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Study on the influencing factors of loading and discharging efficiency in Tianjin Port container terminal

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Study on the Influencing Factors of Loading and Discharging Efficiency in Tianjin Port Container Terminal

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Declaration

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

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

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Title: **Study on the Influencing Factors of Loading and Discharging Efficiency in Tianjin Port Container Terminal**

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Abstract

With the increasingly fierce competition among container ports, container dock's ship loading and unloading efficiency has become the measurement of a port's competitive strength as the main mark. The analysis on the influencing factors of operational efficiency of container terminals is the prerequisite to improve the production efficiency. At the same time，ship tends to be larger, and ship loading volume increases as well. In order to accelerate shipping's operation and lower container transport cost, the ship companies require their ship anchored in the port ought to have higher vessel operating efficiency for shortening the operating time of the ship in terminal. Therefore，port efficiency for shipping companies can be enhanced and terminal operators attention can be paid, and meanwhile, improving the operation efficiency of container terminals of port competitiveness has also become one of the most important aspects.

The ship's operation efficiency is the reflection of the pier's comprehensive ability, single sub system is efficient but it does not mean it could effectively improve port efficiency, and as that universal truth says low efficiency of a single subsystem will reduce the port efficiency. The efficiency of container terminals and ship size and stowage container's quayside crane and quality, operation and yard trailer bridge

game performance with number of it, driver operation level, management level and storage yard layout, storage capacity, line arrangement and stowage planning level are vivid reflection of the pier's comprehensive ability and management level. Therefore, this article in view of every step in the operation of the ship and every subsystem of ship operation efficiency by analysis are the main subjects of this dissertation. A container terminal at the port of each system can fully utilize existing resources, furthermore, good management of each system's operation flow，reducing terminal operating time，improving work efficiency, is the key problem in container port industry. Thus, the study on the efficiency of loading and unloading containers at port is inevitable and a long-term beneficial project.

At present, competitions between container ports are fairly intense; the purpose is to let the ship company ships anchored in terminal. Competition is one of the main means to improve the quality of service, and improving the vessel operating efficiency is to boost the quality of service, which is one of the most important parts. Work efficiency is the main part of this competition among the enterprises, especially in ports; it works at a crucial role in lifting the benefits. After all, containers trade in our shipping industry has its primary function, even plays the pivotal role in developing entire nation's economy. Thus, the managers and operators in port should pay much attention to the every operating step and improve the efficiency generally.

KEYWORDS: Tianjin port, Container port, Loading and unloading efficiency, Operation process

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List of Abbreviations

B/L	Bill of Lading
BPO	Berth Production Operation
BRA	Brazil
CNPC	China National People's Congress
COF	Certificate of Fitness
CSC	China State Council
CY	Container Yard
TDGTRC	Tianjin Dangerous Goods Transport Research Center
DEU	Germany
FIN	Finland
FRA	France
GC	Gantry crane
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (sponsored by Eight UN Agencies)
ISR	Israel
ITA	Italy
JPN	Japan
MEPC	Marine Environment Protection Committee
MSA	Maritime Safety Administration
MYS	Malaysia
NLD	Netherlands
NLS	Noxious Liquid Substances

NOR	Norway
QC	Quay crane
SDS	Safety Data Sheet
SGP	Singapore
SGS	Societe Generale de Surveillance S.A.
SMDS	Material safety data sheet
SOLAS	International Convention for the Safety of Life at Sea
SWE	Sweden
TPAICT	Tianjin Port Alliance International Container Terminal
TPPICT	Tianjin Port Pacific International Container Terminal
TUR:	Turkey
UN	United Nations (New York)
UNECE	United Nations Economic Commission for Europe
USA	United States of America
ZAF	South Africa

Chapter Ⅰ Introduction

1.1 Background of the study

The trend of container ships in a global view is getting larger and economic. Larger ships can bring scale economics effect, which means thus profits from shipping will be outstandingly prominent.

Container terminals as an exclusive phenomena among modern ports, has to be abide by the general laws in developing ports. But admittedly, it still has its individual traits. In terms of characteristics, container terminals are already the medium and pivot of transportation between ocean and offshore worldwide. In many sense, it has gotten rid of the traditional concept of simply being a port, but a center of exchanging information and trading.

Tianjin is city established and flourished from the ports. Tianjin port as a main component of Binhai new area, is grasping the global attention by its soaring economic developing speed. Tianjin port reopened in 1952, after that, on April in 1980, as the special utilized port for international container terminal, it got restored and renewed as well as operated. Tianjin port is the first modern container terminal for international usage at mainland China. Currently, container terminals in Tianjin port contain several professional container spots served by Orient, Wuzhou International, Alliance International, Pacific International, Eurasia International, etc. Those spots can be used for park fourth generated ships, and some of them can even serve as the lots for fifth generated ships, literally. The depth in those spots are

approximately 12-17 meters deep, and wrapped by well-organized banks, inner lanes, yards, infrastructures and so on. All in all, it has cutting-edge techniques, equipments at ports and competent service for relative needs.

