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Research on empty container allocation problem of small-scale liner shipping company in China

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RESEARCH ON EMPTY CONTAINER ALLOCATION PROBLEM OF SMALL-SCALE LINER SHIPPING COMPANY IN CHINA

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): ______________________

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ABSTRACT

Title of Research paper: **Research on Empty Container Allocation Problem of Small-scale Liner shipping company in China**

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According to Drewry Shipping Consultants, from 1998, the ratio of empty containers to total containers handled increased beyond 20 per cent, and this imbalance has lasted until today. The analysts say that the net cost of moving empties is around $7 billion a year.

Owing primarily to the chronic trend of increasing trade imbalances, the efficient and effective management of empty containers has become a critical matter for the liner shipping company, whether the company is large or small.

The purpose of this research paper is to study empty container allocation problem faced by those relatively small-scale liner shipping companies in china. First of all, an overview of empty container problems is taken, including the subjective and objective factors that affect the empty container movements. Then, the empty container allocation problem of relatively small-scale shipping companies in China is analyzed through SWOT Analysis, and strategies that may affect the empty container allocation are considered.

KEYWORDS: Empty container allocation, Trade imbalance, SWOT Analysis, Small-scale liner shipping company

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

TEU	Twenty-foot Equivalent Unit
CFS	Container Freight Station
CY	Container Yard
ISO	International Organization for Standardization
CSCL	China Shipping Container Lines Co., Ltd
LSCI	Liner Shipping Connectivity Index
EIR	Equipment Interchange Receipt

Chapter 1 Introduction

1.1 Background

Empty containers must be shuffled around the world to be refilled, requiring millions of ship, truck and rail journeys that yield no revenue.

"It's a huge expense, a huge headache for the industry," says Neil Davidson of London-based Drewry Shipping Consultants. The net cost of moving empties is around $7 billion a year, say analysts (Miller, 2010).

Container shipping has experienced a rapid development in the last few decades. From 1990 to 2008, container traffic, that is the absolute number of containers carried by sea reflecting the level of trade activity, has increased by 430 percent, from 28.7 million TEU to 152 million TEU. In the same period of time, the global container throughput, that is the ideal number of container movements reflecting the level of transport activity, grew from 88 million to 530 million TEU, an increase of 500 percent. In 2008, about 100 million TEU are empty containers (Rodrigue, Comtois, & Slack, 2009). What factors may cause cargos the huge increase in the number of container movements? First, more and more cargos have been containerized in the past 20 years. The utilization of containers helps to increase cargo handling efficiency and reduce port time. Second, world trade becomes more and more imbalance. That means more and more empty containers have to be transported from surplus regions to deficit places. Thus the number of empty container movement increase. For example, on the Asia-Europe route, European ports, like Rotterdam ports, are facing a high surplus of empty containers. While the Asia ports are confronted with big shortages. Last but not least, with the increase of the scale of the container ships, more and more mega-ships are put into service. That reshaped the container shipping networks towards hub-and-spoke systems. Thus the number of transshipments in the hub ports increase.

There are well over 20 percent of all ocean container movements involving repositioning empty containers transporting from sufficient countries to deficit regions. It is a big problem to the liner shipping companies. It is necessary to point out the economic difference between empty and loaded movements. Empty movement is unavoidable in the freight distribution process because the world trade seems never to be in balance, either in volume or value. Besides, it is also an unavoidable activity of the intermodal chain. In reality, import containers that reached a national port are delivered towards a multiplicity of interior destinations. After stripped, the empty containers must send back to a port to accomplish an export voyage (Lopez, 2003). So the liner shipping company must relocate the empty containers on a local, national and global scale (Olivo et al., 2005). And the cost, which generated by the empty movement, will only be borne by the carriers. Under this situation, liner shipping companies need to pay huge amount of expenses. The payment includes the labor cost, loading, handling, stowing, carrying, keeping, discharging the empty containers and the increasing consumption of fuel, which directly increase the world fleet running cost and affects the development of the liner shipping companies, etc. That means the profitability of a shipping liner company, to a large extent, depends on whether the empty repositioning cost is recoverable or not (Song & Carter, 2009).

1.2 Why study the empty container repositioning problem is important

Since the global maritime logistics market is full of competitive and very complex, global empty container movements has always been a challenging problem in container transportation.

According to Drewry Shipping Consultants, empty containers represent about 23 percent of port handlings worldwide in 2002. This percentage has kept quite consistent for the last decades. And Drewry see no significant reduction in the foreseeable future. According to the survey, it was estimated that the number of global container throughput was 201 million TEU while the empty container throughput occupied about 41 million TEU. Assume that the average cost of empty container movement was $288 per TEU (Drewry, 2002). The liner shipping companies have to pay about $11.8 billion. Meanwhile, empty containers occupy number of slots on vessel. It results that liner shipping companies lose opportunities to yield freight revenue. In today’s high competitive shipping market, shippers have more choices. In order to largely satisfied the uncertainly in demands, the carrier have to find a better way to solve the problem on empty container repositioning.

On the other hand, the problem of repositioning empty containers affects not only shipping companies, but also ports and depots. It directly decreases terminal productivity. And it costs millions of dollars to expand container terminals, which occupy valuable land adjacent to ports and used to store empty containers.

To conclude, the efficient management of empty containers is crucial in the entire shipping network. Thus, if a relatively small-scale shipping company want to survive in this industry, it is necessary for them to find a better way to allocate the empty containers.

1.3 The research purpose of this paper

Many scholars have a deep substantial scientific research on the problem how to optimize the empty container allocation during the last fifteen years. In this paper, I will not do a deep academic research. To me, I want to do a relevant research and analysis of some small-scale shipping lines in China, and try to find some reasonable strategies to relieve their problem.

The research purpose of this paper is to: identify the critical factors that affect empty container movements; to figure out the problem of the empty container movement faced by those small-scale liner shipping companies; and to find strategies to relieve the problem.

In the second section, relevant literature is reviewed.

Chapter 2 Literature Review

Empty container repositioning became an on-going issue since the beginning of containerization. But the problem is more and more significant these years. In the following section, the relevant literature will be reviewed.

White W.W. and Bomberault A.M. (White & Bomberault, 1969) are those of the earliest scholars who researched the problem of empty container transportation. They tried to figure out how to distribute empty freight cars throughout a railway system. The actual movement of empty containers can be examined through a space-time model. Through utilizing the space-time diagram, an inductive network flow algorithm is developed. Meanwhile, they used examples to illustrate this problem. It just applied to simple railway transport. Then White W.W. (1972) used linear programming formulations to research container fleet management. The approach is essentially dynamic in time.

Crainic et al. (1993) built up a dynamic and stochastic model for empty container allocation and distribution between a land transportation and international maritime shipping network. Because of the large number of decision variables, they suggested the length of planning horizon be limited to between 10 and 20 periods in order to get computationally convenient models. In order to select a proper length of planning horizon, it is essential to take the information on the future supply and demand of empty containers into account.

Shen and Khoong (1995) established a decision support system to solve a large-scale planning problem of the distribution of empty container. They developed a network optimization model for empty containers to minimize movement cost and provide decisions on the business aspect covering leasing and returning containers from external sources. They used the day as time-period of a dynamic network and just one type of container is considered. The paper does not consider the technical aspects.

Lai et al. (1995) used a simulation model to solve the problem. They consider minimizing the cost of leasing, loading and the inventory of the empty containers. And they focus on empty containers moved from ports in the Far East to the ports in the Middle West.

Cheung and Chen (1998) compared a two-stage deterministic model with a two-stage stochastic network model for the dynamic empty container allocation problem. The two-stage model helps the liner operators to allocate their empty containers and finally reducing their inventory level and leasing cost at ports. They conduct some experiments with rolling horizons. It concludes that a longer planning horizon is not necessarily better than a shorter horizon. They find solutions in some cases improved, but in some cases worsen, when the planning horizon is lengthened.

The research on the management of empty containers for intermodal transportation networks is not so much. Sook Tying Choong, Michael H. Cole and Erhan Kutanoglu (2002) build up modals to analyze the planning horizon problem related to the tactical management of empty containers for intermodal container-on-barge transportation networks. To their conclusion, a longer planning horizon could inspire the use of inexpensive slow transportation modes.

Lopez (2003) tried to reposition the empty container of the ocean carriers, who is in USA, by investigating the organizational choices of them. This paper is primarily about the carriers' relationship with those inland transport companies. This paper analyzes the costs of each way of externalization, the environment that frames the rail industry and the geography of the USA, force ocean carriers to be part of contracts.

Li et al. (2004) examined the structure of empty container allocation in a single port. The paper addressed the problem of how many empty containers are unnecessary at any one port. And the paper does not consider the transportation problem.

Cheang and Lim (2005) used a minimum cost flow model to solve the problem of the dynamic distribution of empty containers with and without third party leasing from another company.

Olivo et al. (2005) used an integer programming model to solve the problem of empty container management in ports and depots. They adopt an hourly time-step in a dynamic network. Though it generates large-size instances, the two algorithms show a good computational efficiency. According to the model, the decision-makers can decide when to borrow, lease, purchase or give away the containers.

Koichi et al. (2005) designed the liner shipping service networks by considering deploying ships and containers simultaneously. The two key and interrelated issues are often considered separately by most existing design of networks. The problem is examined as a two-stage problem. In this paper, the author assumed when empty containers do not arrive at the demand points in time, necessary empty containers are leased.

Chou (2006) tried to use the mathematic programming method to establish a model for solving the empty container allocation problem. In this paper, Chou did a case study about the long-haul service. His objective is to minimize the cost of the empty container on service route.

Song (2007) considers a periodic-review shuttle service system with random customer demands and finite reposition capacity. He demonstrated the threshold structure of the optimal empty container repositioning policy for two-depots service systems.

Song and Dong (2008) considers the empty container management problem in a cyclic shipping route. A three-phase threshold control policy is developed to reposition empty containers in cyclic routes. Three studies show that, in some situations, simple inventory-based repositioning policies can perform well.

Dong-Ping Song and Jonathan Carter (2009) address the empty container repositioning problem at a micro scale from an ocean carriers' point of view. With the assumption that trade demands could be balanced among the whole network regardless the identities of individual shipping lines, they applies four strategies to quantify the optimistic estimation of empty container movements under three major shipping routes (Trans-Pacific, Trans-Atlantic, Europe-Asia). To their conclusion, external-container-sharing and internal-route-coordination mechanisms can alleviate the degree of empty container movements and reduce the repositioning cost, not eliminate.

