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A study on empty container allocation

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A Study on Empty Container Allocation

By

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DECLARATION

I certify that all the material in this dissertation 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.

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ABSTRACT

Title of Dissertation：**A study on Empty Container Allocation**

Degree: **Master of Science in International Transport and Logistics**

Abstract ： Empty containers of every trade line in the world consume fleet's transportation and waste lots of money. Therefore, raise the extra cost of container transport have already caused the high attention of global container transport operator, broker, consignor and port quay owner. So how scientific allocation and transportation empty container in order to meet what company runs` needs and customer demand have become a question that enterprise pay close attention to study day by day.

In addition, through research of the empty container allocation question, can touch a lot of aspects in enterprise's container management; reflect some questions in the management. Therefore, in according to the achievement of empty container allocation to promote reform and perfection of business management, thus not only can save empty container allocation cost but also can realize the whole enterprise improve of operation quality.

KEYWORDS: empty container, allocation, strategy,

LIST OF CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

ISO	International Organization for Standardization
ABS	American Bureau of Shipping
GL	Germanischer Lloyd
FRP	Fiber Reinforced Plastics
TEU	Twenty feet Equivalent unit
FEFC	Far East Freight Conference
APL	American President Liner

Chapter1 Introduction

1.1 Background of the topics

Container transport in the world is keeping the steady growth situation; the unbalance characteristic of the container quantity is also seriously outstanding. The disequilibrium of trade, and the respects, such as container management, etc. reason, results in lots of empty containers from abundant source area to not sufficient source area every day, namely, has produced empty container allocation question.

Most insiders are thought that every one empty container transport fix cost is about 250-400 dollar. But in fact, this figure may be higher. In past recent years, the growth of most carriers` operation cost had already gone beyond the growth of the income greatly; this has explained surprising extraneous expense produced in logistics of the container.

According to the statistics up to the end of January of 2007, probably 50 million empty containers transporting on every trade line in the world one year, this means there is a empty one in every five containers on average.

Empty containers of every trade line in the world consume fleet's transportation and waste lots of money. Therefore, raise the extra cost of container transport have already caused the high attention of global container transport operator, broker, consignor and port quay owner. So how scientific allocation and transportation empty container in order to meet what company runs` needs and customer demand have become a question that enterprise pay close attention to study day by day.

In addition, through research of the empty container allocation question, can touch a lot of aspects in enterprise's container management; reflect some questions in the management. Therefore, in according to the achievement of empty container allocation to promote reform and perfection of business management, thus not only can save empty container allocation cost but also can realize the whole enterprise improve of operation quality.

1.2. Literature review

In the academia, researches on empty container allocation problem is mainly concentrated on highway and railway now, and under many kinds of transportation way, However, the quantitative study on the problem in multi-transportation way is still relative less. At present, the methods to solve the empty container allocation roughly go following as:

1. Through qualitative analysis, managing the empty container allocation from artificial experience, such as Xu Jianhua（1998）, Zhang Yang(2000) , and Xu Bonian, (2003) etc, qualitative analysis the problem, and had been provided solution to it about empty container allocation countermeasures.

2. Using the method of liner programming operations research (LP). Through establishment of liner programming mathematical model establishing the model of LP about empty container allocation, then one can solve out this model and draw the conclusion. Researchers optimize of quantitative study the empty container allocation by the LP methods, such as C.E.Philip, J.M.Xussman,(1977)

V.B.Mendiratta,(1981) M.A.Turnquist,(1982) Larry L.Ratcliffe, B.Vinod, Fredrick T.Sparrow,(1984) Teoor Gabriel Crainic, MichelGendreau and Pierre Dejax, (1992).Zhong Cheng, Xing Tianqi,(1994) Li Weibin, Zhao Jianhua,(1995) Zhu Fushou, Yang Xinyang,(1996) Dang Jianwu,(1999) Liu Darong, (2000)Shi Xin,(2003) Zhou Hongmei and Fang Fang, Huang Xiaozhang, (2003)etc. There are mainly three types:

① Static Analysis

Zhou Hongmei（The optimize studying of empty container allocation）, Zhao Hongzhou (1991) described the causes of empty containers and the problems existed in the empty container allocation. According to the container business processes, they listed out many elements affected the empty container allocation, and dealt with these elements with assumption, overlooked some minor factors, set these variables or constants. With objective of minimizing the cost of empty container allocation, they established a liner programming model about empty container allocation and solved it.

② Dynamic Analysis

Researcher like Teoor Gabriel Crainic, Michel Gendreau and Pierre Dejax, (1992) Wang Chuanxu, Liu Darong, He Bin (2001), Jiang Liangkui, ect. They studied the land empty container allocation, and believed the demand and supply of empty container is dynamic and random. Therefore they dealt these random variables with identify method (or determine the probability to statistics). ⑴ Lining a special “coverage area” for each section in the system, which intersect but does not overlap. ⑵ Stochastic demand of empty container need to meet (that is deliver empty container to customers) the conservative strategy of “ delay in delivery as late as possible”. That is delivery the empty container to the customer as his request date. Through treatment, according to the location of each stochastic empty container demand, and assigned to a station automatically in order to meet and precision of

knowing how they meet the time. Established a two-stage model of restricted resources, the first stage pointed out that all container flow from station to stations that are related with the customer's need, the second stage is that a simple container store model, which follows storing containers, and changes with the randomness of supply and demand in the station. This model is only applicable to the species of single-box.

③ Using multi-objective programming method

With the objective of container transportation by highway, Li Weibin, Zhao Jianhua(1995) thought that there are a lot of goals in optimization dispatch of container transport by highway, set up multi-objective programming mathematical model. The goals include: the goal counted with the index of container number, and the economic benefit goal counted with the economic index, which had been classified to have priority and been work out. Then the conclusion can be drawn.

3. Using network flow methods. Like W.W.White and A.M.Bomberault(1969) , research the railway transportation empty container allocation, they construct a space and a time model to describe the reality of empty container allocation problems, and gives the induced network flow algorithm, and the corresponding calculation examples of a period to optimize the empty container allocation program, the time interval is uncertain, the conclusion is very credible. For the reason that the research carried out mainly for the railway system of transport demand and supply of empty container allocation and its small size calculation, it is suitable for simple model, and cannot be applicable for out-of-stock situation. W.S.Shen and C.M.Khoong(1995) research the sea transport empty container allocation; their minds are the same as W.W.White and A.M.Bomberault. The model is mainly used to determine the model of network optimization. Decision variable is mainly the one to rent the box or return, and its assumed that the decision- making time interval is fixed, and that each port are facing make out decision in one time interval, which is contrary to the truth, and

cannot be applicable for the out-of-stock situation neither. Moreover, W.C.Jordan and M.A.Turnquist(1983), A.E.Haghani(1989), Kaj Homberg, Martin Joborn and AnT.Lundgren(1998), etc. also use of the network flow method to optimization quantitative analysis empty container allocation.

Otherwise, Liu Hengjiang and Shi Xin(2002), Liu Hengjiang combined the Petri network theory and the empty container allocation transport flow to set up dynamic empty container allocation model in order to study the problems.

1.3 The purpose of the thesis and research significant

As the international container transport service develops swift and violently in recent years, the global goods flow into out-of-balance, the supply and demand contradiction of container is conspicuous day by day. On some international shipping lines, the empty container proportion in the transporting amount of the container even exceeds 25% in the whole year. According to the present development trend, the global empty container allocation freight will exceed 5 billion dollars by 2010. Because of the empty container allocation freight is enormously, how science and rational allocate transport and handle the empty container, how control and reduce empty container allocate cost has been the key factor influence the carriers. It becomes the important subject need to be addressed urgently.

Can see clearly that the empty container allocation brought to the loss economic benefits of liner ship company is clearly. In this paper, the researches of empty container allocation introduce a strategy to optimize the system. Shipping enterprises use these tactics will optimize the allocation activity which will transport the container by sea, reduce the meaningless, unnecessary allocation amount, arrange to allocate and transport

way, circuit, time, etc. rationally. It will contribute to improving container utilization ration of liner ship company, and reduce the allocate cost and increase economic efficiency.

In addition, liner ship company can draw lessons from this paper, arrange for the empty container allocation rationally, prevent unnecessary repetition from being allocated, smooth the container circulates course, while shortening the phased of empty container allocation, accelerate the container turnover, and then improve the utilization rate of equipment and installations, reduce the total storage level of the company container and the taking up of circulating fund, lighten the burden of management of the container.

At the same time, as the liner ship company, research container lease decision is one of the most important respects to control the allocation cost, too. Therefore, this paper introduce the way of choose the lease container way, and offer the ship company with the rent container company sign the agreement should be followed some basic principles while negotiating.

Chapter 2 An Overview of Issues in Empty Containers Allocation

2.1 An Overview of container shipping services

2.1.1 Brief description of containers

1. Definition

The definition of the international standard container by the International Organization for Standardization (ISO) is as follow:

The container is a transportation equipment, (1) which must have excellent durability so that it can be used repeatedly; (2) which must be flexible to accommodate for one or more of shipping mode specifically designed for goods without requiring for midway outfit; (3) which must be equipped with devices for easy goods handing, especially those devices required for moving goods between different modes of transportation; (4) which must be designed for easy goods loading and unloading; and (5) which must have at least 1 m^3 content volume.

It must be noted that only the inspection is passed by a relevant certified organization can container be used as shipping equipment in freight operational transport. Internationally, containers used for freight operational transportation generally have fixed symbols or signs which are in accordance with the International Organization for Standardization and other international treaties. Presently, the international organizations which have the authority to issue such certificates include the American Bureau of Shipping (ABS), Germanischer Lloyd (GL), British Lloyds Register, Japan LR Ship

Goods Inspection, Japan Maritime Association, and Japan Inspection Association. In the container transportation, containers certified by the international standards are the packing equipment for standardized goods shipping, and the basic unit of container transportation. In the course of carriage, the containers are both part of the goods and part of transportation. Most of the containers used for the transportation are provided by shipping companies, or other container shipping businessmen, only a small number of these containers belong to the owners of the goods.