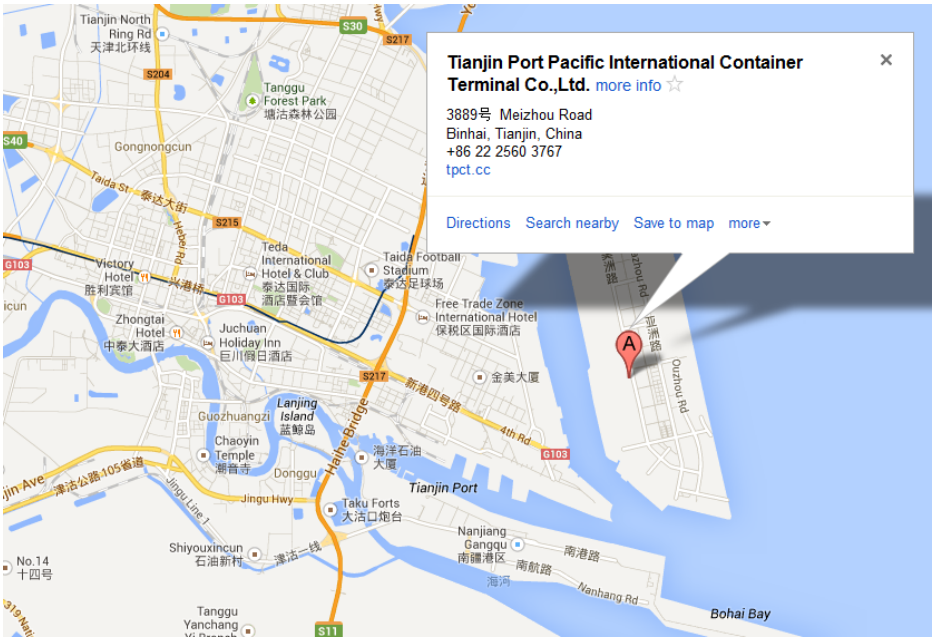

Fig 1.1 the location of Tianjin Port Container Terminal

1.2 Significance of the study

Along with the increasing competition among container terminals worldwide, each terminal begins to take improving efficiency of loading and unloading as the main mean in promoting its capacity. Only if focusing on the analysis about facts that affect loading and unloading rate, general ability will be raised, thus ports can maintain its stature, and contend its proportion in market.

1.3 Methodology

This article will embark on the issues of a series of operating process and analyze it. First step of this process is the collection of containers at gate system, then berth dispatchers may figure out the specific spots for parking, after that, single ship planer will be up to comprehend the structure of ship for the purpose of distributing cargos, lastly, personnel may focus on the arrangement of quayside crane, yard crane, trucks and trailers as well as every single steps may cause potential problems in operations. Throughout the step before the unloading until to the final step, every facts may affect efficient rate can be closely studied. From the analyzing elements in loading and unloading, in order to check out shortages in every step, thus, efficiency thereby enhanced from the existed level.

Chapter Ⅱ Container Terminal Loading and Unloading Efficiency

2.1 Facts affecting regular container terminal loading and unloading Efficiency

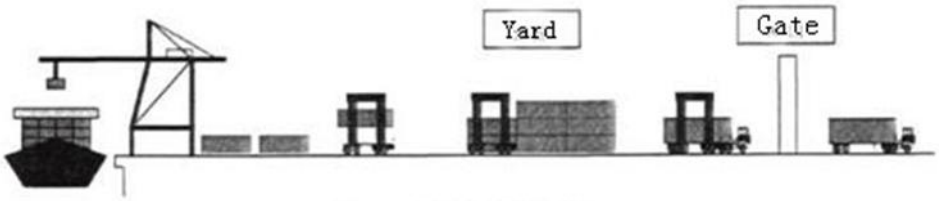

Fig 2.1 Schematic diagram of the container terminal logistics operation

The major function of container terminal is loading and unloading containers, and arranging containers into rightful positions under the directions to map out. This paper aims to study the foreign container terminals, by analyzing vertical plane and horizontal plane, so as to figure out the facts that affect the loading and unloading efficiency(Bi,2009).

European container terminals' loading and unloading mode is on the vertical plane; most of container terminals usually unload from both sides of ships; because berths in Europe are most imbedded berths. Furthermore, all advanced foreign terminals are utilizing the method of loading and unloading at same time. By applying this method, on one side, quayside crane can be fully applied, namely, containers will be loaded on trailers directly from ships, thus, equipments will grasp containers all the time and shifts of quayside crane will also be avoided. On the other side, trailers will not be vacant either on the way from yard to quayside, or on the way from quayside to yard, so that energy will be saved, the efficiency of fully applying equipments will be enhanced, and efficiency of unloading can be boosted as well. However, in regard to the mode of loading and unloading at the same time the terminal requires timely communication, dispatching, and high-quality equipments at yard; Tianjin Port is not able to fulfill this mode of loading and unloading for the time being. Facts affecting regular container terminal loading and unloading efficiency can be shown in Table 1. All in all, the facts can be concluded by three aspects, which are mode of loading and unloading, degree of electronic equipment and degree of logistics.

Table 1- Facts affecting regular container terminal efficiency.

1.mode of loading and unloading	The mode of loading and unloading from both sides of the ship, though makes ships load and unload faster, it has its boned defects that stagnates the efficiency of loading and unloading.
2. Degree of electronic equipment	In considerable amount of foreign container terminals, straddled trucks and GPS guided trailers for transporting purposes will be utilized between ships and yards. Standing the fact, straddled trucks and GPS guided trucks saved labor forces, but straddled trucks move comparatively slower, and grow the time on the road.
3.Degree of logistics	In many cases, lanes for trucks under quayside cranes are fairly broad, by considering this; trucks may be parked slant, when equipments are approaching to containers, drivers may manually adjust equipments horizontally, which may pause the entire operation, and adversely affect the efficiency of loading and unloading.

Source: by author

2.2 The facts influencing the efficiency of loading and unloading in TPCT

As shown in Fig2.2.1, at container terminals, logistics conclude the following categories: ships arrive at ports, ships load and unload, and containers operate in port, containers pile in yard, managements in port and logistics.

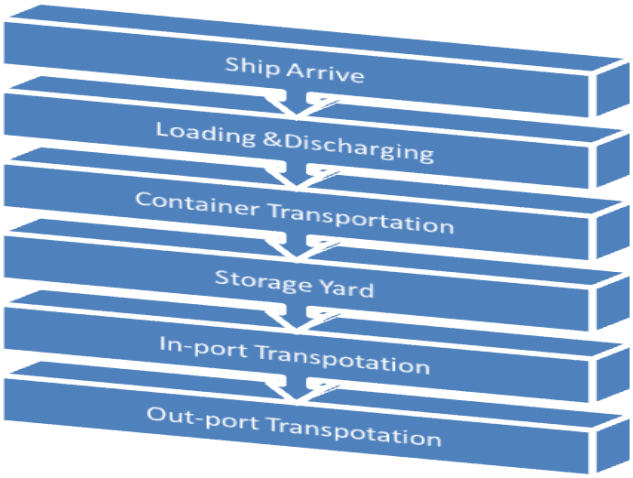

Fig 2.2.1 flow chart of Tianjin Port Container Terminal Operation

Vertical plane of unloading skills in Tianjin Port is a method that lifts containers from one side of ship. This method is utilized by considering the introverted coastline, and berths in port are built along the coastline. Technically, unloading from both sides is twice faster than from one side. However, unloading from both sides has practical difficulties, such as stable GM value, the order of parking, and etc. (Zhang,2002)