Although the container utilization rates have increased since 2004, utilization still depends on the very dynamic nature of container leasing, building and transportation. Sotirios Theofanis and Maria Boile (2009) analyze the empty container transportation at a local, interregional, regional and global level respectively. They consider the key factors that have an impact on the empty container management. Also, they consider improving the management of empty containers by strategies, which are implemented by ocean carriers and other stakeholders.

Eugene Y.C. Wong, Henry Y.K. Lau and K.L. Mak (2010) use immunity-based evolutionary algorithm (IMEA) to solve the multi-objective container repositioning problems in this research.

A large number of literature reviews present the solution to solve the problem of empty container movement. Some of them establish different types of models, including mixed integer programming models and network flow models etc. And some of them are using internet-based support systems such as InterBox and SynchroNet, which are provided by third-party vendors. Apparently a large majority of them seem to achieve effectiveness of empty container operations and reduce cost. But the problem was by no means resolved permanently. The mitigation of this problem still be a research topic.

Chapter 3 An overview on empty container allocation problem

3.1 An overview of container transportation

3.1.1 Brief introduction of container

Container is a standardized reusable box used for the safe, efficient and secure storage and movement of materials and products within a global containerized intermodal freight transport system. It helps the cargo much more convenient and faster to handle and more economical to move. Because standardization makes containers could be applied to the whole transport operation, and the container could be easily transferred from one part of the transport system to another by high speed cargo handling facilities. It also has other advantages, including fewer items lost and stolen, easier loading on or off a vehicle and less paperwork because of the smaller number of items listed etc.

According to various kinds of standards, containers could be classified into different categories as follows:

a) Container size. In recent years 20ft and 40ft containers are widely used in the international container business. Other sizes are 45ft, 48ft and 53ft etc. The width of standard container is 8ft. And there are four kinds in height: 9ft6in, 8ft, 8ft6in and less than 8ft. The container also includes four lengths of 40ft, 30ft, 20ft and 10ft.
b) Container type. According to various container types, they are standard, open-top, folding-flatrack, ventilated, platform, bulk, tank, insulated and integral reefer etc.

3.1.2 The development of containerization

On April 26, 1956, the Ideal X, a converted tanker, carrying 58 trailer vans on its specially adapted decks, sailed from Newark, New Jersey to Houston, Texas. This journey touched off the container revolution.

Containerization of the liner trades has taken more than 40 years. With the development of containerization, the major liner routes and most of the minor ones had been containerized. Containerization plays a crucial role in the global trading network, carrying about 75% per cent of the value of goods carried by sea (Ma, 2010).

Containerization had a huge effect on liner shipping companies and other parts of the shipping industry. Firstly, containerization gave liner shipping companies the opportunities to satisfy the needs of shippers for a “door to door” service. Most liner shipping companies covered the responsibility between the beginning and the end of the ship’s rail earlier. However, following more and more fierce competition, the importance of offering a complete service from origin to the destination is becoming more and more apparent. Secondly, the business consolidated into fewer shipping companies. Liner shipping became the most central sector of the shipping industry. Thirdly, the bustling ports with a huddle of cargo were replaced by modern container terminals with fewer staff and bigger container ships. Forth, ships and shipowning slipped to the sidelines because the core business of liner shipping companies was through transport. Fifth, tramp operators turned to the bulk carrier and tanker markets, because the containerships could not converted between liner charters and bulk. Last but not least, minor bulk cargos carried by specialist vessels such as ‘conbulkers’, vehicle carriers, mini-bulkers and parcel tankers instead of occupying the lower cargo holders, deep-well tanks and ro-ro decks(Stopford, 1997).

3.1.3 Characteristics of the container transport

Container transport develops so fast and become the major mode of transport of general cargo, which is determined by its special characteristics. Container transport has been covered almost all the maritime transport network system in the last forty years. Containerization has become an irreversible trend and it has entered into a relatively mature stage. Since the beginning of containerization, the shipping industry has seen a general increase in productivity, safety, efficiency, and reduction in service time and cost. The main characteristics of the container transport are shown as follows:

First of all, container transport is a standardized transport. The product, general cargo, is transformed into standard units. The International Standards Organization developed standards which applied to dimensions, corner casting strength, the gross weight of the container and port handling/discharging facilities etc. Also, it has uniform rules and regulations.

Second, the container transport has high handling efficiency and productivity. Its efficiency is about 4 times faster than traditional bulk transport and 1.7 times than pallet, respectively. It reduces the working time at the port. Standardizing the cargo unit allowed the liner shipping companies to invest in mechanized systems and facilities. That could automate the container transport process and raise the productivity.

Third, the container transport is a high quality transport mode. It has fewer pieces to be accounted for and fewer items to be lost or stolen. That reduces the probability of the incurrence of damage or loss of cargo. The cargo is easier to be transferred between intermodal modes of transport. Also it has the obligation to sail to a timetable. It offers regular and scheduled service.

Forth, container transport is a high-cost mode of transport. Most of the container ships are large vessels. Both containers and container ships are high investment. For example, it cost OOCL 136 million US Dollars to book s 13000TEU container ship from Samsung in 2011. On the other hand, It needs a huge investment to build high speed port facilities and transport systems.

From the characteristics of container transport, container transport, compared with the traditional mode of transport, the main difference is as follows:

First, it gave the liner companies have the opportunities to offer shippers ‘door-to-door’ service. Previously, most carriers saw their responsibilities as beginning and ending at the ship’s rail. They cannot offer a complete service from origin to destination. Shippers have to enter into several contracts of carriage with different carriers respectively because of different modes of transport.

Second, it fundamentally changed the traditional transport process. All the modes of transport exist independent of others.

3.1.4 Sea container flow

The sea container flow in entire transportation process in generally as follows:

a) In order to transport the cargo, the shippers have a massive demand of empty containers. So the near interior Container Fright Station or the container terminal will send the empty containers to the packing place where the shippers dedicate. If the interior CFS or the container terminal has no enough empty containers, the carrier must allocate the empty containers from other ports, depots or CFS, otherwise, they could rent from the container leasing companies.
b) After they reposition the empty containers, the shippers demand of empty containers are satisfied, The empty containers become the heavy containers after being loaded the goods, Then the heavy container are sent to the CY through interior transportation, and wait for shipment.
c) Through being carried by sea, the heavy containers are transported to another port.
d) The heavy containers are discharged in the unloading port. Through the interior transportation again, those containers reached the consignee’s place, Then the consignee remove the cargo from the container. So the heavy containers became empty containers again. Those containers will be transported to the near CFS or

port.

e) After the empty containers being sent to the CFS or port, they will be reused or return to the container leasing company.

There are two main groups of owners of sea (ISO) containers. One is the ocean carriers, including global, niche and feeder carriers. Another is the container leasing companies. Depot operators, who handle, store and repair empty containers, also own a small share of containers. These containers are usually old ones close to the end of their useful life. Besides these, some shippers, such as big manufacturers, may also own a relatively small amount of containers for their dedicated use (Theofanis & Boile, 2009). That means if the shippers has enough dedicated containers of his own, the shipping company has no necessary to solve the problem on repositioning the empty containers. Thus the process will be much simple. These two processes can be simply described as Figure 1

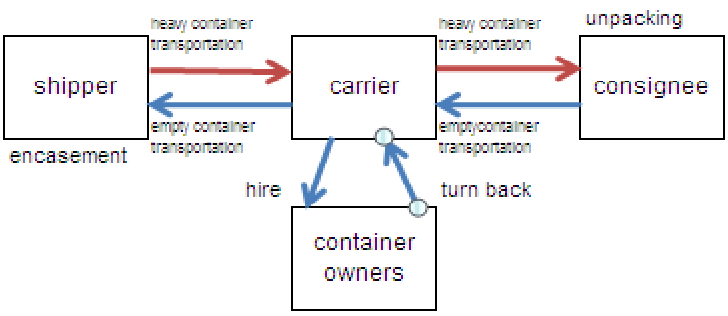

Figure 1 - The container's circulation procedure

Source: The Study on Empty Containers Allocation in the Container Transportation

China: Wang et al.

From the analysis above, the sea container flow can be described as follows (See Figure 2)

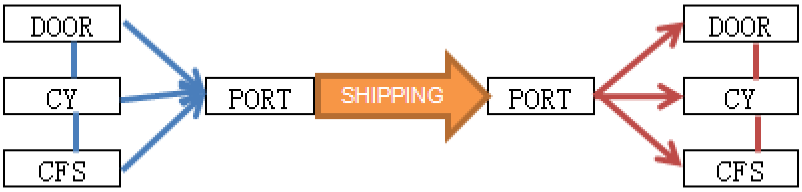

Figure 2 - The sea container flow in entire transportation process

Source: The Study on Empty Containers Allocation in the Container Transportation

China: Wang et al.

As shown in Figure 2, we can divide the container transportation process into three stages:

First stage: on shore (before shipment). The empty containers have been boxed up and ready to be delivered.

Second stage: off shore (after shipment). Heavy containers entered the stage of carriage of goods by sea.

Third stage: on shore (after discharge). After the ship arrives at the port of destination, the heavy containers are discharged and sent to the place where remove the cargo. Then return back the empty container.

Any container wants to complete an entire transportation process, it must experience the three stages mentioned above.

3.1.5 Empty container flow at the local and regional level

As shown in Figure 3, the stakeholders involve in the empty container repositioning process are consignees, consignors, ocean carriers, depot operators, marine terminal operators, drayage operators and, possibly, transport intermediaries. Empty containers can arrived at consigner’s premises through drayage and intermodal transportation. Once filled, a full container is usually drayed to a marine terminal or an intermodal terminal for export. Empty containers can also arrive at storage depots, and be temporarily stored, then oversea repositioned, once off hired by an ocean carrier. A full container, carried by truck either directly through intermodally or a marine container terminal, reach a consignee’s warehouse. Once unpacked, the empty container can be either send back to a storage depot or the marine terminal, or directly leave for a consignor’s premises to be filled with an export or backhauling road. Occasionally, empty containers can be allocated through an intermodal terminal or an empty depot. From storage depots, aged containers, especially those stored over for a long period of time, may be sold out of the transportation network to the secondary market. Empty containers may move between storage deports and marine terminals or between different storage depots for balancing purpose (Theofanis & Boile, 2009).