2. Classification of Containers

(1) Containers can be classified into 3 types by sizes including 20, 40 and 45 feet. The current international standard container has the same width as 8', four different sizes in height including 9'6", 8', 8'6'', and less than 8', and four different lengths including 40', 30', 20' and 10'.

(2) Containers can be classified into 4 types by their materials, including steel, aluminum alloy, fiber reinforced plastics (FRP), and stainless steel containers.

(3) Containers can also be classified based on their usage, including Dry Cargo Container, Reefer Container, Ventilated Container, Tank Container, Platform Container, Open Top Container, Car Container, Live Stock Container, and Garment Container.

2.1.2 Developmental history and characteristics of container transportation

1. Developmental history of container transportation

Container transportation is regarded as a modern transportation mode with more than 100 years of history. The British started the container transportation on railway as early as 1900, followed by the US (1917), Europe (1926) and Japan (1930). However, in flowing several decades, vigorous competition between highway and railway transportation prevented the integration of the two transportation modes. As a result, the advantages in container transportation had not been revealed. Therefore, the container transportation in the first half of the 20th century was in stagnation in its development.

It is now generally agreed that the real container transportation started in the 50s of the 20th century. It was symbolized by the experiment in 1956 carried out by Malcom McClean who was the president of Pan Atlantic Tanker Company. He creatively proposed that the container shipping should be expended from land to marine shipping. He also suggested that only land-sea shipping is controlled by a single company can the great advantage of container shipping be revealed. In April 1956, his Pan Atlantic Tanker Company firstly started sea-land intermodal container shipping between New York and Houston using a T2 type oil tanker containing 60 large containers. The three months experiments showed great economic benefits. Then in October 1957, the world first full container ship, Gateway City, owed by his company, was put to full operation, opening a new era of modern maritime shipping history.

In 60s and 70s of the twentieth century, the advantages of container shipment had been recognized by more and more countries in the world. As a result, the international container shipping, mainly used in sea transportation, had been rapidly developed and the world entered to a critical period of containerization. The fleets used for container shipping have gradually moved from original modification of other ships to the ships specifically designed and manufactured for the container shipping. The scale of fleet was consistently expanded. In order to match the need for container shipping development, all countries started to invest significant amount of funds to equip their port facilities, or

to expand or re-build container piers and to equip with a special loading facility for container shipping, in order to increase the efficiency of port loading and unloading processes. These developments further promoted the development of container transportation. Between 1970 and 2004, world's total container shipping carrying capacity has increased from 230,000 TEUs to 6,544,000 TEUs, and the container ships have reached everywhere in the world. The ships are now in their 5th generation. At present, the containerization for cargo transportation in developed countries has reached more than 80%.

2. The Characteristics of Container Transportation

It is the characteristics of container transportation that speed up its development and enable it to become a major means of cargo transportation. The sea container shipping has more than 40 years of history and connected with almost all sea transportation networks in the world. The containerization of cargo shipping has become an irreversible trend and container shipping is in its stage of maturity. Today's development of container transportation has following characteristics.

First, container transportation is a standard form of shipping services. The common use of container in the transportation for international trade urges to have a set of world-wide international standards related to container shipping services. The standardization for container includes the standards for container appearances and sizes, maximum weights, loading and unloading machineries, stacking machinery, and transport facilities; the specialization and standardization for transportation tools, transportation, loading and unloading, and stacking; the specialization and standardization for technology for shipping organization; and unification and standardization for shipping regulation.

Second, container transport is a form of transport with high efficiency. It possesses high efficiency in cargo handling, about 4 times of traditional non-bulk cargo and 1.7 times of tray cargo. It also reduces the port staying time of transportation tools, which increases operational efficiency and utilization rate of the stacking field.

Third, container transport is a form of transportation with high quality. It has reduced degrees of goods damage and losses during loading and unloading processes. It has also increased the speed of transportation by use of scheduled shipping services, ensuring on time delivery.

Fourth, container transport is a form of transportation requiring for large investment. Most of container vessels are large ships which cost more to build. Based on the information on container transportation, the costs to build a full container ship are 4 times more of a general non-bulk cargo ship. The large investments required for containers making and ships building change the cost structure of a shipping company. The fixed costs in many container shipping companies are more than 2/3 of their total costs. The costs are high to build special port for container shipping, stacking field and facilities. It also requires for special machinery equipments with high efficiency for goods handling. Compared to traditional port facilities and equipments, those specific to container shipping require high technology to build, which further increases original investment for operating container shipping services. In addition, the collecting and distributing System in port logistics for container shipping requires great investment as well.

Based on the characteristics of container transportation, it is clear that the main differences between container shipping and the traditional modes of transportation are as follows:

First, it has revolutionarily changed the port-to-port to door-to-door mode of transport in sea transportation services. Over the course that the goods is moves between inland shipper and consignee, the traditional mode of transport requires that the shipper (maybe seller or buyer or their representatives of a trade contract) sign separate transport contracts with carriers for different modes of transport and in different sections of the transportation course, and be responsible for all necessary intermodal transition works. The container transportation, however, has fundamentally changed the operational mode of shipping services, from single-mode and pure transportation model to multi-mode and transport plus services model.

Second, it has essentially changed uncoordinated and independent transportations between different transport modes in traditional transport process. With sea-land intermodal transportation, it enables original separated land (highway or railway) and sea transportation to become mutually coordinated and supported comprehensive shipping system controlled by a single company. Such good integration between different shipping modes has significantly reduced transport costs, increased economic benefits, and achieved rationale in transportation.

Further, it has fundamentally changed the transport modes for small batch and scattered goods organized independently by the shipper in traditional land transport, and achieved unified and organized land shipping, enabling scaled operation of land transportation.

2.2 Causes of empty container distribution

The essential reason for distribution of empty containers is the imbalance between the demand and supply for freight transportation. Some of the causes for such imbalance are objective and unavoidable, others are subjective, due to irrational scheduling.

2.2.1 Subjective causes

The subjective causes for distribution of empty containers refer to those human factors that are responsible for imbalanced container flow, leading to conflicts in demand and supply of containers. This is usually caused by improper operation policy or problems in management, mainly including:

1. Backlog of empty containers

Port facilities are not well developed to become international transshipment hub port. Most of China's cargo exports need to be transported to Japan and Hong Kong for transshipment. As a result, the cargo input is greater than output in most of container ports or cargo shipping stations in our country, leading to the backlog of empty containers. In addition, the port ability in collecting and distributing goods is relatively low, causing lengthened turnover time of containers and port backlog of containers. In such circumstances, shipping companies have to transport empty containers from nearby ports for use in order to ensure scheduled cargo shipments.

2. Information shortage and out-of-date communication means

Lacking of information has always been the main reason for excessive distribution of empty containers and low efficiency of transportation. Due to incomplete container

information management system between shipping companies and port representative agencies and out-of-date management system, the flow of related container documents is slow and improper; connection documents are incomplete; sharing of information on containers status is retarded. All these problems have significant impacts on the turnover period and distribution of containers. In this circumstance, empty containers have to be called up in order to deal with urgent needs for shipping services.

3. The restrictions to containers return sites in container rental agreement

Due to imbalance in types and quantities of the containers carried in and out of port, the distribution of the container sources is improper. In order to prevent or compensate the losses due to large container backlog caused by return of rental containers, it is strictly defined, in container rental agreement, the sites of container return and associated fees. The fees for container return vary in different regions, ranging from tens to hundreds of US dollars. As a result, container renters should return the containers to predefined sites, or the sites with lower return fees once the rental agreement expires. Otherwise, the renters have to pay greater amount of fees to the rental company for container return.

4. Regional differences in container repair costs and standards

Due to differences in container repair costs and in requirements for container repair among liner companies, the companies usually ship containers to a closer port garage where repair cost is low and repair quality is high for consideration of economic benefits and quality assurance. For instance, the hourly rate for container repair in Japan is about US$35, while US$3.2-3.5 in our country. In addition, some port garages in other countries may over claim repaired items, resulting in irrelevant repair cost estimate.

5. Uses of expired containers or improper containers

Expired containers are those being used by customers for longer than their expiration time. They usually refer to those containers stacked in yards or other places longer than regulated time period. The existence of expired containers has significant impact on normal container flow and reduces container utilization efficiency. Improper uses of such containers also impact on regular management of containers conducted by container management center.

2.2.2 Objective causes

The objective reasons causing distribution of empty containers are mainly those factors responsible for imbalanced goods distribution, e.g. imbalanced container transportation, but not subjected to human factors. Imbalanced container freight volume is essentially caused by differences in trade flow, including differences in volumes and differences caused by different types of equipments. For instance, special containers like reefer and tank containers have their own feature in distribution and usage circles. Generally speaking, it is common in all kinds of trades that consumer goods are usually needed in regions with high population density, which can cause surplus of containers and related equipments. In the meantime, there is a shortage of containers in areas with well developed manufacturing industries. Usually these two areas are not located in the same region. For heavy goods, small containers are used, while for light goods, large containers are required.

1. Imbalanced quantities of in- and out-of-port containers

There are two major causes responsible for this imbalance. One reason is world-wide imbalanced industries and industry structures. Based on a country's industry economics, some countries are dominated by primary industries (agriculture, mining, forestry, animal husbandry, and fishing), some by secondary industries (industry and construction industry), others by third industries (information, science and technology, finance, culture, education and health industries). As a result, large volumes of logistics are formed between different countries, and these logistics have been consistently increased. For instance, China, "factory of the world", requires more containers for export than import, resulting in increased demand for imported heavy containers. Another reason is imbalanced international trade. Once again using China as an example, during the 20 years between 1984 and 2003, 7 years had excessive imports and 13 years with excessive exports (table 2.1). As shown in the table, there have never been balanced international trades for China. Its trade difference is equivalent to total GDP of a middle sized country. This imbalanced trade will definitely lead to imbalanced freight transportation.