Fig 2.2.2 Picture of TPCT

And since the order about single ship parking and operating plan happen at different berths. Thus, if plan is not meticulous, lifting from both sides may not have the best effort. Besides, unloading from single side and loading at the same time also cause some difficulties, on one side, it brings the difficulty in arranging the plan of transporting containers out of yard, because it needs to categorize weight into different levels, which may harm the efficiency of yard. (Daganzo,1989)On the other side, there is a challenge in distribution of single plan, and central dispatching and communications. Currently, foreign advanced ports apply this loading and unloading system, however, Tianjin port has not acquired quality in such a level. In fact, this traditional operating method may restrain ships in the port longer. During the operation of trucks in transporting between yards and ships, half the time, trucks are vacant, in other words, the rate of efficiency is not high, which wastes some valuable time and equipment. Actually, Tianjin port still applies traditional operating mode which equips a yard crane, a truck for serving a stream service, in the meantime, loading and unloading equipment is in a still and hardly fully utilize materials.

2.2.1 The Specialty of Tianjin Port Container Terminal's Gate System

Gate is the entrance of Tianjin Port's container terminal, the exit of the Tianjin port's container terminal and the first step of unloading operation.

The vacant containers, the occupied containers and the exchanges of invoices, all go through the gates. The main responsibilities of gates are: recording the information of cars and entirety of containers as well as the numbers of them; if any fractions ever occurred, the companies which the containers belong to shall be recorded; Printing the tickets of trucks, and checking the exported containers' numbers and cargos;

Printing the delivery receipts; arranging and controlling the traffic volumes. (Pyung,2004)

Gate's system at container terminal, mainly divides into importing and exporting functions. The main function of importing gate aims to collect containers, as well as weight them. If any container is overweighed, for the safety of equipments and ships, it will not be collected. Firstly, Deputy of ships will figure out a cabin for containers which are about to be loaded and transported to container terminals. The gates' system will have the delivery receipts also. Normally, trucks will assemble at the port, if any container does not the number, actually trucks will collect still and pile them at the certain spots. When gates' system is collecting, it will record numbers, sizes and seals. Numbers have already recorded in the delivery tickets, the entire numbers will appear after typing the first several numbers(Imai,2001). Gates' entrance system aims to ship the containers out of the yard. When vacant trailers arrive into the port, this system will automatically print out the invoices to the drivers who are going to load certain cargos, then drivers will follow the directions offered by the invoices to collect the cargos at the promised spot.

2.2.2 The specialty of Tianjin port's container yard

Yard plan system aims to pile, transport, load, unload and store in a serial arrangement. The establishment of yard plan is for the unloading containers' proper arrangement's better off and enhancing the efficiency of using yards; it also helps the equipments to be applied in a better way. The main responsibility of yard plan is arranging and categorizing ships into different orders by following different categories, weights, special required cargos, dangerous cargos, etc. Thus, the layers of and spots of vacant land occupied containers will also be arranged. By fully using

area in the yard and equipments economically and logistics rationally, in order to improve the rate of utilizing yard, loading and unloading can be faster.

As for the containers ought to be shipped into yard within the regulated time for collecting, the ports ought to be arranged into yards' temporary spots for loading, therefore, distributions of containers will be arranged in a specific order under the weight. Ideally, upwardly, containers will be piled, so that the higher positions will be arranged with higher cargos, and then high weighed containers will be at the lower position of the cabin (Nishimura, 2001). Thus damage of the containers caused by yard crane can be vastly avoided. However, within the regulated time, different weighed containers will arrive randomly, in terms of time, because of the rate of utilizing yard, it is impossible to achieve the ideal piling condition.

If waiting for all the containers can be distributed and piled at the regulated spots, it is pragmatically impossible. For instance, Maersk Europe line usually will export 1500-1800 containers, and in that case, port cannot have a buffering zone that magnified and the area of yard is limited and impossible to dispose same categorized containers an entire zone for piling.

If so, yard will be jammed and equipments in the yard will also be consumed. Thus yard plan in the yard needs to follow principle below:

1. When making exporting plan, discharging containers agreed to be unloaded shall be piled respectively.
2. Containers in the same delivery receipts shall be piled assembly.
3 Containers have special requirements shall be pile assembly.
4. Different containers shall be piled respectively.

5. Dangerous containers, fridgerator, large cargos shall be individually piled.

6. Occupied and vacant containers shall be piled respectively.

7. As for the containers will be exported abroad, places shall be close to the berths ships assemble around.

8. When making the plan for unloading containers, containers in a same delivery receipt shall be assembled.

9. When lots of ships park and operate around berths, it is better to avoid unload and load container at same place.

2.2.3 The specialty of berths at Tianjin Port Container Terminal

Berths at container terminal is composed of berth, crane, transporting equipments connect ships and yards and personnel's operate on the ships.

Before arriving at the port, container ships are about to unload containers shall inform the port relative information, for waiting to be arranged a berth to be parked. Ships shall forecast 48 hours earlier and report 24 hours earlier of accurate arriving time. Container ships shall wait for rightful orders when they arrive at berths, and go through lane under guidance to the regulated berths. Container ships ought to go through relative inspections by deputies for unloading, relative inspections is so-called "One Custom and Three Inspections" in China, ships shall go through Customs, Maritime Safety Administration, Bordering Inspection and Health Quarantine. As soon as container terminals and ships exchange their unloading operating plans, port shall arrange quayside crane, yard crane and trailer as well as other equipments for unloading operation (Pan,2001).