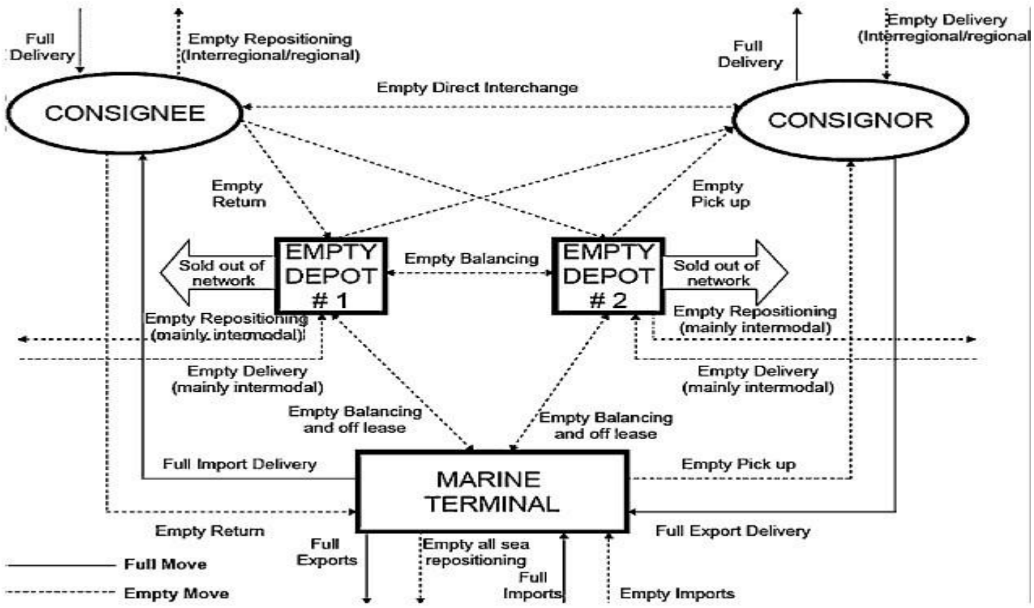

Figure 3 - Empty container Flows at regional and local level

Source: Boile et al. (2006). Empty marine container logistics: facts, issues and management strategies.

3.2 Identify the factors that influence empty container movements

The fundamental reason for empty movement is the trade imbalance. Other factors also may affect the empty container movements, e.g. dynamic behavior, uncertainty in demands/ handling/ transportation, types of containers/ equipments, blind spots in the transport chain, a carrier's operational behavior, tariff imbalance, related expenses of move empty containers from surplus to deficit regions, cost of inland transportation; cost of manufacturing and purchasing new containers in relation to the cost of leasing containers, leasing contract terms, cost of inspection and maintenance of aged containers, the cost of disposal (Boile, 2006).

3.2.1 The objective factors

3.2.1.1 The volume of import and export containers

The fundamental global imbalance of trade between the East and the West as well as the North and the South is considered as the main cause of the empty container handling issues. That means the trade in one direction is more than that in the other. Take the Asia-Europe trade route as an example, Asia ports are confronted with severe shortage of empty containers, while European ports, such as Rotterdam Ports, are experiencing a high surplus of empty containers. The same situation is happening to Trans-pacific trade route. Owing to China's economic boom, although the importing volume to China is increasing, the growth of exporting increases more significant.

3.2.1.2 The type of the import and export containers

The reasons, such as various kinds of import and export goods with different natures, the differences in shipping freight and handling expanses etc, result in the number of different types of import and export containers uneven. Take the Asia-Europe route as an example, cargos carried from east to west are mostly light cargos in recent years, which suitable to use 40ft containers, while the opposite direction are mostly heavy cargos, which suitable to use 20ft containers. That results the cargo flow from east to west are short of 40ft containers, and the cargo flow from west to east are suffering from want of 20ft containers. Thus the movement of empty containers is generated.

Furthermore, there are various types of container which vary in their dimension as well as the goods they are designed to carry. They are designed to carry liquids, grain, frozen food, powders, lumber, building materials, vehicles and chemicals etc. The special containers have their special movements because their special characteristics.

3.1.1.3 The dynamic behavior of container shipping

The trade demands change over time for different seasons. This happens mostly because of seasonal products, like agricultural products etc. For example, wool is one of the chief exports of Australia. Every year in April, Australia will export a large number of wool, which will inevitably lead to a large demand of containers in that period of time. Also, there are a lot of products needed only for special festivals such as Christmas and New Year's Day. Although, they may be predictable to a large extent, these demands still lead to a dynamic impact on the transport system. Empty containers have to be cumulated in advance to satisfy these expected increasing demands of containers. But when the demands decrease, empty containers have to be stored or repositioned. Because the arrival of laden containers to be reused and the needs for empty containers will not match within some constraints, such as time, place and volume difference etc.

Uncertainty is another important factor. It is also an unpredictable element in the transport system. It may exist in customer demands. Demand uncertainty may be the most regular phenomenon. For example, under the recession, a lot of trading companies close down. The demands of containers will decrease. In the current shipping market, the liner shipping companies are confronted with highly competitions. That means shippers have more and more choices. In order to meet uncertainty in demands, the liner shipping companies have to prepare spare capacity and reposition the empty container more efficiently. Also, the uncertainty may exist in container processing activities such as handling, discharging, maintenance, repair and movement. For example, a strike at a port may force liner shipping company to change the vessel’s schedule. Traffic congestions or whether conditions may increase the transport time. These actions will directly lead to empty containers not to be repositioned on time to satisfy the demands, and at the same time, these movements will generate extra expenses.

3.2.1.4 National and regional imbalances in economic development

As national and regional economic development imbalances resulting in the uneven volume and types of cargo, some regions have large numbers of idle empty containers and others are confronted with shortages. That means the empty containers have to be repositioned from surplus regions to deficit areas. For example, it is common that a city, that has great denseness in population, tend to consume a large amount of consumer goods, resulting in many empty containers. However, developed manufacturing regions are short of empty containers. The geographic regions in these two nature do not overlap to a large extent. Thus empty containers generate.

3.2.1.5 Other objective factors

China, as the world leading manufacturer, produced more than 90 per cent of the world's container. It means that the factories have to transport empty containers to all over the world.

3.2.2 The subjective factors

3.2.2.1 Low turnover ratio of empty containers

The turnover period of container mainly depends on the port storage time and container inland turnround. To the inland segment, in one way ocean carrier move full containers and in the other way they reposition the empty containers. And the repositioning empty container is an unavoidable activity of the intermodal chain. When the import containers arrive to a national port, they are mostly sent towards various interior destinations. Then after discharging the cargo, they must return to a port to complete an export voyage. Almost inland container transported by railroad and load. It takes a long time due to the low efficiency of inland transport. Besides, Paul Crinks, President and CEO of International Asset Systems (IAS), stated there are blind spots when containers are moving via rail or truck, or while they are in inland terminals or at shipper/consigner premises (Crinks, 2000). Blind spots in the transport chain may set up barriers against carriers to track their container's location and status in real-time. Thus without having accurate and timely data on container location and status, the carriers could not have a good command of their containers. In other words, they are unable to manage their container fleet effectively, and this will have an impact on the management of empty container repositioning.

3.2.2.2 Backwardness in communication

Backwardness in communication is always the main reason for massive empty container movement and low efficient transport. Due to the backward Container Information Management System between the liner shipping company and the port agency as well as the backward container management, the shipping company has a poor transfer of documents. The low data transmission rate of container status seriously affects the turnround of containers. In order to meet the customer demands, the shipping company has to reposition the empty containers.

3.2.2.3 Legal constraints in container leasing contract

Because the uneven number of empty container between imports and exports, the distribution of containers is not rational. In order to avoid or compensate the losses which are generated by returning the empty containers after the lease. In the charter contract, strict requirements of the container in returning place and charges are set. Container returning charges are also various in different regions, from tens to hundreds of dollars. Therefore, the tenants must transport the container to the dedicated returning place or a relatively low returning cost area. Otherwise, the tenants must pay huge expenses to the lessors

3.2.2.4 Differences in the cost and standard of repairs

Because different areas have different cost of repairs, and different liner shipping companies have different standard of repairs. The liner shipping companies transport the container to the garage where the cost of repair is low, the level of technology is relatively high or near the port, for the consideration of economic or quality. For example, if the container is repaired in Japan, current price of 35 dollars a repairman, and in China, only 3.2-3.5 dollars. Also, in some area, the repair shop fiddle repair project, not accurately fill the estimate report of cost to repair the container.

3.2.2.5 The phenomenon of containers misuse or overdue

Overdue containers are those containers which are stored in the container yard or other places for too long by customers. It has a serious impact on the turnover of containers. It decreases the utilization rate of the containers. Misuse also affects the normal daily management of containers managed by related departments.

3.3 Characteristics of empty container allocation

The characteristics of empty container allocation problem are as follows:

3.3.1 Dynamic

According to the objective factors leading to empty container movement, in a period of time, ports have a relatively steady supply and demand of containers in specified type and size. However, some factors, such as seasonality, emergency etc, will change the demand and supply. In addition, the supply and demand of empty containers are always generated at any moment in practice. The liner shipping company needs to make decision on the number and cargo flow of empty containers at any time or necessary time according to the realities. All of these show the characteristics of dynamic of the empty container repositioning.

3.3.2 Randomness

The randomness of empty container repositioning is mainly reflected in two aspects: demand for or supply of empty containers. The demands for empty containers are generated when shippers book shipping space. The carriers could not forecast the number and the booking time, so the demands for empty containers are random. There are two ways to supply of the empty containers. First, the owner returned empty containers to the CFS or CY after taking delivery of the cargo in the container. Second, rent empty containers from the leasing company or allocate empty containers. The first way achieves both time and number randomness. And the second way is only random in time.

3.3.3 Complexity

Randomness and dynamic features have shown the complexity of the problem.

Transshipment, the restriction of transport capacity and other phenomena existing in the process of empty container movement, actually make the problem harder. Also, various kinds of containers, such as 20ft container, 40ft container, 45ft container, general container, high container, reefer container etc, also increase the complexity of the problem.

Also, the structural changes in global trade lanes also make the freight transportation logistics management a very complex task. Demand levels for container transportation influence the repositioning decision of ocean carriers. On high demand they focus on the immediate repositioning of empty containers to the demand area, while in low demand they try to exploit all backhauling cargo opportunities (ITMMA, 2007). However, backhauling cargo is not always attractive. Such as Asia-US routes, backhaul freight can be as low as 40-50 per cent of the head haul freight rates (Theofanis & Boile, 2009).