Table2. 1 World Trade Quantity of China in Recent Years

Year	Export	Import	Margin	Year	Export	Import	Margin
1984	261.39	274.1	-12.71	1994	1210.06	1156.14	53.92
1985	273.5	422.52	-149.02	1995	1487.8	1320.84	166.96
1986	309.42	429.04	-119.62	1996	1510.48	1388.33	122.15
1987	394.37	432.16	-37.79	1997	1827.92	1423.7	404.22
1988	475.16	552.68	-77.52	1998	1837.12	1402.3	434.75
1989	525.38	591.4	-66.02	1999	1949.31	1656.99	292.32
1990	620.91	533.45	87.56	2000	2492.03	2250.94	241.09
1991	719.10	637.91	81.19	2001	2660.98	2435.53	225.45
1992	849.4	805.85	43.55	2002	3255.96	2951.7	304.26
1993	917.44	1039.59	-122.15	2003	4383.71	4128.36	255.34

Presently, for almost all freight liners across the world, imbalanced goods flow exist which are caused by seasonal variation in freight transportation and imbalanced trades between countries or regions at two ends of a shipping route. With regards to seasonal variations, western nations have their low season early in a year, gradually increase in April and May, leading to increased quantity of trade; Regarding the freight lines, there are three main container shipping routes, across Pacific (Far East / North America), Far East / Europe, and across Atlantic (North America / Europe). In 2005, 57% of global total freights are shipped via these three routes. However, significant trade imbalances are associated with these lines. Along with east-west freight line in Asia, shipping volumes from Asia to Europe in 2002 was 2,860,000 TEU, based on Far East Freight Conference (FEFC), while the volumes to the east were only 1,920,000 TEU, resulting in nearly million TEU differences in trade volumes. Looking at European and American freight lines, the shipping volumes to the west (Europe to North America) in 1998 were more than that to the east (North America – Europe), and such differences are gradually increased. For Far East / North America shipping lines, the same problems exist remarkably. The export from Asia is far more than the import to Asia. For instance, shipping companies serving for across-pacific lines in 2006 almost face to at least 7% increase in shipping costs, which are caused by serious imbalances in goods flow between the east and west ends of the Pacific Ocean. The goods flow ratio between eastbound and westbound reaches 2.8:1, causing 11% increase in costs for empty containers distribution. Table 2.2 shows the shipping volumes and increase rates of above mentioned three major shipping routes between 2001 and 2005.

According to Drewry, the cross-Pacific and Far East/Europe shipping routes have the largest volumes of sea container shipping. From table 2.2, there are significant imbalance in trade volumes between eastbound and westbound shipping along with both cross-Pacific and Far East/Europe shipping routes. For cross-Pacific shipping route, the imbalance refers to more heavy containers (measured by TEU) are shipped into North

American than those shipped out of North America. Such imbalance tends to increase annually. The imbalance between eastbound and westbound shipping on Far East/Europe routes, in the same pattern, is featured that more heavy containers (measured by TEU) are shipped into Europe than those shipped out of Europe.

Table2. 2 Container Transportation Quantity and Increase Rate of the Main Route

Year	Step Pacific Ocean				Far east----- European				Step Atlantic Ocean			
	eastbound	Annual rate of growth(%)	westing	Annual rate of growth(%)	eastbound	Annual rate of growth(%)	westing	Annual rate of growth(%)	eastboud	Annual rate of growth (%)	westing	Annul rate of growth (%)
2000	7211	14.6	3775	9.6	2687	10.5	4077	6.0	1516	0.6	2101	11.1
2001	7352	2.0	3654	-3.2	2822	5.4	4075	0.0	1543	1.8	2124	1.1
2002	8766	19.2	3899	6.7	2978	5.9	4432	8.8	1546	0.2	2181	2.7
2003	9632	9.9	4375	12.2	3255	9.0	5206	17.5	1583	2.4	2207	1.2
2004	11091	15.1	4812	10.0	3701	13.7	6064	16.5	1698	7.3	2298	4.1
2005	12382	11.6	5211	8.3	3983	7.6	7055	16.4	1834	8.0	2384	3.8

2. Imbalance in types of containers used for import and export in a port

Based on the facts that there exist in type and nature of import/export goods, and different rate of service fees for shipping and goods handling, shippers usually use different sized containers for import and export trades from the point of view of economic benefits. Such usage often causes imbalance in goods flow with different types of containers, and in different directions, causing allocation of empty containers.

Using Far East – Europe shipping route as an example, westbound goods are more light cargo, suited to large container shipping; while eastbound goods are more heavy cargo, requiring for small containers. As a result, large containers are shortened for westbound shipping and small containers shortened for eastbound shipping. In addition, imbalance in cargo flow is more series with reefer and tank containers due to their special usage for special cargo shipping purposes.

3. Empty container transportation between where they are manufactured and used

China is dominated in container manufacture across the world, producing nearly 90% of all dry cargo containers, resulting in that all Chinese container manufactures transport their containers across the world.

In summary, objective imbalance exists in freight flow, flow quantity and types of goods. It is unavoidable to generate certain amount of empty containers. However, it is realistic to reduce the amount of empty containers allocation by means of enhanced management and modernized container usage management.

2.3 The characteristics of empty container allocation

Problems with empty containers distribution are mainly manifested as below:

1. Restrictions of time and space

There are many constraints in time and space for allocation of empty containers if these containers are transported by sea. Liner container shipping must be done based on

predefined schedules and routes. In order to satisfy with shippers' demands for containers and ensure shippers' on-time trades, empty containers in reality must be provided within the schedules. Unmet scheduled supply of empty containers will result in loss in credits and violation of contract; early shipping of empty containers from where they are required to where they are supplied will cause loss due to costs used for stacking empty containers. In addition, the quantities of redistributed empty containers by sea are restricted by the left-over shipping spaces because heavy containers always have priority for shipping. Therefore, allocation of empty containers by sea is restricted by time and space.

2. Randomness of requirements for empty container allocation

The randomness of requirements for empty container allocation is manifested by the randomness of empty container demand and supply. When shippers reserve berths to liners, the requirements for empty containers are generated simultaneously. The empty containers are usually supplied by two major sources: one is the containers returned to stacking fields or freight terminals by shippers after retrieving the goods; the other is the empty containers rented or redistributed to the port by freight liners. The first source has obvious randomness to supply empty containers in time and space while the second source is random in time when the empty containers can be supplied.

3. Variability

The objective reasons causing allocation of empty containers determine that ports' demand and supply for certain types and sizes of empty containers remains consistent for certain period of time. However, season change or other unexpected events may alter ports' demand for empty containers. In addition, requirements for empty containers can occur any time, therefore, freight liners must anticipate to plan quantities and direction

of allocation of empty containers based on actual situation. This is characteristics of variability in allocation of empty containers.

4. Complexity

The randomness and variability in allocation of empty containers have already showed the complexity in empty container management. In addition, change of transportation routes, limitation of container transport, and choices of transport modes during the process of empty container allocation further increase the degree of the complexity. The transport flow of containers is involved multiple partners, which easily causes ambiguous connections. Complicated types of containers, such as 20 ft, 40 ft, 45 ft, general containers, high containers, reefer containers and so on all increase the complexity of empty container allocation.

2.4 Problems to be resolved in empty container allocation

From economics point of view, freight liners and other container users will try to make reasonable purchase of containers and propose proper demand for container supply for the purpose of maximizing the economic benefits. Container users purchase definite number of containers, therefore, the number of containers circulating in the market is limited. So the resources for containers are rare. On the other hand, the supply sometimes is more than demand for containers. In such situation, the allocation of empty containers is emphasized how to distribute, how many to be distributed, and when to distribute in order to match current and future needs. When demand for containers is more than supply, it needs to consider shipping some containers from other sites. From this point of view, empty container allocation is actually to solve the imbalance of

supply and demand of containers. It is also to control and decide the flow of containers from the site of supply to the site of demand. The purpose to study empty container allocation is to minimize the costs and to maximize the benefits and satisfy with customers demands. The core in managing empty container allocation is to solve the following four problems:

1. Where empty containers will be shipped from – the shipping routes of empty containers from suppliers to shippers

There are in reality no fixed places for container supply and usage. Some places are at one time users of containers, and can become suppliers at other times. Therefore, it is important to determine the quantities of container supply and demand in different areas for certain time periods so that the supply and demand places for empty containers can be determined for that period of time.

2. When to redistribute empty containers – time for empty container allocation?

The time to ship empty containers is determined to ensure to provide containers for customers when required. Therefore, it must be considered what the best time is to ship the containers with available shipping facilities. Shipping by highway and railway can be generally started whenever necessary and have no significant dependence on transport tools. Shipping by sea cannot be in general started at the time when required because freight liners are generally scheduled for shipping services. In addition, shipping by sea emphasizes on the loading efficiency and prioritizes heavy loaded containers. Empty containers are only considered when extra spaces are available. Further overloading often occurs in liner shipping which may prevent empty containers to be shipped as previously planned. All these situations have increased the difficulty to ensure scheduled empty container distribution by sea.

3. How many empty containers to be distributed – flow volumes between the places of supply and demand?

When determining the objectives of empty container distribution, multiple factors need to be considered including (1) shipping costs such as transportation cost, loading and unloading costs, shipping costs, haulage, disassembly and assembly costs, and handling charges so on; (2) possibility to achieve objectives: to maximize profits and minimize costs, the emphasis must be put on how to achieve the maximum profits and minimum costs; for the purpose to satisfy with customers' demand, the emphasis should be put on how to provide quality services to customers in the shortest time and the fastest speed; (3) feasibility of distribution: whether empty containers can be shipped within the schedule from supplying places to the places demanded; whether the all distribution plans can be carried out successfully within scheduled timer period. With the consideration of all above mentioned conditions, staff can make a plan to decide when, where and how many empty containers need to be redistributed and implement the plan.

4. How to strategically rent containers?

When a port container stock plus the containers redistributed from other ports still cannot match customers' demands, or there are enough containers that can be redistributed but the distribution costs are significant high, freight liners usually select the strategy to use their own containers with rented containers to solve the problem. How to strategically rent containers is determined by the overall objective of allocation of empty containers: to reduce the cost with primary consideration in satisfying with customers' demands.

5. The mode of transportation

As part of the process in empty container allocation, selection of mode of transportation is an important factor which needs to be considered in optimization of empty container allocation. Due to various differences in shipping costs, objective reachability, availability of transport tools within certain time periods among different modes of transportation, different shipping modes will all contribute differently to the overall objectives. Therefore, staff for container distribution is required to choose the best mode of transportation with consideration in pros and cons of all different modes, company's objects and feasibility.