2.2.4 The specialty of single ship at Tianjin Container Terminal

Single ship plan is also called “distribution plan”, a plan about containers will be exported abroad, under the regulations of transportations and operating requirements. Distribution plans where containers will be placed specifically on the ships and the results of distribution will be represented graphically (Torsten,2000). The procedure of container ships’ distribution is mapped as: First of all, according to reserved amount of cabins, distribution center and chief officer shall work out the certain port’s liners’ distribution graph, and then pass this graph to the container terminal. The single ship planer (distribution planer), embarking on distribution graphs and condition of containers will be imported, without violating pre-planned principle of distributing, under consideration of ships’ criteria and operating requirements at ports, to work out the container distribution graphs in container terminal system.

Chapter Ⅲ The Influences of Gate System and Yard System to the Loading and Unloading of Ships in Container Terminal of Tianjin Port

3.1 Existing Problems of Gate System

The Container Terminal Gate is consisted of inlet and outlet, which is the inevitable way for container vehicles to come into and get out of the port. The gate system is not only a major link for cargo owners and container terminals to transfer container equipment, but also an interchange point for containers and cargoes, thus it is an important point to define the responsibilities inside and outside the pier. Container Terminal Gate is also called Inspection Point or Inspection Bridge. The core idea of its management is to achieve an efficient and accurate control to containers and cargoes, thus the operation in station can run smoothly. Therefore, the gate system is one of the most essential parts of management of station system(Ethan,2009).

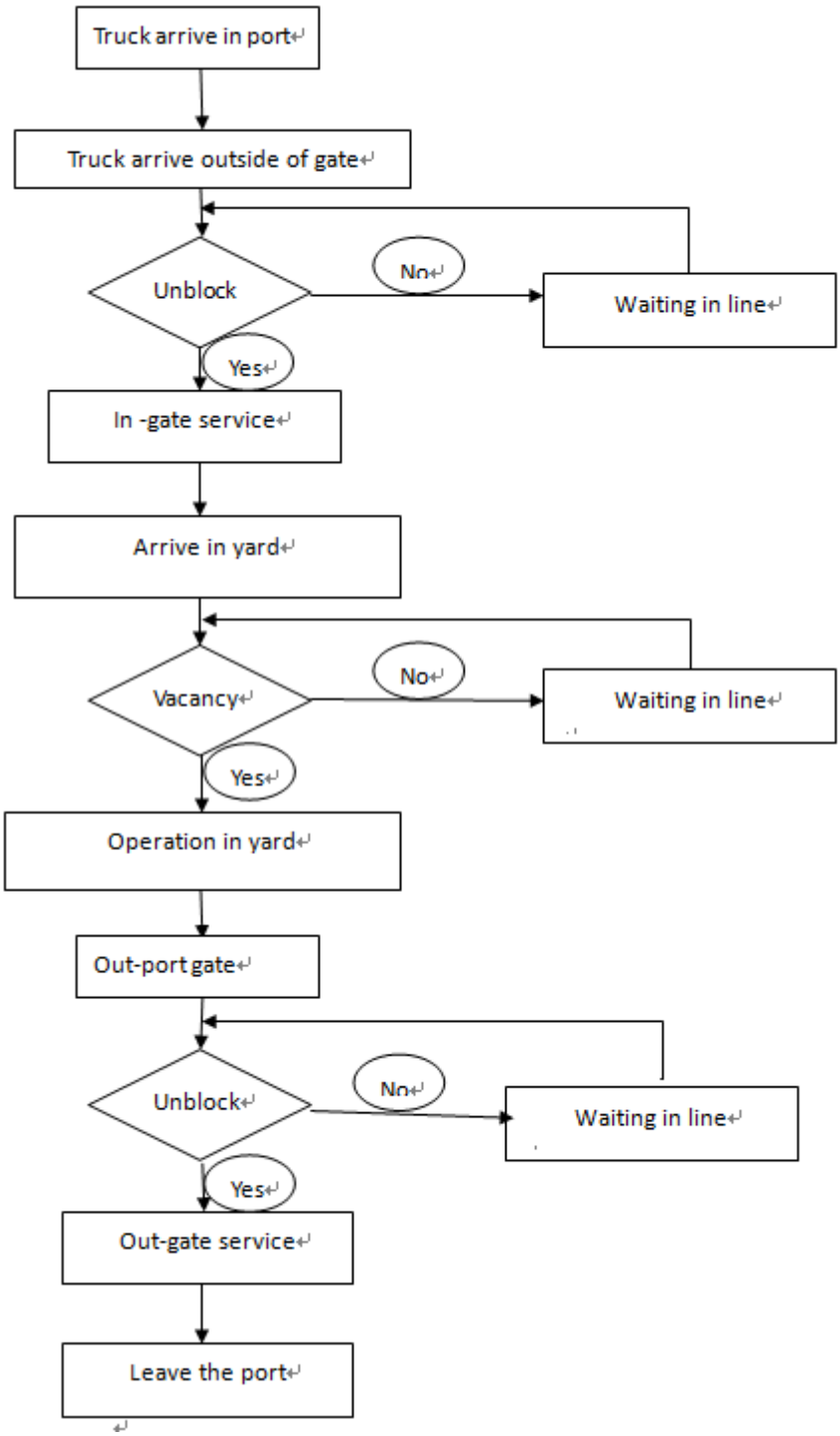

Fig 3.1 the Tianjin Port Container Terminal gate operating diagram

The container terminal gate system of Tianjin Port has the following two features:

1.The gate system is a queuing system

Since trailers arrive at gate to pick up or deliver containers at a random time, we cannot promise a fluent flow of traffic outside the station. In the gate system, each passageway of its gate can only handle the work for one trailer, thus while the arriving frequency of trailers is too high, without proper control, those abundant trailers will wait outside the gate and cause a traffic jam(Kim,2003). If we blindly permit these trailers to drive into the station, then it will also cause jam in the station. If there is a ship doing its operation, the trailers connecting the ship and the station will be interrupted, so that the efficiency of loading and unloading of ships will be badly influenced.

2.Gate operating system had its randomness

a. The operational time of inlet gate and the outlet gate is random;

b. the arriving time for Trailers within the plan is random;

c. The service time for parking yard loading and unloading is random.