3.3.4 Restrained time and space

If the empty containers are allocated by sea, the allocation will be restrained, to a large extent, by time and space. A liner service is a fleet of ships, with a common ownership or management, which provide a fixed service, at regular intervals, between named ports, and offer transport to any goods in the catchment area served by those ports and ready for transit by their sailing dates. A fixed itinerary, inclusion in a regular service, and the obligation to accept cargo from all comers and to sails, whether filled or not, on the date fixed by a published schedule are what distinguish the liner from the trip(Stopford, 1997). In practice, in order to meet the shipper’s demand of containers, the carrier must offer the empty containers on time.

Otherwise, the carriers have to be responsible for the default losses and credit losses. However, if the carrier prematurely transports the empty container from the supply area to the demand port, it will generate the loss of storage charges. In addition, under normal conditions, the shipping space gives priority to heavy container transport, so the shipping allocation is limited by the left space restrictions. Therefore, empty container transportation by sea is restricted by time and space.

3.4 Problems to be solved in empty container allocation

From an economical point of view, according to the rational number of demand and supply, the shipping companies and some shippers, like those big manufacturers, will purchase the containers as reasonable as possible to pursue the maximized interests. It is impossible for the container owners to purchase the container with no constraints. So the number of empty containers which are transferred in the market is limited. In addition, due to the volume of trade of each company are instable, the need of containers are dynamic and unpredictable. Sometimes the supply of container is greater than demand, so the company should focus on when and how to deploy the idle containers to the place where are short of containers or will be short of. And sometimes, the quantity supplied will be smaller than the quantity demanded, they should consider how to allocate the empty containers from other places to meet their needs. Thus the nature of the problem of empty container allocation is how to solve the imbalance between supply and demand, control the flow of containers from the surplus area to the deficit area. The aim of research is the pursuit of cost minimization or profit maximization, are largely extent to satisfy the customer needs. There are four major problems needed to be solved.

a) Decide the empty container flow routes from the supplier area to the demand area. Because in reality the place whether supply or demand of containers are not fixed. They, as suppliers in a period, become demand sites in another time. For a certain period or in a planning horizon, it is important to figure out whether is a supply port or a demand port according to the demand and supply number of empty containers.

b) Decide when to allocate the empty containers. Decide the allocation time is to ensure that the liner shipping company could meet the needs of customers for empty containers on time. It is necessary to take the rational transport time and vehicles into consideration. In road and rail transport, the empty container could be transport basically at any time without the question of no vehicles. However, in shipping, due to the fixed schedule of liner shipping. It is impossible for carrier to allocate the empty container at any time. Besides, to a liner company, in order to raise the loading utilization and to maximize their operational profit, the carriers give priority to carry heavy containers. Sometimes, the shipping space will be overbooked because of booming global trade volume, it makes much harder for the carriers to determine the time when to allocate those empty containers.

c) Decide the number of empty container transported from supply port to demand port. There are several factors need to be considered: first, cost of transportation, which includes charges of transport, handling and discharging, intermodal transfer, packing and unpacking etc. Second, target of the carrier. If the carrier focus on the profit maximization or cost minimization, they should put an emphasis on how to obtain the maximum benefit and minimum cost. However, if they are aim to meet the customer satisfaction, the key they should consider is transport the empty containers in the shortest time, with the fastest time and high quality to meet the need of customer. Third, the feasibility of transporting. The carrier should consider whether the empty containers could be transported within the planning schedule from supply port to demand port. Under the above mentioned conditioned, the container managers decide when and where to allocate the empty containers, and the number of empty containers transported.

d) The strategy how to leasing the container. If the stock of a port and external containers allocated from other ports still cannot satisfy the customer needs, or the cost of allocation are too high, the liner shipping company will choose to leasing company or a mixture use of containers. What strategies the carriers choose depend on what they emphasis more: time or cost etc.

e) Choose what mode of transport. In the problem on how to optimize the empty container allocation problem, the choice of mode of transport is also an important consideration. As the cost of various modes of transport, target accessibility target feasibility, the availability of transport in specific time vary considerably. Making the use of different modes of transport's contribution to the target is not the same, which requires the container managers weigh pros and cons of various modes of transport, consider of the reality and choose the best mode of transport.

3.5 The status quo of the empty container allocation problem

Currently, the major world leading liner shipping companies operating the shipping routes almost cover the world, and their worldwide service network are also cover the main port and regions. Because of some objective reasons, such as a varying number of import and export volume in different regions, varying cargo flow, the structural changes of the Global Production Networks (Notteboom and Merckx, 2006) which have led to a substantial endemic increased in trade imbalances, some seasonal reasons etc., led to the imbalance of the volume of containers between ports and regions. Backlog of containers occur in some place while other place are short of containers. Even in the same region, backlog of empty containers or container deficit may occur various from time to time.

In recent years, with the rapid development of container transportation, how to allocate the empty containers has become the main problem liner shipping companies need to solve. Every movement of empty containers need specified vehicles. That will generate expenses. Besides, it will directly have an impact on the decisions that how many containers the company should be armed with and how many containers should hire from lessors. Therefore, the allocation of empty containers directly relate to the liner shipping companies' operation cost. Inefficient management of empty containers allocation not only waste a lot of empty container resources, but also make the relative costs rapid increase, thus have a profound impact on the economic efficiency of container transport.

COSCON's allocation of empty container is unified under the charge of Equipment Control Center. Under the various routes, they set up operators and relative agency at port. Use one dispatching, three-level management, globally tracking and tracing the containers. The container management has been greatly improved. COSCON allocates the empty containers based on the accurate prediction of cargo flow. Container Management System is the core of empty container supply and demand management. It is an important part of EDI. It is a network-based management information system. It could track and trace the status of containers through computer network at each port. The relative port container agency will update data every day, and take statistics of the supply and demand number of containers and the number of steering. It provides the basis of drawing up allocation planning, thus offering the optimization possibility.

COSCON uses the advanced quality management mode PDCA to unified plan, do, check and action. Unified by Equipment Control Center, issue allocation instructions to Equipment Control Sub-centers and liner operators, EMS balance and try to satisfy most of them. Finally, the Equipment Control Center carries out the Using Plan.

CSCL also set the Equipment Control Center, they are also responsible for equipment supply and control in a global scale, reasonable empty container control and empty container stocking to insure global container request.

In the whole container transport network, the movement of heavy container could be achieved based on empty container movement. If the liner shipping company could not manage the empty container well, it will reduce the efficiency of the global shipping network. If the shipping companies want to reduce the share of the container operating cost, they must speed up the movement of empty containers. Thus there are a large number of empty containers being transferred from surplus area to the deficit regions.

Empty container movements constitute approximately 20 per cent of the world total international container port throughputs at present. The excess capacity will keep on placing pressure on operating margin, and provide a strong incentive for liner shipping companies to minimize logistic costs, and a large percentage of logistic costs are generated by empty container movement. Meanwhile, increasing sophisticated container tracking and management procedures should provide opportunities for achieving economies in the shipping area. Also, trade imbalance on the Asia-Europe routes and trans-pacific routes are expected to become more notable due to the situation that export growth continues to exceed line growth of imports. The North-South trades, such as Asia-Australia, are also facing with this problem. Therefore, it seems inevitable for liner shipping companies to be confronted with the challenge of the managing large amount of empty containers (UNESCAP, 2007).

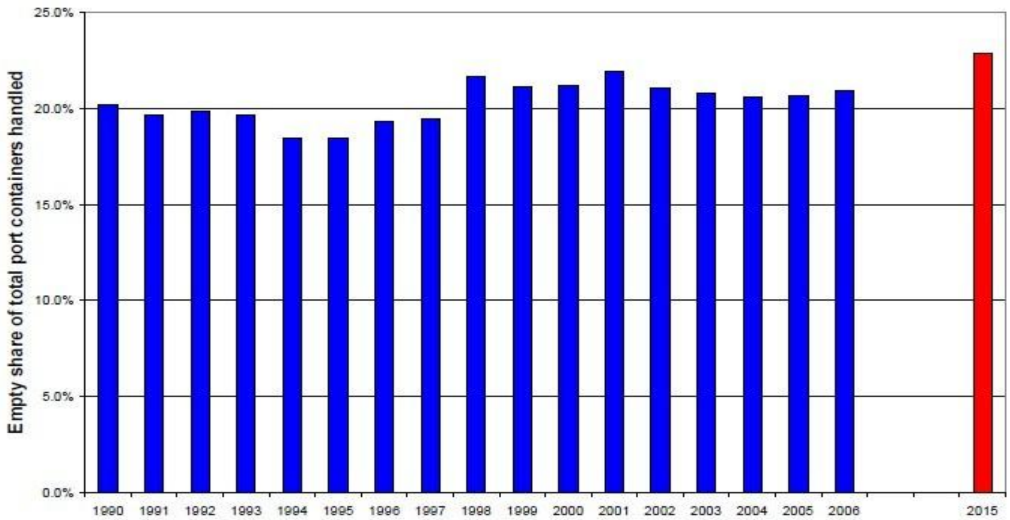

Figure 4 - Share of empty container movements (1990-2006, 2015)

Source: Drewry Shipping Consultants

Figure 4 shows empty share of total port containers handled from 1990 to 2006. As the container logistics towards maturity, the number of empty containers decreased. So the ratio of empty containers to total containers handled was a declining trend until 1995. In 1998, due to the emergency of pronounced imbalance in two main trade routes: Asia-Europe and trans-pacific, caused by Asian currency crisis, the ratio increased beyond 20 per cent. This imbalance has lasted until today. The ratio is estimated to achieve nearly 23 per cent in 2015.

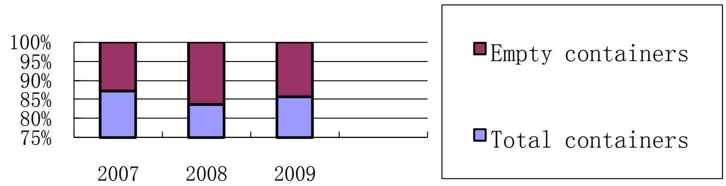

Figure 5 - Share of container movements of North Europe Six-Port from 2007 to 2009

Source: *Global Port Tracker North Europe Trade Outlook (October 2010)*

Fig. 5 indicates the volume of total containers and empty containers handled by the six monitored North European ports from 2007 to 2009. They are Hamburg, Bremen, Rotterdam, Antwerp, Zeebrugge and Le Havre. The ratio of empty containers to total containers is almost 20 per cent. The ratio from 2007 to 2009 is almost 14.6%, 19.6% and 16.8%, respectively.