2.5 The practice and current trends in empty container allocation within marine shipping services industry

2.5.1 The practice of shipping empty containers in marine shipping industry

At present, the main container liner companies operate their business across the world and its service outlets are located in most of main ports and regions in the world. Different regions have different volumes of goods import and export, different shipping destinations, and varied types of goods for shipping. This, together with other factors, will impact on the trades in different regions, resulting in imbalanced quantities of containers that are stacked in different ports and regions. As time goes, the same region may have excessive empty containers stacked and may be short of containers other times. As rapid development in container shipping business, allocation of empty containers has become the major problem that must be dealt with. At the time when containers are used

for shipping business, containers need to be moved multiple times, including shippers retrieving empty containers, loading containers, inland transportation, hauling heavy containers to port, cargo loading, transport by sea, uploading, hauling containers away from ports, container disassembly by recipients, and containers returned to port and so on. Every move may always require for special transport tools, generating certain costs. Therefore, the volumes of required empty container allocation is directly related to matching container quantity and rented container quantity of a freight liner, which will directly determine the costs of container shipping for that liner company. Low efficiency of empty container allocation management will not only waste large quantity of empty container resources, but also significantly increase the costs of container shipping services, which generate very significant impact on the economic benefits of container shipping companies.

1. Problems in empty container allocation management with Cosco

The Container Management Center of Cosco group is responsible for container allocation, for the corporation as a whole. Centered by the department of the company's container management, shipping route operators and representatives of port container management are all part of the corporation's container management system. This is so-called one-level scheduling and three-level administration system. This system monitors and tracks cooperation's containers across the world and enhances its overall management ability of containers. The key is that empty container scheduling and allocation is based on accurate prediction of its cargo flow volumes. For management operation of containers, the core to manage demand and supply of empty containers is the container management system which is an important component of container shipping management system (EDI). It belongs to web-based management information system, networking computers across all ports. This system can track its dynamics of containers. The data is refreshed daily by container management administrators in each

port. The statistics for demand-supply of containers and currently available containers at any time is then generated as evidence to make the allocation plan for empty containers, which optimizes empty container allocation. When planning container allocation, the PDCA general quality management system is used, which is a repeated cycle like: statistics – prediction, plan – implementation – summarization. The department of container management generalizes the information, sends orders for empty allocation to sub-branches of container management and liner operators. This will be repeated several times in order to achieve balanced container allocation and satisfy with demand for empty containers from all aspects. Finally, the department will make the decision and implement the plan for empty container allocation.

2. Container allocation with China Shipping

Issues in empty container allocation exist in almost all shipping routes managed by China shipping Co. The ratio of redistributed empty containers to total used containers is 20 percent. The overall management system of empty containers by the corporation is that the Container Management Center in the corporation headquarter is responsible for overall container usage planning. The representative centers in all affiliated ports are responsible for the actual management of the containers stacked in and outside of the ports. The principle for the corporation to redistribute containers is to do one time shipping of empty containers from the ports with excessive empty containers to the ports with shortage. The overall allocation plan (where, how many and when to redistribute empty containers) is made by the management center and based upon the information of shipping profiles of all shipping routes, including shipping schedules, utilization rate, freight cargo, and shipping plan for containers. Orders based on the plan will be issued to all container management representatives of all affiliated ports and shipping routes operators. The overall plan is finally implemented by the management center after balancing the demand and supply for empty containers from all aspects. In addition, a

department in charge of heavy container shipping services is established in the headquarter of the corporation. This department produces statistical probabilities related to total container usage, produced empty containers, and container demand in order to assist in the management of empty containers in the department of container management.

2.5.2 Current situation and problems in management of empty container allocation

In all distribution networks for containers, the flow of empty containers is essential to the flow of heavy containers. Therefore, irrational management of empty containers will reduce the efficiency of shipping operation. In addition, shipping companies must speed up the circulation of empty containers in order to reduce their portions of the costs associated with container usage. As a result, batches of empty containers are shipped from places with surplus to the places with shortage every day, which creates a situation that many containers are shipped around without profits.

Data from US showed that 20% of the containers shipped by sea is empty containers. The data from major ports in north Europe showed that at least 15% of the containers input/putout of a port is empty ones. Statistics from ports Hanberg and Lutedan indicate that 13-14% of all the containers moving in and out of these two ports is empty containers; similar statistics for the ports of Anteweipu and Masai/fusi, the other two large ports in Europe, show as high as 20% of the containers is empty. The empty containers exported from the Port Masai are very low, but more than 1/3 of the imported containers to the port is empty. The three largest ports in western costal USA, including Los Angeles, Long Beach and Oakland, have as high as 26% of empty containers. In Asia, the empty container ratio reaches to 16% in Japan.

According to the report of the survey conducted by Drewry Marine Shipping Consultation company, the costs for shipping empty containers in all container shipping business across the world are as follows: costs related to directly or indirectly redistributed empty containers in 1997 was as much as US$1.05 billions, which reached to US$1.20 billions in 1998. In 2001, the global container allocation is about 20% of total shipped containers, 50% for some shipping routes, and total costs related to global empty container shipping reached to US$2.5 billions. As this trends goes, total costs for global empty container shipping will reach to US$ 5 billions in 2010. The empty container allocation costs magnificently, it is one of the most common and dominated problems related to container management among all shipping liners, and is directly related to economic benefits in the business of container shipping. Therefore, how to scientifically and rationally redistribute and manage empty containers and how to control and reduce the costs related to empty container allocation have become a key factor that determines business success of container shipping services operators. Whether or not the empty container allocation strategy of a shipping liner is rational and the quantity of the empty containers required to be redistributed will, on one hand, have impact on total containers required for the shipping liner, and on the other hand, will directly influence the business success of the liner. To minimize costs related to container allocation is generally a standard in empty container allocation by shipping liners.

Presently shipping companies have gradually recognized the importance in empty container allocation. Most of marine shipping companies have formed container management center responsible for empty container allocation, and adopted integrated system to manage empty containers. The solution for empty container allocation, however, mostly relies on their practical experience in empty container management. The management is that company container dispatching staff collects data of demand and supply for empty containers from different places, analyzes the data to balance

different situation, and then issues the order for empty container allocation. Then the representatives and branches in different places complete the implementation of the orders. In order to manage excessive quantity of empty containers, to deal with too many affiliated marine shipping liners, and to ensure effective control of empty containers, many large shipping corporations have invested significantly to develop computer management system for tracking empty containers globally so that the corporation can get information on time on situation of the empty containers. Small and middle sized shipping companies invest relatively less on such development. These companies use out-of-date management mechanism, often have some of their containers lost.

The on-site management level varies among shipping liners, which is often determined the quality of services the port can provide and integrated operation level in stacking fields. The shortages in operation management among shipping liners are mainly indicated by the following:

1. It is often lacking of scientific support to form appropriate match in supply and demand of containers for shipping services. The inappropriate prediction for the demand for container usage causes significantly over-stacked empty containers in some regions, and no containers available for the areas requiring for.
2. Low level in management of representative ports, low quality in information tracking, and unable to provide accurate base data for container allocation.
3. The on-site allocation is improper, often causing repeated allocation, which increases costs for empty container allocation and uploading.
4. Incomplete system for container retrieval and return, without standard forms for container retrieval and return, causing confused retrieval and return, unclear responsibility, and even lost containers.

It is generally accepted that current management for empty container allocation cannot be matched to the requirements for the development of the shipping services. For instance, it still has relative longer circulation period of containers, low efficiency of cargo shipping, out-of-date approaches in container tracking, low ability in macro-level control, and lost containers etc. It is an urgent issue we are facing to enhance management of empty containers to rapidly form a rational and scientific management system in containers.

Chapter 3 Study in Strategy of Empty Container Allocation in Marine Shipping Services

Given how empty containers are generated, it is possible to find an optimal strategy for empty container allocation through research. Therefore, empty containers can be moved from where excessive empty containers exist to where they are lacking. The allocation will be only done once. Avoidance of twice or more than twice allocation of empty containers will reduce the cost of allocation.

3.1 Build Port as International Container hub port

The input and output in all ports in China are relatively too small to become connection port of containers. The well know ports in Asia include Busan, Kobe, Tokyo, Yokohama, Kaohsiung, Hong Kong and Singapore where a large portions of containers in our country are connected for the next shipping. Therefore, it is necessary to build container connection port in our country. In 2003, the input and output of containers in Shanghai was 1.128 million TEU, the 3rd world largest container port. It has gradually played a more and more role in international marine shipping services. Shanghai port has now been assigned to many important duties by the government. The establishment of Shanghai Marine Shipping Exchange Institute and Shanghai Marine Shipping Management Center are the foundation upon which Shanghai will become international marine shipping center. As of November 2008, Shanghai port has completed a total of 25.78 million TEU of container input and output shipping, 108.1% of the same month in previous year, and reduces the difference to Singapore and Hong Kong.

At the same time, the port input/output in our country has been increased rapidly. The port production has made remarkable achievements. As showed by figure 4.1, the input/output of containers in Guangzhou port continues to increase, far advanced to Tianjin port. Actually, the increase in input/output in Guangzhou port tops among all ports in China, becoming a series threat to its neighbor ports, Shenzhen and Hong Kong. This indicates a successful change in production mode in Guangzhou port. In addition, Lianyungang port with more and more success in container input/output first time entered to the top 10 largest ports in 2004. It is even better in 2008, exceeds Yingkou port, ranked at the 9th, and continues to grow. Ningbo port, implementing strategy of low price and good quality services, has gained significant amount of import cargo sources in Zhejiang province and partner with some freight liners to operate destination end marine routes.