In the whole process of ship loading and unloading in Tianjin Port, the gate system had many problems, mainly reflected as follows:

1.Intricate Human Operation

The intricate human operation will affect the capability of the whole pier, thus becoming the bottleneck problem of the pier. Even though in recent years, the automatic level of production operation has improved a lot in Tianjin Port, the human operation is still needed in many aspects of daily work. For instance, when trailers drive into or leave the station, they have to swipe their 1C card to get through. The working staffs at gate need to input the information of the trailer and the container

into the CATOS service system by their hands. After the system having checked the relevant information, it will print a small piece of note to show the specific place of the container (Hwan,2004). Therefore, before the driver gets the note, he has to wait outside the gate until the staff finishing the input and affirmation of information. This kind of intricate human operation extends the non-work waiting time in some degree, making the gate work busier and decreases the passing efficiency.

2. Congestion outside the Gate

Sometimes we can see that because that the trailers wait for a too long time outside the gate, they accumulate into a block which resulting a serious traffic congestion. This situation happens for many reasons. On one hand, it is caused by the randomness of arriving time of trailers outside the gate and the randomness of mechanical operation inside the yard. On the other hand, because of the dense traffic volume inside the yard, the pier has to stop the entry of trailers outside the gate. Sometimes the gathering of trailers will cause potential safety risks. If the waiting time exceeds the promised time to customers, the service degree and production efficiency will be seriously affected(Lam,1994).

3.2 Gate System's Influence to Ship Loading and Unloading Efficiency

The influence of human operation at gate to ship loading and unloading is also very crucial. For instance, for a 40-feet HT container, if the cargo owner or the forwarder makes a wrong report of OT, the ship manifest at container terminal will also be OT. If the staff at inlet gate does not examine carefully with the box type and think the box type matches its manifest well and receive the container, then this mistake cannot be checked in the checklist(Martin,2004). At last, this container will be loaded as a 40-feet OT container. If this cabin of the ship can only load on layer of HT boxes,

since the 40-feet OT box reflected in the system is actually a 40-feet HT box, the inconformity of hatch cover will occur after loading. The hatch cover need to be put back to the quay and the unmatched box need to be re-loading to a proper position of the ship. Thus, the precious loading time is wasted.

Sometimes when collecting the containers of a specific ship, because the export volume of the containers is very large, when the containers enter into the gate consecutively, the staffs at the gate will often have the situation of wrong information input. For example, the actual box number is S K U 7 0 0 8 3 1 1, but the staff record it as M S K U 7 0 0 8 8 1 1 due to his carelessness. Thus the M S K U 7 0 0 8 3 1 1 container will become non-manifest container with actual box in the checklist, while the MSKU7008811 container is a non-box container with actual manifest. If the loading staff does not notice it, it is highly possible that this container cannot be loading normally(Sun,2005). When the cargo owner finds out the reason of loading rejection, he will require the port to make compensation, which brings direct financial loss to the port. If the loading staff finds out this problem at later stage of loading operation, but at this time the right loading area has been fully loaded, then in order to load this container, other loaded containers will be unloaded or exchanged, no matter in this port or the next port. In this way, not only the pier will suffer an economic loss but also the handling efficiency of the ship will be impacted directly, which brings a total drop of loading efficiency.

3.3 Existing problem of yard system

Yard Planning System refers to a series of plans and arrangement of storage, delivery, loading and unloading, preservation of containers at the yard. Yard system is formulated for a more reasonable use of ground resources and a higher utilization

rate of the yard, thus makes the mechanical equipment more efficiently used. The main responsibility of the yard system included following aspects: First, piling the containers up in accordance with different sequences of ports of call, different types of containers, weight classes, special loading requirements of cargoes, dangerous goods boxes and other different conditions separately. Second, determine the position and the number of layers of empty boxes and heavy containers. Third, by taking advantage of space resources, use the machinery and equipment economically in the yard. Distribute the traffic flow reasonably, so as to improve the utilization of yard, increase loading and unloading efficiency. Forth, when the imported container ship is unloading, stack the containers inside the terminal first and then distribute to transferring station. For exported containers, gather them together and stack them in the yard to load when ships arrive here.

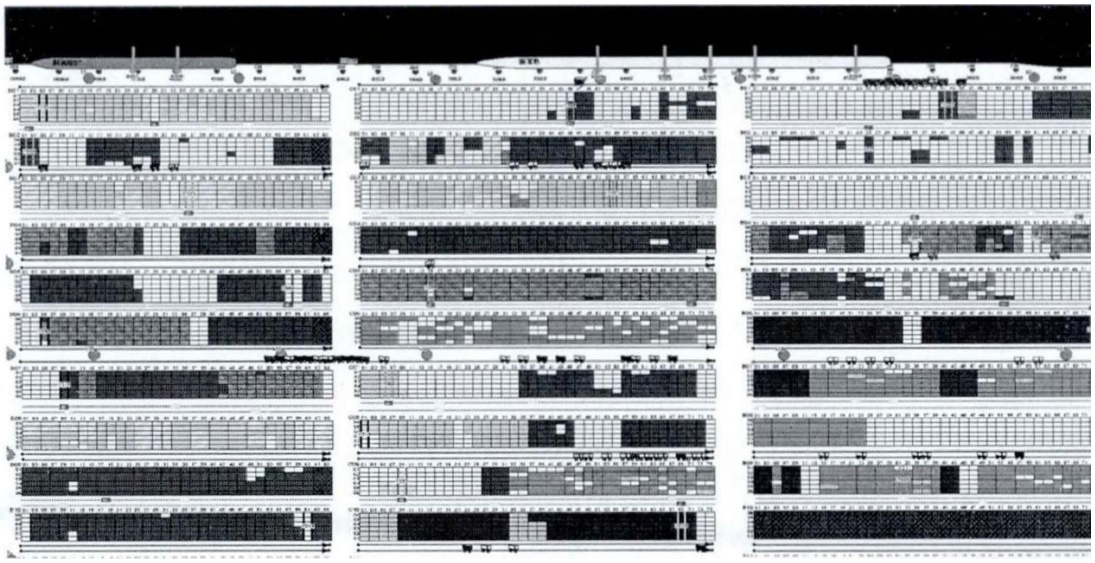

Fig 3.2 the container terminal yard map

From the view of Yard Planning System, we can divide the container yard into the front yard and the back yard. These two parts are divided according to their locations. The front yard is near the front edge of quay, which can be use to temporarily stack

the imported containers which are just unloaded from ships and the exported containers which are going to be loaded onto the ship. This arrangement shorten the distance between ship's rail and the yard in loading and unloading operation, decrease the waiting time of quayside container crane or field container crane, increasing the loading and unloading efficiency of ships at port.