According to Drewry Shipping Consultants, empty container movement costs $25 billion. Due to the huge cost of empty container movement, how to verified and rationally solve the problem on empty container allocation become a key factor affecting their operation. Liner shipping companies' decision on empty container allocation is reasonable or not, on the one hand, affecting the total number of containers the company should be armed with. In fact, 43.3% of the world containers' fleet is owned by lessors, and the other 56.7% is owned by operators (ocean carriers and intermediaries). To be able to manage a carrier-haulage service, the ocean carrier must have a park of containers two and a half times the vessel capacity of the ocean carrier (Lopez, 2003). On the other hand, it will directly affect the company's operation performance. On real business, most liner shipping companies deal with the empty container repositioning problem based on least cost.

Currently shipping companies increasingly emphasis on the allocation of empty containers. Most of them established the Equipment Control Center to unified manage it. In reality, most of them solve the problem guided by practical experience. According to the demand and supply requirement of different sub-centers and agencies, the container operator of the Equipment Control Center will do an overall balance, then make and issue the allocation instructions to them, finally the allocation completed by them.

Because most liner shipping companies own a large number of containers and shipping routes, they invested a large sum of money to the development of container tracking and tracing information system in order to have an effective command of containers. The information system could help the liner company to sufficient, accurate, on-time and comprehensive grasp the dynamic status of the empty containers. So some small-scale or medium-size shipping companies invest in this aspect are relatively small, management methods are also lagging behind. That results in many lost of containers.

As for the on-site management, the levels of companies are not even. It depends on the service level of port agencies and operating levels of CY. Operational management of the companies still leaves the following to be desired.

a) The routes and ports should have a reasonable park of containers with scientific measurement. If they do not do a good supply and demand forecasting of empty containers, that results a serious backlog of empty containers in some areas, while the empty containers are not available to some other places.
b) The low level of port agency, and the poor quality of information tracking and tracing making it impossible for the container operators to work based on an

accurate basic data.

c) Unreasonable operating on the port site. The unnecessarily secondary allocation of empty containers often occur, increasing the cost of allocation, loading and discharging.

d) The system of returning and picking up empty containers are not perfect. Equipment Interchange Receipt (EIR) to use non-standard, resulting in the transfer is not clear and the confusion of responsibility, and even lost containers.

Therefore, the current means of managing the empty container allocation have not kept up with development needs, such as long turnover time, low transport efficiency, poor tracking and tracing information system and macro-control ability etc. strengthen the empty container management, moving in the new direction of standardized and scientific management is an urgent subject need to be solved.

Chapter 4 Analysis of the empty container allocation problem of relatively small-scale liner shipping companies in China

4.1 General introduction

China's container transportation industry is flourishing, which provides good business environment for the shipping lines, since the reform and opening-up for 30 years. According to the data on ci-online.co.uk, COSCO and CSCL are the sixth and eighth biggest shipping lines in the top 20, respectively, which 30 years ago is no way to image. In fact, in recent years, demand for container transport in China, driven by rapid growth, Shandong Yantai International Marine Company, SITC,, Minsheng Shipping Co., Ltd. etc. According to the data on China Portcontainer, to the end of 2007, about 180 China's shipping companies have the qualification for running liner shipping companies. They own about 2129 vessels. The total TEU capacity is more than 1 million TEU. Currently, the world's leading liner shipping companies have set up a sole proprietorship, joint venture or offices in China, Shanghai, as a country aim to build Shanghai International Shipping Center, attract top 50 liner shipping companies to carry on business. The world's largest classification society, like DNV, GL, LR etc., has also opened a representative office in Shanghai.

Table 1 - Liner Shipping Connectivity Index (LSCI), 2004-2009

Economy	2004	2005	2006	2007	2008	2009	Rank 2009	Change2009/2008	Change 2009/2004
China	100	108.29	113.10	127.85	137.38	132.47	1	-4.91	32.47
Hong Kong (China)	94.42	96.78	99.31	106.20	108.78	104.47	2	-4.30	10.05
Singapore	81.87	83.87	86.11	87.53	94.47	99.47	3	5.01	17.60
Netherlands	78.81	79.95	80.97	84.79	87.57	88.66	4	1.09	9.85
Korea,Republic of	68.68	73.03	71.92	77.19	76.40	86.67	5	10.28	18.00
United Kingdom	81.69	79.58	81.53	76.77	77.99	84.82	6	6.83	3.14
Germany	76.59	78.41	80.66	88.95	89.26	84.30	7	-4.96	7.71
Belgium	73.16	74.17	76.15	73.93	77.98	82.80	8	4.82	9.64
United States	83.30	87.62	85.80	83.68	82.45	82.43	9	-0.02	-0.87
Malaysia	62.83	64.97	69.20	81.58	77.60	81.21	10	3.61	18.38

Source: www.unctad.org

In 2004, UNCTAD (UNCTAD, 2009) introduced Liner Shipping Connectivity Index (LSCI), which aims at capturing how well countries are connected to global shipping networks. The current version of LSCI is generated from the five components: (a) the maximum vessel size; (b) the number of services; (c) number of ships; (d) the container-carrying capacity of those ships; and (e) the number of companies that deploy containerships on services from and to a country's ports. The data is derived from Containerization International Online. Most overseas trade in manufactured goods is moved in containerized regular liner shipping services. LSCI provides a countries connection to global network liner services. It helps port operators, policymakers, investors and traders to evaluating a country's position within the network. From Table 1, we can figure out that China continues to have the highest LSCI. Hongkong (China), Singapore followed (UNCTAD, 2010). All the data means, China will lead the way to a new era of container transportation. However, for some relatively small-scale liner shipping company, it is an opportunity, but also a severe test.

4.2 SWOT Analysis on the problems of empty container allocation faced by small-scale Chinese liner shipping companies

SWOT method is considered here to analysis the internal strengths and weakness, and external threats and opportunities of solving the empty container allocation problem of those relatively small-scale liner shipping companies in China. Then different strategies are tried to figure out by combination of these factors.

(1) Strength factors

S1: Large number of liner shipping companies. China owns the largest number of liner shipping companies in the world. Those small-scale liner shipping companies could improve their competition by mutual cooperation.

S2: The logistic service industry is widely covered in the country. That means, in the case of multimodal transport, the small-scale liner shipping companies can improve their turnround ratio of containers by taking advantage of this strength factor.

S3: Manpower cost here is relatively low.

(2) Weakness factors

W1: The size of most liner shipping companies is relatively small. In addition to COSCO and CSCL has a larger scale and in a competitive position, other shipping companies generally relatively small in size. They do not have the advantage of economies of scale.

W2:Information systems are imperfect. Because the information system between the relatively small-scale China shipping company and port agents is not perfect, management lags behind, resulting in poor circulation of the container and incompletely document transferred. Also, the speed of date transfer is slow. That results those relatively small-scale China shipping lines could not have a good command of the status of containers. To a large extent, it contributes to the inefficiency of allocation of empty containers.

(3) Opportunity factors

O1: Shanghai is being built into the international shipping center. Shanghai is China's largest city and largest port. Shanghai is playing a more and more important role in the international shipping industry, her status in continuously improved. Meanwhile, the state has given Shanghai a series of important functions in shipping industry. Shanghai Shipping Exchange, built for the Shanghai International Shipping Center has laid an important function. The role of the transit in Shanghai is gradually apparent. So accelerating Shanghai International Shipping Center construction, making it an international transit hub, from the root preventing the import and export imbalance, may largely reduce the empty container allocation.

O2: China, as the world leading manufacturer, produced more than 90 per cent of the world's container.

O3: Interregional difference in repair cost and standard. Different areas have different cost and standard of repair. The liner shipping companies transport the container to the garage where the cost of repair is low, the level of technology is relatively high or near the port, for the consideration of economic or quality. For example, if the container is repaired in Japan, current price of 35 dollars a repairman, and in China, only 3.2-3.5 dollars. Also, in some area, the repair shop fiddle repair project, not accurately fill the estimate report of cost to repair the container. Thus, to those China shipping companies, in China, it costs the shipping lines less money on repairing containers.

O4: Policy support. August 2003, the Chinese Ministry of Transportation formally ratify that international liner shipping companies can use their own operating ships to allocate the empty containers in China's coastal ports. Allow international liner shipping companies allocate empty containers in China main ports along the coast, will help to improve the operating environment of the coastal ports. It can contain a large number of containers transit in foreign ports, and promote the container hub construction and development. At the same time, it could reduce the cost of transporting empty containers from outside ports, optimize the formulation of service network, and finally lower the transport cost.

(4) Threaten factors

T1: Port facilities in China are not perfect.

T2: Low turnover ratio of empty containers. It takes a long time due to the low efficiency of inland transport. The low turnover ratio results in the severe backlog of containers in the port. The liner shipping company has to allocate the empty containers from the near port in order to guarantee the schedule.

T3: Legal constraints in container leasing contract. In order to avoid or compensate the losses which are generated by returning the empty containers after the lease. In the charter contract, strict requirements of the container in returning place and charges are set. Container returning charges are also various in different regions.

T4: The imbalance of the volume of import and export containers. The fundamental global imbalance of trade between the East and the West as well as the North and the South is considered as the main cause of the empty container handling issues. That means the trade in one direction is more than that in the other. And the volume is not fix, it is dynamic and not predictable. That makes the allocation of empty containers becoming harder.

T5: The imbalance of the type of the import and export containers. The reasons, such as various kinds of import and export goods with different natures, the differences in shipping freight and handling expanses etc, result in the number of different types of import and export containers uneven. Take the Asia-Europe route as an example, cargos carried from east to west are mostly light cargos in recent years, which suitable to use 40ft containers, while the opposite direction are mostly heavy cargos, which suitable to use 20ft containers. That results the cargo flow from east to west are short of 40ft containers, and the cargo flow from west to east are suffering from want of 20ft containers. Thus the movement of empty containers is generated. Furthermore, there are various types of container which vary in their dimension as well as the goods they are designed to carry. They are designed to carry liquids, grain, frozen food, powders, lumber, building materials, vehicles and chemicals etc. The special containers have their special movements because their special characteristics.

According to the SWOT analysis before, some reasonable ways are tried to figure out to relieve the problem in the next part of this paper.