Table3. 1 2008 China international standard port container throughput top 10 rankings

Rank	Port Name	Cumulative since the beginning of the year, 10K, TEU	Since the beginning of the same period last year, %
1	Shang Hai	2578.59	108.1
2	Shen Zhen	1973.25	104.9
3	Guang Zhou	1031.2	122.4
4	Ning Buo	1016.62	118.3
5	Qing Dao	919.65	106.4
6	Tian Jing	776.06	119.6
7	Xia Men	464.28	110.3
8	Da Lian	410.83	118.4
9	Lian Yun Gang	262.98	148.4
10	Ying Kou	188.32	149

Near sea shipping service routes attract the most competition among shipping liners in our country, with most shipping liners participating in the competition, with the densities scheduled shipping liners. A large portion of the cargo shipped in these routes requires for connections and exchanges. For instance, 48% of shipping to Korea are connection cargo. Most of our exports to US need to be connected in ports in Japan, Korea and Singapore. With gradually increased shipping routes in China and the changes in connection ports, the flow direction after connection of the cargo shipped by near sea routes will also be changed. The current port competition pattern shows that ports in Korea are still in developing stages, the connection port function in ports in Singapore, Taiwan and Japan are gradually downsizing, while Shanghai port is gradually emerging as a new connection port. Therefore, to speed up development of Shanghai international marine shipping center, and to enable it to become international connection port will stop our country's cargo to be connected in other countries. This will fundamentally avoid imbalanced ratio of exist and entry of containers, so reduces allocation of empty containers.

3.2 Alliance and Cooperation of All Related Enterprises (Shipping Liners, Container Rental Companies and Container Manufacturers)

3.2.1 Alliance between Shipping Liners

Theoretically, the more container spaces a freight liner has, the more shipping service routes it has, the more options it has for empty container allocation. For a freight liner, its alliance and cooperation with other shipping liners will help expand its services and achieve sharing containers. Development of such alliance networks among those

main trade shipping routes will enhance and promote container exchanges between shipping liners so that empty containers can be efficiently shipped by shipping liners.

Today the competition among international freight liners is no longer between individual companies, rather more and more between business groups. This is because that customers not only require for high quality services on every shipping route, but also ask for rapid cargo connections, high density scheduled liners and low cost for shipping services. All these requirement force liners to be alliance or cooperated.

Cooperation between liners can be many kinds, such as liner space rental or exchange, shared ship agreement or strategic alliance etc. Among all different types of cooperation, liner space rental is the simplest, commonest and feasible one. Temporarily rented liner spaces can increase shipping capacity in certain shipping routes.

Exchange of shipping spaces is another close cooperation between shipping liners. The exchange is actually dural space trade, e.g. one side sells its space to another side and buys other side's space in the same time. The space exchange can occur in different shipping routes, but mostly occurs in the same shipping routes. It is an approach to expand service area, and has become an important component for main shipping routes of some freight liners. For instance, COSCO, Hanjin and K-Line, YangMing have achieved mutual space exchange along Atlantic and Aisa-Europe shipping routes.

Line sharing agreement refers to sharing liner in specified shipping routes. It can cover one or many shipping routes. It doesn't require every member of the agreement to share certain shipping services, but every member can have shipping space defined in the agreement in every scheduled shipping service. The typical example in this aspect is the liner sharing agreement in Atlantic shipping route.

For strategic purpose, members of strategic alliance have reached long term cooperation agreement. This alliance of liners can increase utilization rate of liners for container shipping and utilization rate of containers, and reduce shipping services for empty containers.

This cooperation among freight liners will increase utilization rate of container equipments, reduce allocation of empty containers, and reduce the costs for container management. Because every shipping company has varied cargo shipping quantity and demand for containers in every port or origins of cargo, the places where some companies have excessive and stacked empty containers may be the same places where other companies have large demand for empty containers. With carefully made plan, mutual exchange and allocation of these empty containers can reach win-win objective. For instance, Cosco has actively cooperated with K-Linei, Yangming and hanjin in use of containers. Presently, this named as CKYL alliance has become the largest container alliance group in the world. The excessive containers of Cosco in some ports have been rented, or free to other freight liners. Cosco then collects their containers in the places requiring for containers or places with lower cost for empty container allocation, greatly improving the situation that Cosco requires containers for services. There are many agencies in North America and Europe who specialize in this type of business. The purpose is to allocate excessive empty containers of a company to those shipping companies in the same area requiring for empty containers, and then the empty container users will return the container to designated regions. Such operation will reduce quantity of redistributed empty containers of all shipping companies.

3.2.2Alliance and cooperation between shipping liners and container renting companies

Shipping company can compare the costs between renting and redistributing empty containers, and rent containers to match the demand when renting cost is relatively low. Freight liners can sign a favorite contract with container renting companies. Based on actual demand for container usage, the company can rent containers in places where containers are lacking and cost of allocation is high, then return rented containers to renting companies in places where excessive empty containers exist. This way, on one hand, will satisfy for demand for containers, and on the other hand, save fees for container stacking and allocation. Freight liners can be secondary container owner, subletting their rented containers. Some companies may only temporarily sublet a few extra empty containers, others have made large scale container rental plan. For instance, the American President Liner (APL) has recently sublet about 10% of rented containers to other shipping liners.

Participation in use of spare spaces of shipping liners on a shipping route may enable shipping liners to move around empty containers in high efficiency. Container renting company can also take charge of overall management of all containers of a shipping liner, which can reduce the cost for small size container shipping companies.

3.2.3 Cooperation between shipping company and container manufacturers

The liner companies can cooperate with container manufacturers to provide free shipping services for the containers that the manufacturers build and need to be shipped to users, in the meantime, enjoy free or low cost in using new containers made by the manufacturers. Given that China will still be the center of container manufacture in the world in next several decades, it can be predicted that there will be at least 150,000 TEU new containers provided to shipping liners. The manufacturers will be happy to cooperate with liners in order to reduce the costs for new container delivery. For

instance, Cosco cooperates with container manufacturers and other associated container owners, providing shipping services for new container delivery while enjoying free use of container or one-way free use of containers, saving significant amount of costs for container usage.

3.3 Other strategies

3.3.1 Rational design and adjustment of shipping routes

Through adjustment of the operation of shipping routes, traditionally required docking to ports can be changed to reduce the quantity and distance of redistributed containers, then reduce the loss due to imbalanced shipping volumes of containers. This is a common and effective approach currently used by freight liners. If there are fair amount of cargo suited for container shipping within short distances around the regions with excessive empty containers, the adjustment of shipping routes may be easily made to ship those cargoes, reducing cost for container allocation. Middle East and Australia are the places with large amount of cargoes suited for container shipping in Far East and South Asian regions. Therefore, liners on Maersk Europe/Australia shipping routes all dock to ports in north Singapore. At present, due to large amount of cargoes in Middle East areas, many shipping liners have used shipping routes of Europe-Middle East-Far East-Europe and Europe-Middle East-South Asia-Europe more and more. In addition, in the eastbound of Australia-Europe shipping route developed by Maersk, lines dock in Santos Brazil because of increased amount of export cargo. Due to increased export in Mumbai and Karachi, more and more container shipping companies have started a new shipping route Far East-Middle East-South Asia-Far East in order to make use of large

amount of Far East, India and Pakistan exports. APL has developed a shipping route connecting Singapore and Red Sea via Gulf of Aden so that it can use Singapore as international connection port to redistribute empty containers from Australia and Saudi Arabia and make use of Colombo and Aden as connection ports in Gulf to ship import and export cargoes from Gulf region, India and Pakistan.

In addition, the CMA's global route is an examplenary shipping route to reduce requirement for empty container allocation. In this Europe-North America-Australia-Asia-Europe global shipping route, only the shortest portion of Australia-Asia is the weak point of the whole shipping route. Such a route has significantly reduced the cost. Wilson William's North America-Australia-Asia-North America is also a good shipping route which can reduce cost of shipping services.

Although this kind of route can reduce allocation of empty containers and cost of shipping services, the use of many regional connection transportation rather than direct shipping routes has increased shipping times and reduced the quality of services. In addition, such routes require high level management of shipping liners and need to build high efficiency local transportation networks.

3.3.2 Strengthen control of land shipping services for empty containers and costs for allocation of empty containers along with common regional shipping routes

Because it is rare that the main route ships owned by liners directly dock the ports, more and more containers need common regional routes and hauling to move containers to other ports and sites in inland for container return. This will cause fair amount of work that the liner owner need to arrange land hauling of empty containers and allocation via common regional shipping routes. Generally speaking, such costs are even higher than the cost for long distance marine empty container shipping by liner owners' main route ships. Because allocation of these empty containers is usually

arranged by local regional representatives, plus complicated allocation routes and varied fee rates etc, it is difficult for ship owners to control the details of operation, so that it is difficult to know if the fees paid are appropriate. For a company with annual 300,000 TEU container shipping volumes, the costs for hauling and common regional routes allocation of empty container in a year can reach to millions of US dollars. It is necessary, then, to study regional liners and hauling fees in nearby regions in order to confirm rationale of representative service costs.

3.3.3 To accelerate container flow circle by multi-intermodal shipping services

While containers are circulated in use, the turnover speed can be increased by enhancing logistics system and control the length of time when containers on routes. By increasing efficiency of cargo handling in port, increasing direct exchange ratio in multi-intermodal shipping services, the time of containers in port will be reduced. By close coordination among different shipping systems as railway, highway, marine and inland waterway shipping services, the time used for containers circulating inland will be reduced so that the utilization rate of containers will be raised, providing more container sources and reducing quantity of empty containers to be redistributed.

3.3.4 Appropriately using various types of containers

When shipping cargoes, selection of appropriate containers can be made by considering the input-output volumes of all ports on the shipping routes and whether or not containers can be used out when returning from the destination port. Such selection will help appropriate utilization of containers and reduce allocation of empty containers.

For the routes with relative smaller batch cargoes, containers with middle sizes need to be selected for use. For instance, if there are more light goods in import-export trades, large sized containers can be considered for use. For those routes with imbalanced in-out volumes of cargoes, foldable containers should be considered for use. To fold such foldable containers, three people are needed as one working group. The whole process to fold a container requires about 15 minutes. Selection of such foldable containers can reduce the losses in shipping spaces and varied handling fees when liners come back from the destination.

In addition, when shipping non-risky liquid chemicals, containers specific to liquid cargo should be considered for use. Bags for liquid cargo weighs only about 2% of the cargo weight when emptied. A 20 feet long ISO standard container can return 15 foldable liquid bags and other accessories. Therefore, originally required space for 16 20 feet containers can now be done in one container space. This will no doubt save fairly amount of money for marine shipping services.

