, p.35; Konings, 2005, p.224; Karmelic, Dundovic, and Kolanovic, 2012, p.223). According to Song and Dong (2011), "operational imbalances" may result from cargo requirements in addition to overall trade surpluses or deficits (p.92). Special equipment is needed for some types of cargo; for instance, perishable cargo must be transported in reefer containers. However, in order to reduce cargo handling costs, light goods is better transported in 40-foot containers rather than 20-foot ones (Song and Carter, 2009, p. 294). Even on an otherwise balanced transaction, equipment must be moved empty if one export location demands a certain sort of equipment that cannot be used for the subsequent export of the previously receiving location.

The variations may also be increased by the trade patterns of the various actors who own the containers. While "company specific imbalances" result from each company's own client mix and trade structure, regional, temporal, and operational imbalances can be categorized as structural imbalances. Even in a location that is generally balanced, empty transports are frequently needed because, in theory, each owner only utilizes their own equipment. To a certain degree, company-specific imbalances can be prevented because they are not structurally based. The possibility to lessen empty repositioning brought on by imbalances unique to a company is examined in this research (Shintani, Konings, and Imai, 2010, p.762).

EFFECTS OF EMPTY CONTAINER LOGISTICS

Since empty containers must be relocated due to any imbalance, empty logistics has substantial dimensions and is therefore an important part of any carrier's design. Approximately 40% of all inland movements and 22% of all containers moved at sea are empty (Mongelluzzo, 2004, p.10; Shintani, Konings and Imai, 2010, p.750; Crainic, Gendreau and Dejax, 1993, p.104). This has an impact on society, the environment, and businesses. The expenses of empty relocation are high for carriers. Carriers' direct expenses for empty container logistics was USD 33 billion in 2011. These direct expenses consist of the cost of container maintenance and repair as well as transportation and terminal fees. In addition to these direct expenses, empty repositioning results in indirect expenses like greater expenditures for a larger fleet of equipment and more work on the administrative side. Other actors, including leasing companies, shippers, and terminal and depot operators, are also significantly impacted by empty container logistics (Lun, Lai, and Cheng, 2010, p.151). However, empty container logistics also have an impact on society and the environment, primarily because empty transfers result in more traffic overall. Infrastructure bottleneck use is already high, and more traffic raises emissions and infrastructure consumption (Flämig, Wolff, and Herz, 2011, p.49). Finally, non-renewable fuel is wasted as a result of needless transportation (Hüttmann, 2013, p.52).

RESEARCH GAP

Literature has given the subject of empty container logistics a great deal of attention. Brito, Konings (2011) and Hüttmann (2013) have up-to-date summaries. The earliest records of containerized cargo shipping date back to the 1970s (White, 1972; Ermolev, Krivets and Petukhov, 1976; Pezier, Cresswell and Davenport, 1979). Since then, however, attention has not changed. Empty repositioning's expenses and efforts in particular have been extensively explored (Olivo, Di Francesco, and Devoto, 2003; Notteboom and Rodrigue, 2008). The majority of publications share a characteristic of providing both possible solutions and a description of the consequences of empty container logistics. As previously demonstrated, these strategies fall into two categories: external (cooperative) and internal (optimizing). Additionally, they can be categorized into methods for preventing and effectively carrying out empty container transports (figure 2).