4.3 Strategies and solutions to those relatively small-scale shipping lines based on SWOT Analysis

The market share of the ten biggest world carriers increased from 50 per cent of the world's capacity in January 2000 to 62 percent in June 2011, corresponding to a growth in the cumulated capacity from 2.5 million in 2000 to 9.7 million TEUs in 2011. COSCO Container L. and CSCL represent 3.9 per cent and 3.2 per cent, respectively (AXS-Alphaliner, 2011). To those relatively small shipping companies, it's a big challenge to survive and growth. As for empty container allocation, it is a chronic and structural problem of container transportation no matter whether the shipping lines are big or not. Here, according to the cause of empty containers, I want to find out the strategies to avoid the second or more times empty container allocation from surplus area to deficit area decreasing the running cost of the shipping lines.

(1) Strength - Opportunity

(a) Cooperating between shipping lines

Liner shipping companies, with a scale in a given situation, constantly looking for new ways to improve the utilization of containers by breaking the traditional mode, become a focus these years. In the past twenty years, many liner shipping companies, in one hand, improve the utilization of resources to reduce the business risk through restructuring. On the other hand, shipping lines are coordinating the container flows over different service routes or they share container fleets with other liner shipping companies. These measures improve the utilization of containers, and decrease the allocation of empty containers. They played a significant role in reduce the cost of container management.

In theory, the more vessel slots and service routes the liner shipping company own, the wider opportunities for easing the repositioning problem they have. If the growth in capacity for the main carriers is general, the path chosen by shipping lines differs however (Cariou, 2000; Slack et al., 2002; Notteboom, 2004). First, chartering and direct investments in new vessels are the main vectors. Another path is mergers and acquisitions and strategic alliances (Cariou, 2008). Of course, according to different period considered, to each individual carrier, one way over another is preferred.

To those relatively small-scale shipping lines, to cooperate with each other maybe better for them to yield more profit with low input. There are variety kinds of cooperation between liner shipping companies, such as space/slot charter, space/slot exchange/co-charter, vessel sharing agreement and strategic alliance. However, to the relatively small liner shipping company, their shipping network may not be wide enough to perform the sufficient route-coordination.

In order to enhance the competitiveness of the shipping company, they could constitute an alliance or cooperate with each other, thereby sharing the container fleets or coordinating the container flows over different service routes on the major routes. Thus the liner shipping company could allocate the empty containers more efficiency.

Nowadays, the competition in international liner shipping is no longer merely competition between companies, it shows a trend of strategic alliance group competition. Because the customer requires not only the quality service in all routes, but also requires effective transshipment, high-density shipping schedule, low freight, that all drive the shipping company to cooperate with each other. There is a simple theory submitted by Kadar to explain the purpose of alliance, one plus one creates more than double effectiveness (Kadar, 1996). Liner companies use the strategy that joint fleet, slot charter, slot purchase, slot exchange and share of port usage etc. to improve the productivity of container facilities, to increase the freight revenues, to effectively reduce the cost of allocation and operation, and to enjoy economies of scale by sharing resources with other liner companies but without investing anymore capitals. The supply and demand of the empty containers are constantly changing to different ports. It is possible that the place some liner companies have a backlog of containers is the place where other companies have a heavy demand. If the companies could have a well-planned strategy, it is often a win-win situation. Take CKYH as an example, the CKYH consists of four famous carriers. They are COSCON, K-line, Yang Ming and Hanjin. COSCON has sufficient amount of containers in some area, and the surplus containers will be offered to others in an appropriate manner, such as leasing. Then they collect containers in the place where they have a demand or the cost of allocation is relatively low. Of course, the COSCON pick up containers from other liner shipping companies to solve the problem of want of containers. That can largely lower the cost of allocation. In Europe and North America, there are many agencies specializing in this business. They aim to adjust the supply and demand of empty containers among different liner carriers. That could greatly reduce the cost of allocation.

(b) Cooperation between shipping lines and leasing companies

Leasing arrangements fall into three types: Master Lease, Long Term Leases and Short Term Leases. The liner shipping company could make a comparison between hiring from leasing companies or repositioning. If the cost of hiring is low, then choose to hire, and vice versa. The liner shipping companies could sign leasing contracts, which are benefit to them, with the leasing company. According to the actual demand, they could rent the containers at the place where they are lack of containers, and return back to the leasing company at the place where they have surplus containers. On the one hand, the requirement of empty containers is satisfied, on the other hand, the shipping company may save the cost of stowage charges and allocation. Also, the shipping company could rent containers from leasing companies and contemporarily sublet some idle empty containers to others.

Leasing companies participating in the use of the empty space of a ship, make it more efficiency for the liner shipping companies to allocate the empty containers. The leasing company could also be overall management of all carriers' container, which is benefit for the small company to reduce running cost and to raise efficiency. This strategy represents some practices emerged recently. The internet-based support system such as InterBox, SynchroNet System, Greybox InterExchange provide neutral platforms to facilitate different companies to exchange containers. Some third-party information management system could help the liner shipping companies to reduce the movement by offering data in reason extent through their database. For those relatively small-scale shipping lines, if they need containers due to some emergency, and they are in short of funds, they also could hire containers from leasing companies to avoid instant investment. In addition, compared with cooperate with other shipping lines, the advantage is its neutrality and geographic width.

(c) The cooperation between shipping lines and container manufacturers

China, as the world leading manufacturer, produced more than 90 per cent of the world's container. Thus it is inevitable for those container manufacturers to delivery their containers to their overseas buyer. Those shipping lines could take the opportunity of this, offering them free transport service in exchange for using the new containers free or at a relatively low cost.

(d) Speed up the ratio of turnround by intermodal transportation

In the container transfer process, strengthen the collection and dispatching system, control of containers' transit time, to speed up the container turnround time. Choosing these ports with effeicnecy handling equipment can increase the handling efficiency. Also, reduce inland costs by improving inland transport network.

(2) Weakness - Opportunity

(a) Strengthening the construction of Container Information System

In the management methods, the larger shipping companies have established relatively efficiency management information system. It is essential to have a good command of the status of those empty containers. And the accuracy of data is also very important. Like COSCO, they set Rejection and Parking Lot to ensure the accuracy of data. Though buying an information system will surely make a hole in those small shipping lines' budget, shipping companies should change the concept of the operation, strengthen scientific management. Global monitoring, tracking and tracing not only can reduce the situation of lost and misuse, but also can improve the customer service satisfaction by efficient transport.

(b) The correct choice of container

On the shipping routes with relatively small quantities of cargo, the size of containers should not be too large. If the most import and export cargos are light cargo, large-size container could be considered. In actual business, due to the factors, such as seasonality and cargo imbalance etc, the shipping lines should control the container proportion under a certain level, especially the long term leasing container are considered as ownership of containers. If the proportion of self-purchasing container and long term leasing container exceed a certain level, the career should bear a large amount of expenses generated because of the idle containers and allocation of empty containers. If the carrier equipped with short term leasing container, that will reduce the cost of allocation and idle container when the volume of cargo decrease. So, the career should have a proper proportion of short term leasing, long term leasing and self-purchasing containers, which could improve the utilization of containers and decrease the cost of management.

On the other hand, the mass-market foldable shipping container nears to the market. Industry official say that trucks, barges, ships and trains could carry four times as many as containers if they were folded and stacked on top of each other (Miller, 2010). If carriers use this container, it would cut the cost of moving empty containers by as much as 75 per cent. It corresponds about billions of dollars. However, it still needs to be proofed. The small-scale shipping lines could focus on the development trend of the foldable containers.

4.4 Optimization strategies and solutions

From an economic perspective, most liner shipping companies in pursuit of maximize economic benefits by purchasing of containers as reasonable as possible. So, the number of containers circulating in the market is relatively limited. But because of the dynamic and randomness of the container market, it is hard to allocate the empty containers. The core issue of the empty container allocation is decide and control the cargo flow from supply area to demand area in order to solve the existed imbalance.

As we discussed above, if the small-scale liner shipping companies want to survive in the liner shipping industry, they must control their empty container allocation cost. In theory, the more vessel slots and service routes the liner shipping company own, the wider opportunities for easing the repositioning problem they have. So, in my point of view, it is better for them to cooperate with each other.

For the global movement between surplus and deficit regions, the careers have several options. If the outflow of containers exceeds the inflow, the carriers can choose following options. First, import empty containers from surplus areas (allocated from regional places or overseas). Second, lease containers from lessors. Third, purchase containers. Forth, match the needs with other carriers (Theofanis & Boile, 2009). The goal of empty container allocation is to meet the customer needs, based on the pursuit of cost minimization. So, the small-scale company should consider combined several options mentioned above with the relevant cost and schedule.

We assumed that there are two shipping lines operating on the same shipping routes, the shipping route is fixed, the schedule is fixed and they want to cooperate with each other. Meanwhile, both of them could finish a complete range in the planning period. In addition, before the plan, the empty container number of supply and demand can be confirmed, and the supply and demand ports are confirmable.

a, b: represent two liner shipping companies.
(m,n): represent a shipping route from region m to n.
(j,k): represent a shipping route from region j to region k.
S: represent the supply area.
D: represent the demand area.
$m,j \in S; n,k \in D.$

$S^a_{i,}$ S^b_i: volume of empty containers supplied by company a or b at region i, respectively.

$D^a_{j,}$ D^b_j: volume of empty containers demanded by company a or b at region j, respectively.

C^a_{ij}, C^b_{ij}: unit cost of transporting an empty container from region j to region k for shipping line a or b.

R^a_j, R^b_j: unit rate of hiring an empty container at region j.

H^a_i, H^b_i: unit cost of loading an empty container at region i.

U^a_j, U^b_j: unit cost of unloading an empty container at region j.

M^a_{ij}, M^b_{ij}: the maximum volume of empty container can be transported from region i to region j by shipping line a or b.

r: whether the ship arrive at region i first. If yes, r=1. If no, r= 0.

t: whether the (p,q) ≧ (i,j). If yes, t=1. If no, t=0.

x^a_{ij}, x^b_{ij}: the volume of empty containers allocate from region i to region j by shipping line a or b.

k^a_j, k^b_j: the volume of empty containers hired at region j by shipping a or b.

v^{ab}_{ij}: represent the capacity shipping line a rent from shipping b from region i to region j.

the objective is to minimize

$\sum_L (\sum_i \sum_j C^a_{ij}x^a_{ij} + \sum_j k^a_j R^a_j + \sum_j x^a_{ij} H^a_i + \sum_i x^a_{ij} U^a_j + \sum_b \sum_i \sum_j C^b_{ij}\ v^{ab}_{ij})$

This means the shipping lines want to minimize their cost of allocation. There are five costs are include. First, cost of empty containers transported by self-companies. Second, cost of empty containers hiring from leasing companies at port j. Third, cost of loading empty containers at port i. Forth, cost of discharging empty containers at port j. Fifth, cost of empty containers transported by the cooperate company.