When required for container exchange with foreign shipping liners, internationally used containers should be selected for use. In actual operation, when self-purchased containers and long-term rented containers occupy certain proportion of overall port's containers, the container shipping companies will be responsible for costs for containers stacking fees and allocation fee. When rented containers constitute certain proportion of equipped containers and when shipping cargoes are decreasing, the costs for empty containers and allocation will be reduced. Freight liners need to rationally determine ratios among feasible renting containers, long term renting and self-purchased containers in order to improve container circulation circle and raise the degree of their usage.

3.3.5 To strengthen the development of information system

Large shipping companies should develop and improve information system for global container management in order to obtain container status and related information, so that the companies will be in an active position to control self-needed empty containers to avoid passively redistributing containers. For instance, Hapag-Lloyd studied problems specific to empty container allocation and improve its management flow, which resulted in the best achievement in 1999-2000 in company's 154 year history. Income was increased from 3 billion Euros to 3.6 billion Euros. The profit increase, after considering depreciation, was 109 million Euros, equivalent 130% increase.

3.3.6 Operation scales

Maersk's success in merging P&O has become super marine shipping group, which proposes a new pattern in resolving imbalanced container transportation in the world. Maersk has developed global transportation network, together with its ownership of series of connection ports and advanced computer management system across the world, it can determine the best allocation location of any container in any time, and can use the cheapest approach to redistribute containers.

Although scale operation required high level hardware in operation network, computer system, connection ports and business management, this operation is the best approach in reducing imbalanced container transportation. Although current alliance and mutually rental spaces can reduce original investment, this incomplete cooperation and complex partners in different shipping routes, and competition among partners all

significantly reduce economic benefits of scale management. Given the economics of scale management in container transportation, Maersk's global network will be more and more adopted by other container shipping companies. This will no doubt cause a wave of business merges. As showed in figure3-2, the top 10 container shipping liners in the world have owned 60% of total business. Therefore, any of their movements such as merge, cooperation and alliance will generate huge impacts on overall market of marine container shipping services.

Table3. 2 The latest top 20 rankings of two big liner companies

Company	Rank	Global capacity, % quota	TEU Total	Total number of ships	Self-owned ship, TEU	Total number of self-owned ships
Maersk	1	16.3	1,974,889	546	1,046,384	193
MSC	2	10.3	1,248,702	382	712,015	214
CMA	3	7.5	904,396	381	282,257	90
Evergreen	4	5.2	623,851	176	363,425	102
Hapag-Lloyd	5	4.1	496,914	139	256,581	61
COSCO	6	3.6	441,014	142	242,561	95
CS	7	3.6	431,718	139	251,192	87
APL	8	3.4	409,207	126	134,798	37
NYK	9	3.3	399,585	120	245,632	49
Han Jin	10	3.0	359,802	86	126,821	24
MOL	11	3.0	359,725	112	179,498	40
OOCL	12	2.9	253,977	83	204,915	36
K-Line	13	2.6	309,382	94	169,306	34
Hamburg Sud	14	2.4	286,461	119	116,209	38
ZIM	15	2.4	286,082	113	136,009	42
Yang Ming	16	2.3	274,281	83	172,825	51
CSAV	17	2.3	272,589	91	21,208	4
HMM	18	1.9	234,721	53	76,465	14
PIL	19	1.4	173,832	111	103,358	72
Wan Hai Lines	20	1.2	142,981	83	101,237	52

Chapter 4: The Choice for Land Empty Container Allocation for shipping company

With the development of international multimodal transportation system, more shippers choose door-to-door shipping services. The shipping company deliver cargo directly to recipients' factory or warehouse, which provides great convenience to shippers. The shipper only needs to select a single shipping operator and pay one-time fee. When conflicts occur, shipper only needs to deal with the operator. However, this brings another problem to the liners. There are no profits to be generated from recipients back to the port. How to better manage empty containers and to reduce cost is a realistic question. Usually there are four options available for shipping liners when redistributing empty containers by land: seeking for empty container shipping operator in the market, signing contract with railway shipping company; use of highway transportation trucks, or via IMC providing shipping services.

4.1 Periodically seeking empty container shipping operators in the market

So-called periodically seeking for empty container shipping operators "spot reposition" is that shipping liners chose operators providing empty container transportation services periodically from market. There are many operators providing land container shipping services in market. Shipping liners contact with service operators via telephone, fax or email and inform them the origin and destination and time for container allocation. Shipping market can provide fee rate based on the number of empty containers, distance of allocation and time. If both sides agree with the contract,

the contract is effective immediately. Such trade is characterized by rapid agreement and short contract. However, there are many deficiencies in such trade:

(1) When the agreement can be reached is an unknown factor. Such uncertainty may not be a problem if no time limit is applied to the allocation of empty containers. For shippers however, they often need to have empty containers delivered within certain period of time.
(2) If no proper operators can be found in the market by shipping liners, containers will be left in the port, which generates costs (US $2 per container daily storage fee in New York port).
(3) It is difficult to sign contract with railway shipping companies. In United States, for example, railway shipping companies, which dictate transportation market, only sign contracts with large liners for large trade contracts. For railway shipping companies, large trade contract can bring them stable sources of cargo for shipping, and can save a large amount of fees for trades (as for shipping liners, a contract with railway company can obtain low priced transportation).
(4) Due to fixed price of shipping services for empty container allocation, it is not feasible to reduce the price any more by negotiation

Therefore, shipping liners do not often seek for shipping operators directly from market. For example, shipping liner company CMA has only 2% of its trade in such a way.

4.2 Allocation of empty containers via railway shipping services

Shipping services by railway usually provide large shipping volumes with relatively low price. If shipping liners can sign transportation contract with railway shipper, they can gain rather large quantity of empty container shipping with lower prices.

Using railway system for empty container allocation by shipping liners can often be seen in the US. The four major railway systems in the US including UP and BNSP in the west and CSX and NS in the east have taken a large portion of empty container transportation. Just in September in 2002, total container shipping volumes have reached to 4.6 million TEU.

Large shipping liners may consider signing a yearly-based contract for shipping services. Based on liners' previous required shipping volumes and the container shipping volumes in the new contract signed with shipping liners, a railway transportation company can sign a new contract with new price if actual transported containers are more than the specified in the contract. If actually transported containers are less than specified in the contract, the liners still have to pay the prices according to the contract. For instance in the contract signed between CMA and BNSF, it is clearly stated that 50,000 TEU needs to be transported in a year through BNSF. If actual containers from CMA are less than 50,000 TEU, costs based on transportation of 50,000 TEU still have to be paid. If actually transported containers are more than 50,000 TEU, a new contract needs to be signed. Usually it is unclear if a railway company is willing to do the business. Even it accepts the contract, costs can be increased.

It is generally impossible for shipping liners to merge railway shipping company to carry out the empty container shipping services. On one hand, shipping liners do not have large amount of funds for railway infrastructure development, on the other hand, anti-trust agencies do not support any merge between shipping liners and railway shipping companies.

4.3 Empty container transportation by highway trucks

Highway trucks are the commonest mode for empty container transportation. Shipping liners can carry out truck transportation in two ways, one is to invest to its own truck fleet, other outsourcing services.

For shipping liners, it is much easier to develop proprietary highway transportation than railway shipping services. The investment to the hardware of highway transportation includes truck fleet, EDI and GPS application, which is affordable for a shipping liner. However, there are also problems related to highway truck transportation. Too many destinations and containers have complicated the process of empty container allocation via highway truck shipping services, which prevents shipping liner to invest enough human resources and capital for its operation. Large shipping liners like Maersk-Sealand, P & O, NOL/APL, K-Line and so on are not involved in this type of shipping business.

Professional truck fleet equipped with well developed information network and professional management is the first choice for shipping liners to outsource highway shipping services for empty container allocation. Outsourcing highway transportation has advantages in several aspects.

Shipping liners are dominated in business relationship between liners and truck fleet. Truck fleet has to provide high quality services as required by shipping liners. For example, the vice-chairman of Transus transportation alliance said “shipping liners are the main customers, we have to satisfy with their needs if we want to become their service providers”. The highway transportation company has developed a shipping

network which covers areas where other transportation services (including railway) cannot reach to. Of course, shipping liners do not require highway transportation to provide inter-continent shipping services which will cost high due to too long distances. In regional allocation of empty containers, shipping liners usually choose highway shipping services first, making use of well distributed and covered transportation network to achieve door-to-door delivery services.

Another advantage for liners to outsource highway transportation is that they can negotiate trucking service prices. Liners have relative more containers and can get good service prices. For instance, the services prices of Transus alliance companies are related to the number of containers provided by liners and their business relationship.

In addition, highway shipping service market is over supplied. In such more supply than demand market, liners have options to choose service providers based on their needs. For instance, CMA liner develops a list of truck house carriers and clearly identifies their requirements for possible candidate providers in on-time delivery, information system, and transportation technology for reefer container etc. Only truck fleets satisfy with these requirements can become the service candidates.

4.4 Services provided through Intermodal Marketing Company

Intermodal Marketing Company (IMC) here mainly refers to those who can provide railway shipping services but do not own transportation tools (a third party to lines and railway shipping companies).

As mentioned previously, railway shipping service operators are not willing to negotiate with liners for contracts with short term and small volume of shipping services. Comparing relationship with railway shipping operators, IMC has better position than liners. When liners select railway shipping services, they can directly contact with a railway company, and also can obtain railway shipping services via IMC.

IMC mainly coordinates multimodal transport of goods. With a fixed rate, IMC provides liners or domestic shippers with services including container retrieval, goods loading, storage, and transportation. In order to attract liners, IMC also provides value-added services including logistics, warehouse storage, EDI, insurance, and cargo tracking. In addition, IMC can provide to liners lower than railway services for empty container allocation. The reason that IMC can provide lower price service is that IMC can provide services to many liners, which can form scale services, that IMC has very good business relationship with railway shipping services so that they can negotiate a good price.