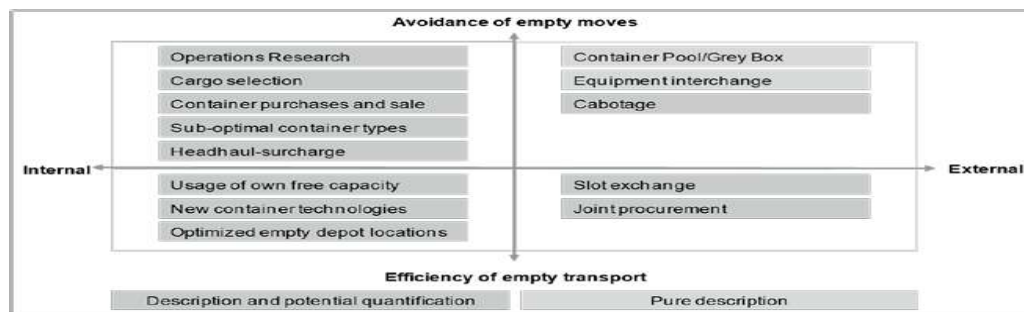


Fig. 2: Status of research on carriers' empty container strategies

In order to carry out empty container transportation effectively, both internal and cooperative procedures have been thoroughly described and perhaps quantified (Song and Carter, 2009, p. 292). Cooperative solutions to prevent empty transfers, however, have not received much quantitative research. According to Dang, Yun, and Kopfer (2012, p. 708), "[...] little research has been published on the coordinated optimisation of empty container positioning [...]" describes the current state of research. The reasoning behind using equipment interchange to reduce the number of empty transportation needed has been explained by a number of authors. Boile computes a theoretical potential (2006, p. 65f.). A mathematical model is established by Song and Carter (2009, p.301f.) employing a fictive imbalance-breakdown for personal carriers. Neither author performs a thorough qualitative analysis using real data. Even fewer empirical studies have been done on grey-box or container pools. The idea is to transfer equipment ownership from an individual carrier to a separate third-party business. The early 2000s saw the beginning of theoretical discussions of this tactic (Hanh, 2003; Lopez, 2003, p. 350). Although Mongelluzzo (2004) outlines the benefits of equipment pooling, he also finds major obstacles to implementing this type of collaboration. Other writers that have written about equipment pooling in container shipping include Hüttmann (2013), Ferulli (2010), Notteboom, and Rodrigue (2008). Song and Carter (2009) evaluated the possibility of equipment pools as well, but they did so using hypothetical data and at the level of aggregated commerce. The dearth of quantitative studies on the possibility of equipment interchange is summed up by Braekers et al. (2011, p.697): Future studies may find ways for carriers to work together to save money [...]. Technological advancements [...] appear to be intriguing possibilities to ease and/or lower the expenses associated with empty container handling. The possible cost savings of these technologies, however, have not received much attention up to this point. Lastly, the majority of studies adopt the viewpoint of a single shipping firm or ocean carrier.

3. RESEARCH METHODOLOGY

The network model suggests that carriers can minimize the number of empty moves needed by exchanging equipment (Weber, 2008, p.63; Delfmann et al., 2010, p.45; Vahrenkamp, Kotzab and Siepermann, 2012, p.10; Klaus, Krieger and Krupp, 2012, p.445; Doborjginidze, 2005, p.21). Through a case study, this paper will evaluate how carrier-to-carrier container interchange affects the overall number of empty transfers needed in the system. Real empty container transportation information was gathered in order to fill the research gap—the absence of a quantitative capability analysis. In 2012, eleven international carriers of empty containers were asked to submit their transports. Nine carriers actually took part, and they gave thorough information about their empty travels. The sample is very use able, as these nine carriers account for around 46% of the global container carrier fleet (Alphaliner, 2013). Carrier participation in the sample spans all pertinent international shipping regions.

Every empty container movement was documented, together with the month, the equipment size and type, the carrier name, and the starting point and destination locations. For this study, approximately 35 million vacant container moves were supplied. Since the various refer solutions make an interchange easier than for dry equipment, only dry containers have been investigated.

Theoretically, a carrier with excess empty cargo (i.e., more equipment than required to convey the export cargo) could give this equipment to another carrier with a container shortfall. From a system perspective, an equipment exchange would make sense in this situation, but individual shippers may still decide not to supply containers for competitive or self-optimization reasons. However, if both companies' containers were controlled by someone else, the decision to exchange them would be based on system optimization rather than the preferences of any one carrier. In order to evaluate the possibility of equipment exchange between carriers who still own their equipment, analysis of the equipment's destination has been left out. Since this would be the starting point for any upcoming shipments, those carriers would have to know the location where they would receive their equipment back. However, this company would have to handle all shipments regardless of the equipment's provenance if all the equipment was owned by a single entity.

The term "match" refers to any avoidable empty import or export. Three criteria must be satisfied for a match to be considered in this analysis. The import and export from a specific location must first come from two distinct businesses. Second, the machinery type and size of the containers must match. 3. The import and export must take place in the exact same month of 2012. A prospective match will be considered for the analysis if those requirements are satisfied. The next chapter describes the empirical analysis's findings.

4. CASE STUDY RESULT

Approximately 35 million moves in 308 geographic clusters were examined in total, spanning all areas. Whether the empty container flows of the various carriers had opposite directions in the same month of 2012 was evaluated in detail. According to a sample that represents about 45% of the global market, more than two million empty moves might have been prevented in 2012 by liners trading equipment with one another if the above-mentioned conditions for a successful match had been followed. This is equivalent to 6% of all empty moves.