3.4 Yard system's influence to ship loading and unloading efficiency

In recent years, large-scale container ship has gradually developed in Tianjin Port. The cargo handling capacity of containers is increasing year by year; and the turnover rate of containers in yard is also accelerated. At this time the Yard Planning System will tend to increase the utilization rate of the ground excessively, thus they may stack the containers of different weights and destinations into a same stock, and does not stack special containers together accord to the bill of lading, resulting in a serious mixed stack. In this way, the transposition rate during importing and exporting operation will be inevitably very high; most of the time will be wasted on the transposition during loading procedures, which has a serious impact on the efficiency of loading and unloading of ships.

The influence of transposition operation during loading and unloading in Tianjin Port Tianjin Port mainly reflected as: the weight classes and the loading requirement are discrepant in the yard plan, causing a transposition operation of exported containers. When making the loading plan for a single ship, the stacking order requires putting the heavy boxes beneath and light ones above. Therefore the ideal condition in the yard is to put the light boxes under the heavy ones. However, since the exported containers are stacked very randomly, to improve the utilization rate of the ground, the exported containers are usually classified to different categories according to their destinations and weights, then being arranged. But some ships have a higher

standard for weights during loading, which is conflicting to the selection principle, thus leading to a transposition operation during loading and reducing the loading and unloading efficiency.

There are many ways to improve ship loading and unloading efficiency and reduce the transposition rate. For example, before the single-ship plan has stowage for exported containers, we can have a pre-transposition to irregular boxes with machinery to avoid the transposition during loading operation. For transit containers, in order to be convenient for their re-loading, their temporary stacking places need to be considered in prior during unloading. Besides, we can also make reasonable arrangement of yard layout and transportation path.

Transposition operation in the yard is one of the most influential factors of loading and unloading efficiency of ships. The higher transposition rate is, the lower loading and unloading efficiency is. Reduce the rate of box transposition helps improve the efficiency of loading and unloading of ships, shorten the retention time at port, and improve the passing capability, and enhance the competitiveness of the port.

ChapterⅣ The Influences of Berth System and Single-Ship System to the Loading and Unloading of Ships in Container Terminal of Tianjin

4.1 Problems in berth system

Berth plan is not only an important part of comprehensive plan, but also one of the key elements to make sure loading and unloading operations carried out successfully. Its main duties are, before the ship arrived in anchorage, according to the current berth usage, formulate a reasonable berth allocation plan, in order for high efficient arrangements for docked position, each ship's crane allocation and start time and completion time, and draw out the daily berth figure responsible for the ship's berthing, un-berthing and other matters.

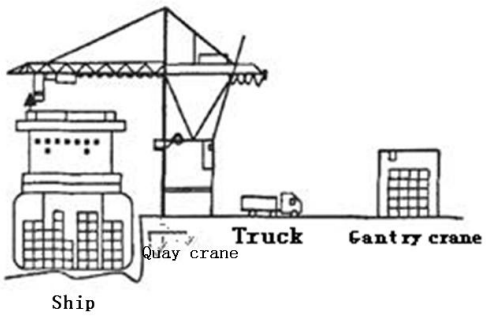

Fig 4.1.1 Illustration for berth operation

In addition to berth depth, length, mechanical resource allocation, and other information of waterway draft, berth plan should also include comprehensive information of the ship, such as tonnage, draft depth, containers of loading and unloading. When establishing berth plan, the above issues should be considered seriously. If time arrangement is wrong or not reasonable, it would have great impact on efficiency of loading and discharging.

Fig4.1.2 the Tianjin Port Container Terminal berth flowchart

Tianjin Port Container Terminal berth planning systems main contents:

1. According to the actual usage of berths developing ship berth plan, including clear length of ship, berthing direction, the number of cable used, the specific location of the ship docked.

2. According to Container Terminal Equipment configuration and requirements of shipping companies' schedule, the dock should make sure the preparation of "vessel operation day and night schedule," and arranged circadian production and precautions (bulky cargo operations are required instruction in advance), arranging ship berth plan.

4.2 The impact of berth system in affecting loading and unloading efficiency

According to pre-distribution arrangement, berth system arranges specific amounts of crates at different bay positions, thus, the industrial line can be avoided in overusing, otherwise, once the distribution of industrial line is messed, namely, one of the lines is overused, the length of stay will be enlarged, ships will be detained then.

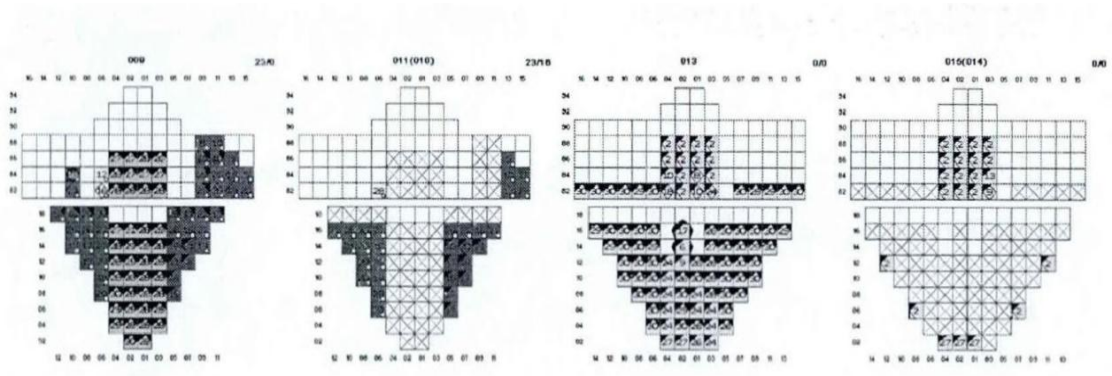

Fig4.2 Ship's bay plan

Besides, different ships have major distinct in inner structures, some cabins are single-slides whose spaces are simply able to contain 20-feet containers, and lines use single-slides may be overused when frequency is higher. However, sometimes, berth systems may oversight the defects of this design or realize the inconvenience after approaching, which may cause severe mistakes and occur confusions even chaos at berths.