HLX is one of large American IMC with as many as 7,000 containers shipped daily. It has 30 representative agencies forming a network covering every regions of USA, close to inland, railway and highway shipping companies. It owns 6,000 transportation trucks and can become complete connection between railway transportation and customers' warehouses. It has 25 years experience in business and has become leader in related technology with well developed information exchange system which can provide real-time information on payment status and physical status of containers etc. It has established good business relationships among all railway shipping companies, the major customer of the four largest railway shipping companies. Liners like P & O Nedlloyd, Hapag-Lloyds, NYK, Yangmin, CMA-CGM like to use HLX for the IMC for land transportation of containers.

The advantages that liners use IMC for empty container allocation include (1) that IMC can obtain shipping spaces and much lower prices for small quantity goods transportation from railway shipping companies based on their well developed business relationships. For such, railway transport does not normally like to deal with liners; (2) that IMC provides door-to-port complete services. Its business experience, information system and technology are all better than liners, therefore, it can provide better quality services.

Table4. 1 Several of the transportation organization chooses empty

The market for carriers in sight	Target	Highway
	Condition	No fixed objectives: no restrains on amount of containers, distance and time
	Utilization	Rarely used (e.g. shipping company - Tamiflu only used 2%)
	Coordination mechanism	Price adjustment mechanism
	Limitations	No economic scale effect, May produce container stranded
Rail carriers	Target	Railroad companies
	Condition	Long distance, More boxes, Big shipping companies, Shipping company and the railway company have good cooperation relationship
	Utilization	Often used
	Coordination mechanism	Railway company monopoly prices
	Control mechanism	Railway company quotas, Predict quotas in the contract based on the past.
	Limitations	Stipulate in the contract have strict terms, Shipping company vulnerable, the railway company controls price and quantity; Contract negotiations limited.
Highway	Target	Highway transportation suppliers

carriers	Condition	Short transportation distance, Small number of boxes, Comprehensive transportation networks, equipment and professional knowledge to guarantee the successful transportation of empty boxes.
	Coordination mechanism	The contract relationship
	Control mechanism	Suppliers to have certain restriction, Supplier prestige contract relationship
	Advantages	Because of large amount of boxes, shipping company dominates the negotiation in contract. Shipping company benefits from the comprehensive transportation networks, equipment and professional knowledge supplier provided.
	Limitations	Fees could be very expensive for large number of boxes and long distances.
Middlemen services	Target	IMC
	Condition	Long distance, more boxes, Shipping company cannot direct talks with railway company, IMC have comprehensive transportation networks, equipment and professional knowledge to guarantee the successful transportation of empty boxes.
	Coordination mechanism	The contract relationship
	Control mechanism	The contract indicates expressly supplier of quality standards, IMC reputation
	Advantages	Because of large amount of boxes, shipping company dominates the negotiation in contract. Shipping company benefits from the comprehensive transportation networks, equipment and professional knowledge IMC provided.

Chapter 5: Case Analysis

Analysis of current situation on empty containers for port G

5.1 Current situation of empty container in port G

The volume of input/output containers of port G, in 2007, broke through 1.5 millions standard containers, increasing 20% of last year. Total business income in 2007 was RMB ¥205 millions, 16% more than last year. However, its increase in profit was 8%. This is mainly because that empty containers often occur during container transportation. Based on statistics, the empty containers input/output in port G is 20% of total input/output containers. The empty containers in port G is characterized by large quantity, slow allocation, and single type of containers. In port G, no charges are applied to container stacking services and prices for empty container transportation are low. Such situation does not make noticeable benefits. However, as a connection port, port G needs to reserve empty containers for the needs of its own and other ports. Therefore, how to redistribute empty containers to reduce the quantity and proportion of the empty containers stacked in the port is an urge issue to be resolved.

5.2 Causes for the current situation of empty containers for port G

5.2.1 Port perspective

1 Quantity and type of containers in and out of the Port

Seasonal variation in goods sources determines similar seasonal variation in container cargo shipping. The trades between regions and countries at the other ends of the shipping routes and port G are not balanced, leading to imbalanced cargo flows. From perspective of seasonal variation in cargo shipping services, early year is usually low season for Japan and Korea. In April and May, cargos start to increase and required containers rapidly increase. July and August are the golden season for port G. This pattern causes containers on the international shipping routes stacked in the port. Domestically, ships going from north to south are usually fully loaded while ships to north carry large quantity of empty containers. From shipping routes aspect, the main international container shipping routes are Korea and Japan. Its main export cargoes are agriculture products, mineral stones, and construction materials, which require large quantity of container. These characteristics determine that port G needs to reserve a large quantity of empty containers. Shortage of source goods in Japan and Korea causes large amount of empty containers being carried back to the port and stacked in the port. Commonly used containers are 20 feet and 40 feet. Shipping liners use port G as connection port, gather all southbound and northbound ships in port G for empty containers connection services. Although the need for the quantity of containers does not vary significantly, the demand for the type of containers changes significantly. Therefore, those containers stacked in port G may not be the ones demand by other ports due to relative consistent types of containers. This will cause serious stacking of empty containers in port G. The fact is that imbalanced quantity and type of containers in and out of port G has caused too many empty containers stacked in the port.

2 The scale of the port

The scale of a port is the foundation of the port development. If port scale is not large, the quantity and sizes of ships in and out of the port will all be limited. Compared to other two ports, the infrastructure of port GI is listed in table 5.1.

	Port G	Port L	Port M
Assets	Total assets for 32 million yuan, has more than 392 loading/unloading machinery, the largest crane capacity for 63t	Assets amounted to 248 million yuan, loading and unloading mechanical 1010, largest crane capacity for 102t	Total assets of 110.4 billion yuan, loading and unloading mechanical 752, the largest crane machine for 320t, can receive/discharge the fifth generation of international container ship
Berths	Total of 46 berths, 23 million t class berths, 7 professional container berths, maximum anchorage capacity of 200,000 t	Total of 89 berths, 40 million t class berths, 13 professional container berths, maximum anchorage capacity of 200,000 t	Existing 72 berths, maximum anchorage capacity of 200,000 t, 13 special container berths, 7 deep-water berths, can receive/discharge the fifth, sixth generation container ships.
Area	The waters area about 867.4 square kilometers, the land area approximately 6 square	The waters area about 346 square kilometers, the land area approximately	The waters area about 420 square kilometers, the land area approximately 10 square

	kilometers	8.4 square kilometers	kilometers
Stacking area	Stacking area for 150 million square meters, including 24 million square meters for special container yard	Stacking area 136.4 square meters, the container yard 89 million square meters	Stacking area 225 square meters, the container yard 83.7 million square meters
Navigation route	All domestic ports along the navigation routes, and open to 100 ports around the world; has five directly container route in Japan, Korea, Hong Kong and other countries.	Open to more than 140 countries and regions; the maritime transport to 8 international container routes including Hong Kong, Japan, southeast Asia, and European.	Domestic routes to northeast, north China, east China coastal provinces, trade with more than 450 ports of 130 countries and regions around the world; have 13 container routes.

As showed by the table, port G has less berths, and even less berths for containers. The tonnage of a ship that can dock in port G is less than port M. Its areas in water and stacking fields are less than other two ports. The more berths a port has, the more ships can dock to the port, so that heavy and empty containers in the port can be shipped out on time. The port water area determines the sizes of ships to be docked because ships need to make turn when docking to a port. The disadvantages in these two aspects determine that number of container shipping liners in and out of port G is less and the tonnage of these ships are small. These will directly influence on containers allocation. In addition, there is no charge for empty container stacking in port G so that liners will leave empty container in the port for longer period of time, causing reduced area of stacking field in port G and container stacking field becoming smaller. Because

of limited number of containers stacked in the field, the ratio of empty containers is increased due to increased empty containers and decreased heavy containers.

3 Development of the port information system

The central control office of port G is located at the top level of the office building so that the office staff can oversee the operation of entire port. On the other hand, this is because the port hasn't been equipped with live surveillance system to monitor the operation of entire port. Out-of-dated information technology is manifested by delayed transfer in cargo handling invoices and plan so that the port is unable to make appropriate arrangement for upcoming liners docking and cargo handling. In the same time, predicted empty containers coming to the port cannot be loaded to liners which go to the ports demanding for empty containers. This eventually causes empty containers stacked in the port.

4 The construction of matched service facilities of the port

In order to carry more containers, liners usually do not load large quantities of feul, fresh water, vegetables and other stuff, but add the stuff in the next port. Port G however is unable to supply heavy oil to liners which need this type of oil. Therefore, liners have to consider loading enough heavy oil for those ships which dock to port G in order to continue their journeys, and also try not to send ships needing heavy oil to port G. This will eventually reduce the number of ships docking in port G, which further causes stacking of heavy and empty containers. After docking to the port, liners have to go to shopping center far away to purchase vegetables and other stuff, plus unfamiliar with the port, which often causes delayed return to the ship so that ship will have to depart later than scheduled, impacting on both heavy and empty containers exchange and connection.

5 Navigation signs and symbols

The navigation signs and symbols are the facilities provided by the port to guide and lead liners to enter to the port, in order to provide convenience for liners to dock to and depart from port and to ensure safety of liners and facilities of the port. They mainly include waterway, anchorage and navigation signs. Port G has relatively less waterways where the water depth can only allow small tonnage ships to enter. This is like number of berth, reducing number of liners docking to the port, and transportation of heavy and empty containers. Anchorages are the water areas provided by the port for liners to wait for berth, safe berthing, shelter, custom inspection, health inspection, cargos handing and regrouping ships. When berths in the port are full, ships can stay in the waterway to wait for berth in order to ensure port business not to be interrupted. Port G also has less number of anchorages. Because its water is shallow, only small tonnage ships are allowed. This will impact the quantity and efficiency of transportation of heavy and empty containers.

5.2.2 Container company perspective

The repair requirements for containers vary with different container renting companies. With equivalent technology for container repair, labour prices enable port G to charge lower fees for container repair than the fee charged by regions with advanced economics. Lines deliver repairment needed containers to the garage nearby port G for repair. Due to limited sizes of stacking field of the garage, the containers for repair or repaired containers for shipping are all stacking in the port for shipping. Due to imbalanced quantity and type of containers in and out of port G, and surrounding areas of port G do not have many container renting companies, the most of the containers used by port G comes from Shanghai or other regions with large quantity of input and output

of goods. In order to prevent that renters return their containers to the places with stacked containers causing its loss, these container renting companies will detailed precisely where to return containers, charges for returned containers, and the consequences violating contract in renting contract. When rent expires, the renter can only return containers to designated places or the regions with lower fees in order to avoid risk of violation. The shippers can only use pass-by liners for shipping service in order to reduce the cost for shipping. Therefore, expired rented containers increase in port G.