Subject to the follow constraints

$\sum_j x^a_{ij}r + \sum_b \sum_j v^{ab}_{ij}r \leq S^a_{ij}$

This represents that the volume of empty containers transported by company a plus the volume of empty containers transported by cooperate company b cannot beyond the total volume of empty containers from the supply regions.

$\sum_i x^a_{ij}r + \sum_b \sum_i v^{ab}_{ij}r + k^a_j = D^a_j$

This represents that the volume of demand of empty containers should equal to the volume of empty containers transported by company a plus transported by cooperate company b plus the volume of empty containers leasing from leasing companies.

$\sum_p \sum_q x^a_{pq}\, t + \sum_b \sum_p \sum_q v^{ab}_{ij}\, t \leq M^a_{ij}$

This represents that the total number of empty containers should not exceed the maximized capacity of empty containers.

Last but not least, all of these are non-negative.

Though the model above, the shipping lines may minimize their total cost of allocation by considering cooperate with other shipping lines. Here, they have three ways to meet the demand of empty containers. They could transport empty containers by themselves or using other shipping lines' capacity by paying a stated price. Also, they could lease containers at the port of destination from the leasing company. It is very important for them to decide what means to use and how many containers should be handled by that means, respectively, then the shipping line could decrease the cost.

Chapter 5 Conclusion

This paper has a research on the empty container allocation problem of relatively small-scale liner shipping companies in China. As for empty container allocation, it is a chronic and structural problem of container transportation no matter whether the liner shipping company is big or not. To my point of view, it is a big challenge to those relatively small-scale liner shipping companies, which directly influence their survival and growth.

Critical factors that impact empty container allocation are identified. According to those factors that influence the empty container movements, fundamentally caused by trade imbalance, several strategies are suggested in this paper to those relatively small-scale liner shipping companies. All of those strategies may avoid the second and more times empty container allocation from surplus area to deficit area and yield more profit with low input.

■ As in theory, the more vessel slots and service routes the liner shipping companies own, the wider opportunities for easing the repositioning problems they have, those small-scale liner shipping companies can coordinate the container flows over different service routes or share container fleets with other small-scale liner shipping companies. Even under certain situations, several of them can constitute an alliance.

■ Those small-scale liner shipping companies can hire containers from container leasing companies, some of which have powerful and professional Management Information System for Container Leasing.

■ In China, a special method can be considered that those small-scale liner shipping companies can cooperate with container manufacturers, as China produced more than 90 per cent of the world's containers.

■ As for the system, it is essential for those small-scale liner shipping companies to strengthen the Collection and Dispatch System, and Container Management System. It speeds up the ratio of turnaround and helps them to have a good command of the status of their containers.

■ The correct choice of container is also very important.

As for the model, I refer to a great number of models established by others. To those relatively small-scale liners shipping companies, cooperating with other shipping companies and hiring some number of containers from other leasing companies may be a better choice for them. In this model, both two aspects are considered. However, it needs a large number of mathematical operations to solve the problem. Restricted by my subject, I do not make calculations. The shipping lines can make a calculation as soon as the total figures are in. This may help shipping lines to make a decision on how many containers to allocate from surplus area to deficit area and how many containers had better hire at the demand region etc. In actural, the problem is complicated due to the randomness and dynamic features of empty container allocation. The model in this research simplifies the factors that influence the empty container allocation. It is just considered the loading and discharging cost, leasing cost, and transport cost, etc..

In future research, strategies need to be improved and studied in depth, making it more suitable to those relatively small-scale liner shipping companies in China.

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The Drewry Independent Maritime Advisor web site gives further information on shipping industry
(http://vpn.library.shmtu.edu.cn:2309/)

The UNCTAD web site gives further information on Transport Newsletter (http://www.unctad.org/Templates/Search.asp?intItemID=2068&lang=1&frmSearchStr=LSCI&frmCategory=all&section=whole)

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Appendices

Appendix 1 LSCI, 2004 – 2009

Economy	2004	2005	2006	2007	2008	2009	Rank 2009	Change 2009/2008	Change 2009/2004
China	100.00	108.29	113.10	127.85	137.38	132.47	1	-4.91	32.47
Hong Kong (China)	94.42	96.78	99.31	106.20	108.78	104.47	2	-4.30	10.05
Singapore	81.87	83.87	86.11	87.53	94.47	99.47	3	5.01	17.60
Netherlands	78.81	79.95	80.97	84.79	87.57	88.66	4	1.09	9.85
Korea, Republic of	68.68	73.03	71.92	77.19	76.40	86.67	5	10.28	18.00
United Kingdom	81.69	79.58	81.53	76.77	77.99	84.82	6	6.83	3.14
Germany	76.59	78.41	80.66	88.95	89.26	84.30	7	-4.96	7.71
Belgium	73.16	74.17	76.15	73.93	77.98	82.80	8	4.82	9.64
United States	83.30	87.62	85.80	83.68	82.45	82.43	9	-0.02	-0.87
Malaysia	62.83	64.97	69.20	81.58	77.60	81.21	10	3.61	18.38
Spain	54.44	58.16	62.29	71.26	67.67	70.22	11	2.56	15.78
Italy	58.13	62.20	58.11	58.84	55.87	69.97	12	14.10	11.84
France	67.34	70.00	67.78	64.84	66.24	67.01	13	0.77	-0.33
Japan	69.15	66.73	64.54	62.73	66.63	66.33	14	-0.30	-2.82
Taiwan Province of China	59.56	63.74	65.64	62.43	62.58	60.90	15	-1.67	1.34
United Arab Emirates	38.06	39.22	46.70	48.21	48.80	60.45	16	11.65	22.40
Egypt.	42.86	49.23	50.01	45.37	52.53	51.99	17	-0.55	9.12
Saudi Arabia	35.83	36.24	40.66	45.04	47.44	47.30	18	-0.14	11.47
Oman	23.33	23.64	20.28	28.96	30.42	45.32	19	14.90	21.98
Greece	30.22	29.07	31.29	30.70	27.14	41.91	20	14.77	11.68
Canada	39.67	39.81	36.32	34.40	34.28	41.34	21	7.06	1.68
India	34.14	36.88	42.90	40.47	42.18	40.97	22	-1.21	6.83
Morocco	9.39	8.68	8.54	9.02	29.79	38.40	23	8.61	29.02
Malta	27.53	25.70	30.32	29.53	29.92	37.71	24	7.78	10.17
Thailand	31.01	31.92	33.89	35.31	36.48	36.78	25	0.30	5.77
Sri Lanka	34.68	33.36	37.31	42.43	46.08	34.74	26	-11.34	0.06
Portugal	17.54	16.84	23.55	25.42	34.97	32.97	27	-2.00	15.43
Panama	32.05	29.12	27.61	30.53	30.45	32.66	28	2.21	0.60
South Africa	23.13	25.83	26.21	27.52	28.49	32.07	29	3.58	8.94
Turkey	25.60	27.09	27.09	32.60	35.64	31.98	30	-3.66	6.38
Mexico	25.29	25.49	29.78	30.98	31.17	31.89	31	0.73	6.60
Sweden	14.76	26.61	28.17	25.82	30.27	31.34	32	1.07	16.59
Brazil	25.83	31.49	31.61	31.64	30.87	31.08	33	0.21	5.25
Lebanon	10.57	12.53	25.57	30.01	28.92	29.55	34	0.63	18.98
Iran, Islamic Rep. of	13.69	14.23	17.37	23.59	22.91	28.90	35	5.99	15.21
Australia	26.58	28.02	26.96	26.77	38.21	28.80	36	-9.40	2.22
Denmark	11.56	24.25	25.39	22.10	26.49	27.68	37	1.19	16.12
Pakistan	20.18	21.49	21.82	24.77	24.61	26.58	38	1.98	6.41
Viet Nam	12.86	14.30	15.14	17.59	18.73	26.39	39	7.65	13.53