4.3 The existed inadequacies of single-ship system

Single-ship plan is to arrange the placement of containers on board stowage plan, through the ship's stability, the venue of the port of discharge containers of different field position and weight calculations, resulting in optimal production plan. Single vessel stowage planning system is divided into actual production figure and ship production planning operations of two parts. Making a good pre-stowage Planning can make container handling smooth, loading efficient and also can make the unloading of ships secure to ensure the safety of the ship as well as fulfilling fully rational use of storage capacity container ships(Wang,2007).

Planning system as a single ship pier leading import-export operations of the ship

plays a vital role. The main function of a single boat plan is before the ship docked at the pier, the container is expected to be exported in the terminal system for the export of ships loading chart stowage work, such as the ship docked at the pier after the completion of joint inspection, carried out with the ship pass chart audit work. Import operations of the ship when they encounter problems, for helping to solve, handling import containers at berths.

4.4Influence to loading and unloading efficiency of single ship system

In the practical operation of container ships at terminal, single ship planer is taking charge of making distribution plans and the central dispatcher is taking charge of arranging working orders of quayside cranes. When making the distribution plans, if a same row of containers cannot be distributed into a same bay on the ship, the planer will distribute those containers to different cabins according to his understanding of loading sequence (Akio,2005). However, in practical works, the central dispatcher has a different thought with the planer usually, which may lead to a transposition of containers. For example, there are 4 boxes in the same row of a yard; these four boxes can be distributed to Bay 3 and Bay 5 in two groups, with two containers in a group respectively. For the single ship planer, he may think that the loading of Bay 3 is before Bay 5 during loading operation, thus he may distribute the first two boxes into Bay 3 and the later two into Bay 5. However, in the actual process of loading, the Bay 5 is first loaded than Bay 3, which makes a necessary transposition of the two containers at top.

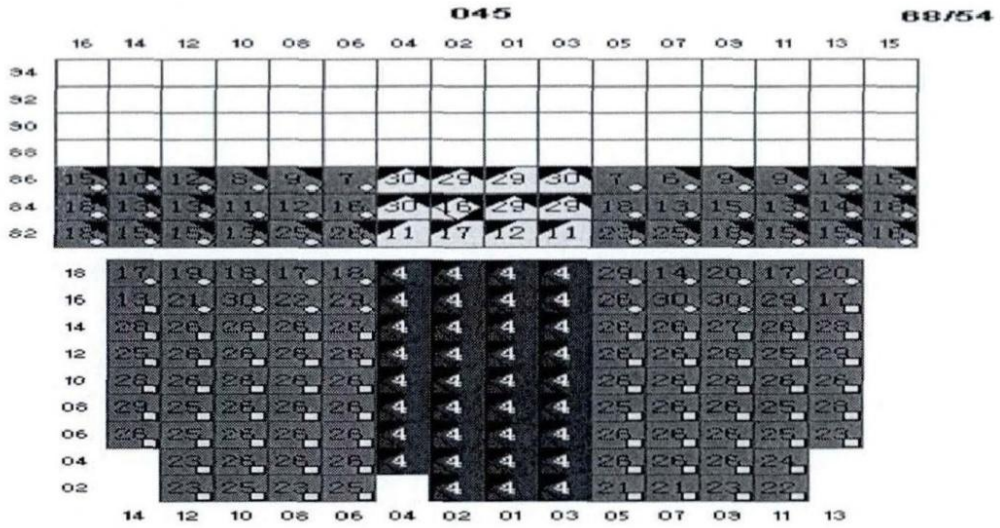

Fig4.4 Overstock in port

Distribute Container Volumes according to Operating Situation. When the single ship planer making the distribution plans, he must try to keep each operating line in balance, which can shorten the operating time of ships at port, improving the loading and unloading efficiency and ensure the timely departure.

Chapter Ⅴ The Influence of Container Terminal's Mechanical Systems and Other Factors of Tianjin Port on Efficiency of Ship Loading and Unloading

5.1 The influence of mechanical systems on the efficiency of ship loading and unloading

The container gantry crane is the special crane for loading and unloading the container at the wharf apron. It consists of hoisting mechanism, car entrance mechanism, truck entrance mechanism and elevating gear.

The transtainer, namely gantry container crane, is the loading and unloading equipment for the container operation at the container yard. Some of them utilize the fuel oil to drive. Rail-mounted container gantry crane which utilizes electric energy to drive is one of the special machineries at the container yard. Equipped with 20' and 40' extension-type slings for lifting load, it slings and stacks the containers with the wheel rolling on the track, within the stipulated scope of container yard.