5.2.3 Liners perspective

So-called expired containers refer to those containers stacked in the stacking field, warehouse and other sites have longer than regulated time period. This will also indirectly reduce number of usable containers, leading to containers stacked in the port. If there are problems like expired containers and wrongly used container with a liner, it will bring unnecessary trouble to the port. They have to pay find for violation, but also influence the port to empty containers. Wrongly used containers can influence normal business operation of a port, and is possible to interrupt normal business operation of the port. These will further impact normal circulated quantity, reduce utilization rate of containers, leading to stacking empty containers.

5.3 Major solution for current status of empty containers in port G

5.3.1 Strengthen port infrastructure construction

Without infrastructure, good staff cannot do anything. With better infrastructure but without good staff understanding the operation, facilities in the port will be a waste. Port G was flourishing in Yuan and Qing dynasties because mainly it had such infrastructure that other ports didn't have. Today, compared to ports C and M, port G is not well developed both in hardware and software. Therefore, port G should develop its hardware while enhancing its software.

1.The hardware construction

First, the port needs to increase its hinterland. As a transit port, cargos to be transferred have to stay in port G. Therefore, only enough stacking areas can satisfy with liners requirement. To the back of port G, it is economic and technology development zone, island T is located to the north side of G port. Therefore, the development zones can be used to its development of container stacking field. As port's storage zone, the stacking fields in neighbored ocean can be reserved for transit containers. This will raise transit rate of containers, reduce the rate of empty containers. In addition, stacking fields can be reconstructed for centralized development and increased efficiency.

Second, out-of-dated equipments need to be substituted. Available and useful equipments need to be checked and served. Professional teams are responsible for professional equipment maintenance, and link responsibility for maintenance needs to be associated to each individual staff.

Third, we should promptly replace the unloading equipments that are being used, the existing machinery equipments for timely maintenance, established the professional equipment maintenance team, and equipment maintenance responsibility implementation to specific individuals.

Fourth, trouble-free operation of equipments not only can ensure handling efficiency, but also can prevent injury of working staff. Therefore, using bidding mechanism to purchase mechanic equipments and using installment for payment. This can achieve high performance equipments with low costs.

Fifth, matched service facilities construction in port G needs to be strengthened to provide convenient services for liners docking to port G. Department in charge of railway transportation needs to be established. When container shipping services are not urgent, container transportation via railway can be achieved with lower prices. In addition, railway transportation is not affected by climate very much so that the transportation of heave and empty containers can still be carried out during bad weathers. Container transportation truck fleet also needs to be enhanced to ensure on time transportation of heavy and empty containers.

Sixth, number of routes in port G needs to be increased. Direct shipping services need to increased. Both direct and indirect shipping services need to be integrated. Direct shipping services have greater profits to make and are not affected by other ports. They are also less difficult to develop and can reduce empty container ratio of the port.

2. Software optimization

First, application of computer systems and wireless communication equipments to port business operation will increase operation efficiency. Therefore, port G needs to increase the development and maintenance of its computer systems, and make use of advanced software for container operation, and ensure EDI to be delivered timely and accurately. The major equipments of wireless communication are radios which are required to have longer charged battery in order to prevent delay communication between field staff and central control office, affecting operation efficiency. It is

important to develop live surveillance of the port, stacking fields by central control office, in order to discover mistakes on time.

Second, port G needs to speed up technical training for staff, arranges regularly scheduled technical training sessions. “technique competition” among staff of the port can improve staff’s techniques. When recruiting new staff, open and transparent competition, scored based on capabilities can recruit good staff. It is important to remember that human resources are important resources of an enterprise. With exchange program with other large ports, staff will have time to learn advanced management form other ports so that the soft increase in operation efficiency will be achieved.

Third, establishment of information feedback department to receive appraisal of services by customers is necessary. Penalty is not necessary but recognition of staff with great appraisal will encourage staff improve their service quality. It is necessary to have every staff understand the culture of the enterprise. Problems can be solved fast, reducing the possibility of impact on business operation.

5.3.2 Timely transition of empty containers

As a transition port, stacking of empty containers in port G cannot be avoided. After empty containers arrive, port G needs to predict the quantity, time and ratio between large and small empty containers to be transported. Port G also needs to report to liners the situation of empty container stacking in the field, whether or not there are excessive empty or heavy containers, so that liners can arrange allocation of empty containers based on the prediction.

5.3.3 Choice of appropriate time for empty container allocation

The schedule of liner business sailing is generally fixed. In order to ensure full load in every sail, liners require containers off loaded on time when docking and departing from the port so that containers stacked in the port can be loaded to the ship on time. Port G should select an appropriate time for empty containers allocation, ensuring timely loading to current liners, then planning empty transportation within the port so that these containers can be loaded to the liners.

5.3.4 Well plan liners' berth and departure

When expecting relative many liners will dock to and depart from the port, inaccurate port plan will mess up the docking and departing times of all ships, causing elongated tabor time in anchorage. This will significantly affect heavy and empty container transportation. Therefore, the port needs to enhance the following:

First, strengthen the contact with the liner companies which can be achieved by obtaining liners docking and departing plan through telephone and emails. It is necessary to try to get accurate information, for instance, special staff can be sent to liners to be in charge to reporting schedule of liners.

Second, maintenance of close contact with liners to obtain longitude and latitude of liners, navigation speed, turn speed and wind direct etc. This information can be used to estimate if liners will arrive to port on time and if time and gantry cranes, door cranes and container allocation vehicles need to be adjusted accordingly.

Third, it is necessary to obtain information on weather on time, particularly when weather showing change from bed to good. To increase gantry cranes on tome to ensure cargo handing operation to complete on time.

5.3.5 Tripartite together

By the end of 2007, container renting companies own 45% of global total containers. Obviously, it is essential to establish business partner relationship with container rental companies. The types of cooperation between liners and container rental companies include short and long term renting and varied length of time rent. In addition, the requirements by the rental companies for return sites and return time cause that liners have to stack empty containers in port. Therefore, port G can partner with container rental companies to be responsible for transport empty containers to return sites by vehicles. This will encourage container rental companies to build return sites nearby the port. Port G can also negotiate with liners that if liners can use containers from one single rental company, the port can give good prices for empty container transportation. Coordination amongst these three parties can reduce the risk of not on time return containers by liners. The containers of rental company can be retrieved on time, reducing number of empty containers stacked in the port.

5.4 Summary

Port G is located in Bohai Bay. It is a transit port. Compared to other two large ports, it has disadvantages in both hardware and software. Port G should identify the differences to other large ports. With the good timing that our country’s economics

develops rapidly, port G should increase business scale, expand port's berths and waterways, optimize business pattens, enhance management, and establish cooperation with liners and container rental companies which have business relationship with port G. So that three parties help each other and gain benefits, resulting reduced stacked empty containers and eventually increasing profits.

Chapter 6 Conclusion

This text has carried on deep research to the question of empty container allocation optimized. Analysis the main objective cause that empty container allocation produces and Main factor influencing the empty container allocation. Have announced the characteristic of empty container allocation and has proposed reducing several suggestions of empty container allocation cost according to the subjective reason why empty container allocation produced.

Meanwhile, analysis and studied to the container empty container allocation question of transporting by sea. In systematic analysis causes and transports the container empty container allocation question reason foundation at present. It has offered the suggestion of improving empty container allocation question what the liner ship company can pass the establishment and adjustment the course and intermodal transportation and Use the container of all kinds correctly and strengthen the construction of information system of container etc.

At the same time, analysis to the strategy of container leasing management and assessment elements. But we also clearly see. Although the above strategy can reduce costs, but there are a variety of methods some limitations, it should also be quantified by mathematical methods of management.

At the same time, in order to control the cost of container transport, freight must be day-to-day work of analysis and control of the initiative to start, rather than relying on equipment alone passive management managers. Container transport cost control is a very systematic work. A lot of work must analysis a large amount of data. In terms of the accuracy of the data or timeliness of liner companies require a set of comprehensive

computer system to support. Today's container transportation has been unable to escape the computer; the competition among liner shipping company is also reflected in the computer system competition in large extent. In addition, the support of government policies, such as to allow the international liner companies in China's container ports and air transport, for operators to reduce transport of empty containers from the outside of the costs, and optimize the layout of routes to reduce China's foreign trade goods, transportation costs are important strategic significance.

Reference

Teoor Gabriel Crainic, Michel Gendreau, Pierre Dejax,(1992) Dynamic and stochastic models for the allocation of empty containers. Journal of the operational research society.

White W W, Bomberawlt AM.(1969) A net work algorithm for empty freight car allocation. IBM System journal.

Key numbers, Containerization International, October 2003.

White W, W. Dynamic transshipment networks an algorithm and its application to the distribution of empty containers networks 2.

H.Florez. Empty container repositioning and leasing and optimization model PH.D. dissertation polytechnic institute of New York.

Mendiratta V B，Turnquist M. A model for management of empty freight cars. Transportation Research.

CrainieT.G., GendreauM. , DejaxP.(1992) Dynamic and stochastic models for the allocation of empty containers. Journal of The operational Research Society.

Jordan W.C.，Turnquist M.A. A stochastic dynamic model for railroad car distribution. Transportation Science.

Beaujon G J，Turnguist M A. A model for fleet sizing and vehicle allocation[J].

Transportation Science.

Liu Zhiqian (2008) An analysis of empty container repositioning *Port technology*

Liu Hengjiang (2001) An analysis of empty container repositioning *Containerization*

Zhou Hongmei Fang Fang (2003) On the optimization model of empty containers disposition of shipping *Journal of WuHan university of technology(transportation science & engineering)*

Yang Yinqi (2007) The research on the empty container allocation

Nie Jun Gao Xiaojian (2004) Strategy for dispatching and collection of empty containers *Containerization*

Website:

http://www.clarksons.net/markets/
http://www.snet.com.cn