Economy	2004	2005	2006	2007	2008	2009	Rank 2009	Change 2009/2008	Change 2009/2004
Argentina	20.09	24.95	25.58	25.63	25.70	25.99	40	0.29	5.90
Indonesia	25.88	28.84	25.84	26.27	24.85	25.68	41	0.83	-0.20
Jordan	11.00	13.42	12.98	16.46	16.37	23.71	42	7.34	12.71
Romania	12.02	15.37	17.61	22.47	26.35	23.34	43	-3.02	11.32
Colombia	18.61	19.20	20.49	29.13	21.64	23.18	44	1.54	4.56
Ukraine	11.18	10.81	14.88	16.73	23.62	22.81	45	-0.81	11.63
Uruguay	16.44	16.58	16.81	21.28	22.88	22.28	46	-0.60	5.84
Dominican Republic	12.45	13.95	15.19	19.87	20.09	21.61	47	1.53	9.16
Russian Federation	11.90	12.72	12.81	14.06	15.31	20.64	48	5.32	8.73
Venezuela, Bolivarian Republic of	18.22	19.90	18.62	20.26	20.46	20.43	49	-0.03	2.21
Nigeria	12.83	12.79	13.02	13.69	18.30	19.89	50	1.59	7.05
Slovenia	13.91	13.91	11.03	12.87	15.66	19.81	51	4.15	5.91
Jamaica	21.32	21.99	23.02	25.50	18.23	19.56	52	1.33	-1.76
Côte d'Ivoire	14.39	14.52	12.98	14.98	16.93	19.39	53	2.46	5.00
Ghana	12.48	12.64	13.80	14.99	18.13	19.33	54	1.21	6.86
Bahamas, The	17.49	15.70	16.19	16.45	16.35	19.26	55	2.91	1.77
Chile	15.48	15.53	16.10	17.49	17.42	18.84	56	1.42	3.36
Israel	20.37	20.06	20.44	21.42	19.83	18.65	57	-1.17	-1.71
Djibouti	6.76	7.59	7.36	10.45	10.43	17.98	58	7.56	11.22
Ecuador	11.84	12.92	14.17	14.30	13.16	17.09	59	3.93	5.25
Peru	14.79	14.95	16.33	16.90	17.38	16.96	60	-0.42	2.17
Philippines	15.45	15.87	16.48	18.42	30.26	15.90	61	-14.36	0.45
Trinidad and Tobago	13.18	10.61	11.18	13.72	12.88	15.88	62	3.01	2.70
Senegal	10.15	10.09	11.24	17.08	17.64	14.96	63	-2.67	4.81
Mauritius	13.13	12.26	11.53	17.17	17.43	14.76	64	-2.67	1.63
Guatemala	12.28	13.85	18.13	15.40	15.44	14.73	65	-0.71	2.45
Yemen	19.21	10.18	9.39	14.28	14.44	14.61	66	0.17	-4.60
Costa Rica	12.59	11.12	15.08	15.34	12.78	14.61	67	1.83	2.02
Togo	10.19	10.62	11.09	10.63	12.56	14.42	68	1.86	4.23
Namibia	6.28	6.61	8.52	8.37	11.12	13.61	69	2.49	7.33
Benin	10.13	10.23	10.99	11.16	12.02	13.52	70	1.50	3.39
Cyprus	14.39	18.53	17.39	18.01	11.81	13.31	71	1.50	-1.08
Kenya	8.59	8.98	9.30	10.85	10.95	12.83	72	1.88	4.24
Cameroon	10.46	10.62	11.41	11.65	11.05	11.60	73	0.55	1.14
Congo	8.29	9.10	9.12	9.61	11.80	11.37	74	-0.43	3.08
Angola	9.67	10.46	9.46	9.90	10.22	11.31	75	1.09	1.64
Syrian Arab Republic	8.54	11.84	11.29	14.20	12.72	11.03	76	-1.70	2.49
Puerto Rico	14.82	15.23	14.68	15.96	15.62	10.92	77	-4.70	-3.90
Honduras	9.11	8.64	8.29	8.76	9.26	10.68	78	1.42	1.57
New Zealand	20.88	20.58	20.71	20.60	20.48	10.59	79	-9.89	-10.29
Nicaragua	4.75	5.25	8.05	7.89	8.91	10.58	80	1.68	5.83
El Salvador	6.30	7.32	8.07	7.90	8.67	10.34	81	1.67	4.04
Finland	9.45	10.16	8.58	10.70	9.72	10.15	82	0.43	0.70
Tanzania, United Republic of	8.10	8.59	8.71	10.58	10.46	9.54	83	-0.92	1.44
Libyan Arab Jamahiriya	5.25	5.17	4.71	6.59	5.36	9.43	84	4.07	4.18
Mozambique	6.64	6.71	6.66	7.14	8.81	9.38	85	0.57	2.74
Sudan	6.95	6.19	5.67	5.66	5.38	9.28	86	3.89	2.33
Poland	7.28	7.53	7.50	7.86	9.32	9.21	87	-0.12	1.93
Gabon	8.78	8.76	8.72	8.57	8.93	9.16	88	0.23	0.38
Fiji	8.26	8.32	7.24	7.35	10.31	8.74	89	-1.57	0.48
New Caledonia	9.83	10.34	9.00	8.81	9.23	8.74	90	-0.49	-1.09
Madagascar	6.90	6.83	8.31	7.97	7.82	8.64	91	0.82	1.74
Netherlands Antilles	8.16	8.23	7.82	9.22	8.56	8.57	92	0.01	0.41

Economy	2004	2005	2006	2007	2008	2009	Rank 2009	Change 2009/2008	Change 2009/2004
Guam	10.50	10.52	9.56	8.73	8.56	8.57	93	0.00	-1.93
Croatia	8.58	12.19	10.47	12.33	15.36	8.48	94	-6.88	-0.10
French Polynesia	10.46	11.14	8.91	8.60	9.01	8.39	95	-0.62	-2.07
Algeria	10.00	9.72	8.70	7.86	7.75	8.37	96	0.62	-1.63
Guinea	6.13	6.89	8.71	8.47	6.41	8.32	97	1.91	2.19
Lithuania	5.22	5.88	5.66	6.83	7.76	8.11	98	0.35	2.88
Bahrain	5.39	4.34	4.44	5.99	5.75	8.04	99	2.29	2.65
Norway	9.23	8.31	7.34	7.80	7.91	7.93	100	0.03	-1.30
Bangladesh	5.20	5.07	5.29	6.36	6.40	7.91	101	1.51	2.71
Ireland	8.78	9.66	8.18	8.85	7.64	7.60	102	-0.04	-1.18
Gambia, The	4.91	6.13	4.80	4.74	4.97	7.53	103	2.56	2.62
Mauritania	5.36	5.99	6.25	7.90	7.93	7.50	104	-0.44	2.14
Papua New Guinea	6.97	6.40	4.67	6.86	6.92	6.58	105	-0.34	-0.39
Kuwait	5.87	6.77	4.14	6.22	6.14	6.54	106	0.40	0.66
Tunisia	8.76	7.62	7.04	7.23	6.95	6.52	107	-0.43	-2.24
Cuba	6.78	6.51	6.43	6.71	6.12	5.92	108	-0.20	-0.86
Bulgaria	6.17	5.61	4.47	4.83	5.09	5.78	109	0.70	-0.38
Estonia	7.05	6.52	5.76	5.78	5.48	5.71	110	0.24	-1.34
Sierra Leone	5.84	6.50	5.12	5.08	4.74	5.56	111	0.83	-0.28
Liberia	5.29	5.95	4.55	4.50	4.25	5.49	112	1.23	0.20
Maldives	4.15	4.08	3.90	4.75	5.45	5.43	113	-0.02	1.28
Latvia	6.37	5.82	5.10	5.87	5.52	5.18	114	-0.34	-1.19
Cape Verde	1.90	2.28	2.76	2.45	3.63	5.13	115	1.50	3.23
Iraq	1.40	1.63	4.06	2.61	1.20	5.11	116	3.90	3.71
Comoros	6.07	5.84	5.39	5.51	5.15	5.00	117	-0.16	-1.08
Seychelles	4.88	4.93	5.27	5.29	4.49	4.90	118	0.40	0.01
Barbados	5.47	5.77	5.34	5.79	5.36	4.75	119	-0.61	-0.72
Iceland	4.72	4.88	4.75	4.72	4.72	4.73	120	0.01	0.01
Cambodia	3.89	3.25	2.93	3.25	3.47	4.67	121	1.20	0.78
Samoa	5.44	5.33	5.09	6.50	6.66	4.62	122	-2.04	-0.82
American Samoa	5.17	5.30	4.86	6.28	6.44	4.60	123	-1.84	-0.57
Haiti	4.91	3.43	2.91	2.87	3.44	4.40	124	0.95	-0.51
Guyana	4.54	4.37	4.60	4.51	4.36	4.34	125	-0.02	-0.20
St. Lucia	3.70	3.72	3.43	4.21	4.25	4.25	126	0.00	0.55
Vanuatu	3.92	4.48	4.41	4.34	4.36	4.22	127	-0.15	0.30
Faeroe Islands	4.22	4.40	4.43	4.45	4.20	4.20	128	0.00	-0.01
Suriname	4.77	4.16	3.90	4.29	4.26	4.16	129	-0.10	-0.60
Grenada	2.30	2.52	3.37	4.09	4.20	4.13	130	-0.07	1.83
Saint Vincent and the Grenadines	3.56	3.58	3.40	4.34	4.52	4.13	131	-0.40	0.57
Tonga	3.81	4.75	4.45	4.07	4.23	3.99	132	-0.24	0.18
Solomon Islands	3.62	4.29	3.97	4.13	4.16	3.96	133	-0.20	0.34
Brunei	3.91	3.46	3.26	3.70	3.68	3.94	134	0.26	0.03
Micronesia, Federated States of	2.80	2.87	1.94	3.13	3.85	3.85	135	0.00	1.05
Georgia	3.46	3.81	2.94	3.22	4.03	3.83	136	-0.20	0.37
Congo, Dem. Rep.	3.05	3.03	2.66	2.68	3.36	3.80	137	0.45	0.76
Palau	1.04	1.04	1.87	3.07	3.79	3.79	138	0.00	2.75
Myanmar	3.12	2.47	2.54	3.12	3.63	3.79	139	0.16	0.67
Northern Mariana Islands	2.17	2.20	1.85	2.86	3.76	3.76	140	0.00	1.59
Equatorial Guinea	4.04	3.87	3.76	3.36	3.86	3.73	141	-0.12	-0.31
Virgin Islands (United States)	1.77	3.00	3.22	3.76	3.81	3.70	142	-0.11	1.94
Guinea-Bissau	2.12	5.19	5.03	5.22	5.34	3.54	143	-1.80	1.42
Aruba	7.37	7.52	7.53	5.09	5.09	3.52	144	-1.57	-3.85
Eritrea	3.36	1.58	2.23	-	3.26	3.26	145	0.00	-0.10
Saint Kitts and Nevis	5.49	5.32	5.59	6.16	6.19	3.08	146	-3.11	-2.41

Economy	2004	2005	2006	2007	2008	2009	Rank 2009	Change 2009/2008	Change 2009/2004
Kiribati	3.06	3.28	3.05	3.06	3.06	2.85	147	-0.20	-0.21
Marshall Islands	3.49	3.68	3.26	3.06	3.06	2.85	148	-0.20	-0.63
Somalia	3.09	1.28	2.43	3.05	3.24	2.82	149	-0.42	-0.27
Switzerland	3.53	3.40	3.20	3.27	3.01	2.74	150	-0.27	-0.79
Dominica	2.33	2.51	2.33	2.40	2.31	2.73	151	0.41	0.40
Antigua and Barbuda	2.33	2.56	2.43	3.76	3.82	2.66	152	-1.16	0.33
Sao Tome and Principe	0.91	1.28	1.57	1.64	2.54	2.38	153	-0.16	1.47
Albania	0.40	0.40	0.40	2.28	1.98	2.30	154	0.31	1.89
Belize	2.19	2.59	2.62	2.61	2.32	2.30	155	-0.02	0.10
Greenland	2.32	2.32	2.27	2.27	2.36	2.27	156	-0.09	-0.04
Qatar	2.64	4.23	3.90	3.59	3.21	2.10	157	-1.12	-0.54
Cayman Islands	1.90	2.23	1.79	1.78	1.78	1.76	158	-0.02	-0.14
Bermuda	1.54	1.57	1.57	1.57	1.57	1.57	159	0.00	0.03
Czech Republic	0.44	0.44	0.44	0.44	3.20	0.44	160	-2.76	-0.00
Montenegro	2.92	2.92	2.96	2.96	3.20	0.02	161	-3.18	-2.90
Paraguay	0.53	0.53	6.32	6.30	0.65	0.00	162	-0.65	-0.53

Source: UNCTAD, based on data from *Containerisation International Online.*