Exchanges of equipment are possible in every region. The number of clusters that lacked matching potential was just 95. Of these, 45 clusters had only one active carrier, which precluded any collaboration. As a result, only fifty clusters exhibit equivalent imbalances across all carriers. North East Asia, the third largest containerized activity region, has 2% of empty moves, but Europe and North America have 13% each, the highest relative matching potential. Between three and seven percent of avoidable empty transportation are seen in the majority of other locations.

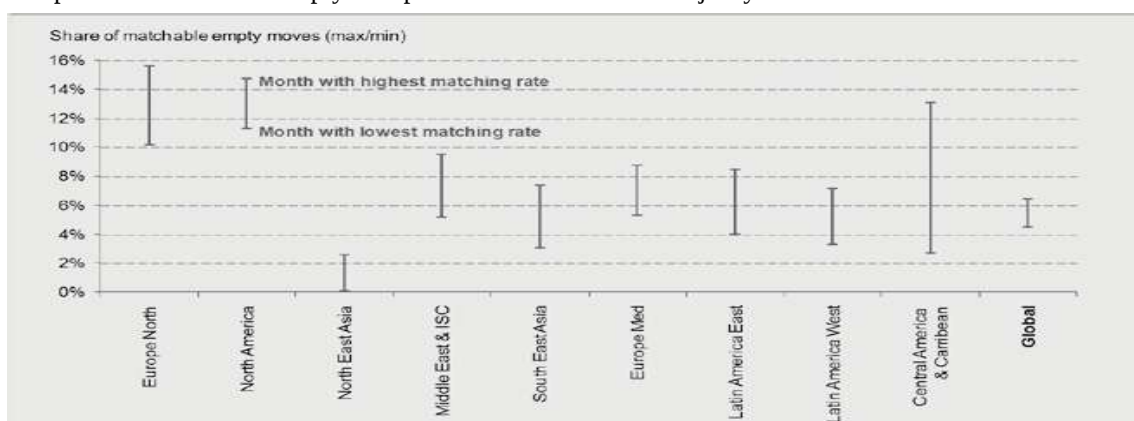


Fig. 3: Range of monthly shares of avoidable empty moves per region

5. DISCUSSION

The effect of sharing container technology on the quantity of empty container transfers needed is measured in this study. Cooperation among carriers or a joint equipment-owning unit has been demonstrated to reduce the number of necessary moves. The reason for this is that carriers have varying equipment imbalances, which means that some of the imbalances are company-specific. According to Lun et al. (2010) and Theofanis, Boile (2008), among others, the majority of imbalances are assumed to be similar among carriers (Theofanis and Boile, 2008, p.59; Lun, Lai and Cheng, 2010, p.161). This indicates that 6% of imbalances are company-specific, which in turn quantifies the prevalent perception in literature. However, this study additionally shows that a sizable portion is company-specific and, therefore, preventable. This study also fills a research gap by responding to Braekers, Janssens, and Caris' (2011, p.697) request to determine the cost-saving prospects from equipment interchange.

The study's findings also provide validity to the study of collaboration in empty container logistics by dispelling the main objection to the suggested solutions (such as equipment swapping, container pooling, etc.), which is that all carriers have comparable imbalances. This also applies to practical cooperative solutions. By demonstrating its potential, this study could aid in removing one of the main obstacles to collaboration in empty container logistics.

6. CONCLUSION

Since this report showed how transferring equipment in empty container logistics might save money and transportation, the study was carried out after the fact. In other words, every empty move was predictable. Since not all equipment surpluses and shortfalls are predictable to the degree required to swap equipment, it is appropriate to refer to this potential as theoretical since it is unlikely that more than a portion could be achieved in actuality.

Even so, this study provides a useful hint because it demonstrates the absolute maximum value of an equipment pool and the benchmarks against which any equipment pool might be evaluated. Future studies should contrast the ex-post analysis's theoretical promise with the potential that has been actually realized in other industries (such as pallet pools and airfreight containers). The behavioral components of equipment interchange are also purposefully ignored in this research. For instance, a business may be reluctant to share its technology due to competition concerns.

To enhance the practical significance of the demonstrated outcome, future studies should additionally look at the factors that influence the possibility for cooperation. As seen, there are notable differences in the percentage of preventable empty moves across different geographies, equipment kinds, and historical periods. Therefore, if it was evident what drove the potential—that is, what criteria impact whether an equipment interchange is promising—the value of an equipment pool could be improved.

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