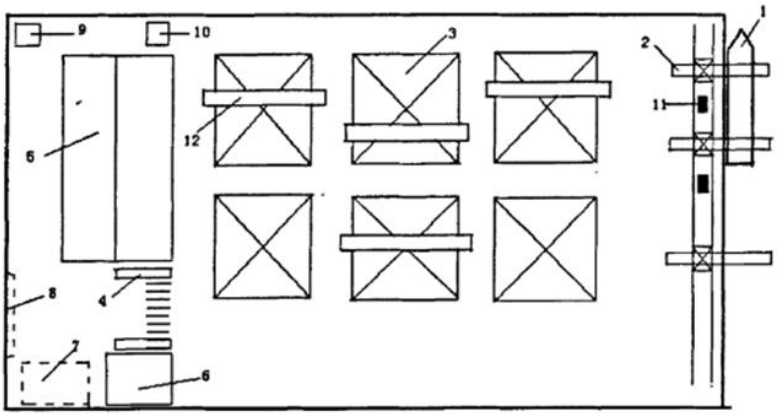

Fig 5.1 Layout of Tianjin Port Container Terminal

1.Ship;2.Quay crane;3. Yard;4.Gate;5.CFS; 6.Administration Building;7.Parkinglot;8.General Gate;9.Substation;10.Filling Station

The advantages of the yard crane which utilizes electric energy to drive at the container terminal yard are on the fact that it can reduce the production energy consumption, reduce the cost, and protect the environment. However, it also brings some negative effects to production operation. For example, at least two electricians at present are needed when the yard crane depending on electric energy to drive needs switching power supply. If there are several yard crane of that kind, we need many electricians. When the ship loading and unloading operation is ongoing, there may be a waiting state of the yard crane. In general, the waiting time of switching power supply of every yard crane is about half an hour. Therefore, when a ship is being unloaded, the field will be temporally unavailable, the trailers around the field will be blocked up, and the containers cannot be carried from the field on the process of lading. As a result, the situation of waiting of the yard crane and trailer, the discontinuity of the ship operation and the situations mentioned above will influence the efficiency of the ship operation.

If the electric energy yard crane has a mechanical breakdown when conducting ship operation, the collision avoidance and shift of the field are not feasible and then the other yard cranes cannot take the place of the electric energy yard crane, because of the link of cables. In the process of shipping operation, there is a prediction that certain container in a cabin which cannot be carried from the field, which will lead to the inability for the stowage of location to conduct the operation. Therefore, when repairing the yard crane, control dispatchers will have to rearrange the sequence of the operations of the gantry crane, thus the key operating line appears. In addition, the conflict of striving for the field when the yard crane is on the process of dispatching containers. Such a series of elements will influence the efficiency of the ship loading and unloading as well.

5.2 Influence of Other Factors to Loading and Unloading Efficiency of Ships

The proficiency of machinery drivers of yard cranes, quayside cranes and container trucks will also affect the loading and unloading efficiency. When drivers of yard cranes and quayside cranes pick up the containers, skillful drivers can pick up a container successfully in once or twice, unskillful drivers may try five or six times. The container truck drivers need to park their trucks below the yard cranes or quayside cranes. An accurate parking will be easier for container picking-up, thus the proficiency of drivers will have an impact on the loading and unloading efficiency. Besides, the working condition of machines will also affect the efficiency. The maintenances of machinery can avoid operational breakdown, keep a normal operating line and improve the efficiency.

Chapter Ⅵ ountermeasures of Improvement of Ship Loading and Unloading Efficiency in Tianjin Port

In regard to the problems of intricate human operations, traffic jam outside the gate and the human operational errors of gate system of container terminals at Tianjin Port, we put forward a series of countermeasures:

1. Wide Use of Radio Frequency Card

Ask the trailer company to enter relevant information into the radio frequency card in advance and send it to the offshore system. When the trailers going through the gate, as long as swiping the card, the relevant information of license number and container number will be reflected in the gate system. The gate staff only needs to check whether this information is valid and completed. The human input is avoided. Thus the checking time at the gate is saved, and meanwhile prevents the communicational obstacles and unbalance between the gate system and the transportation company, achieving a timely and ordered entrance and exit of gate and yard, increasing the operational control level, saving the waiting time at gate and improving the production efficiency.

2.Build some large-area buffer zones for trailers between gate and yard

When the yard work is very busy or the most machinery is at operation, the discharging order of container trucks will not occur. At this time after checking up the relevant information at gate, trucks can go directly into the buffer zone the wait for the entering orders. For those trucks whose information is not valid or correct, or the containers are damaged in the procedure of information input and takes much time possessing the gate and causing congestions, this method is especially effective. The establishment of buffer zone can take a control of trailers step by step and

effectively shorten the connection problem between the gate and the yard, which insure the fluent flow at uttermost.

3.Establish the Online Pre-record System

Before the container truck entering into the gate, the transportation company can send the container information, the truck information, the cargo information and the relevant document to port system in advance and transfer it to the gate system through EDI. The port can make the arrangement ahead of time. In this way, the information communication between quay and Transportation Company can greatly improve the passing ability of gate. The improvement of information level and the reasonable arrangement of entrance and exit of trailers can save much time of information input with bare hand in some degree, reducing the probability of human error.

6.2 Countermeasures of Yard System

To the questions of the conflicting of container receive and delivery, the transposition of containers inside the yard and other ones which may affect the loading and unloading efficiency of ships of yard system in Tianjin Port, we put forward a series of countermeasure.

1. Optimize the Place Selection of the Unloaded Exported Transit Containers

When we arrange the place of the unloaded exported transit containers, we can make it according to one-way or two ways. In the ground selection of exported transit containers, we can stack those same two-way boxes in a comparatively concentrated stock, at the same time select the position by Place Selection System according to the ports. Thus the transposition rate of exported transit containers will be much lower, and the operational efficiency of loading will increase, at the same time reduce the

operational conflict between unloading and loading.

2. Strengthen Exported Containers Piling Plan

In order to reduce the loading operational conflict in container terminal, the stacking of containers should be appropriate, that is to say, Container shipping operations to reduce the presence of earth piled conflict to "decentralization", that same voyage export box, we cannot focus too much on the venue stockpiling together, nor are in scattered everywhere. Excessive concentration of stacking, between the operating line during loading box appears indisputable case; venue if dispersed everywhere in the field of bridge loading operation will stop running, making on-site scheduling management chaos. Under normal circumstances, the same box area should be kept the same name, voyage boxes to be shipped. If the venue tension can also be stored in the same box area in different name, voyage boxes to be shipped, but to fully consider the different vessel name, voyage schedule, try not to make a similar schedule to be shipped boxes stacked in the same venue, in order to avoid conflicts when loading operations.

3. Lower the Stocking Height Properly

The containers in Tianjin Port can be roughly divided into three categories: imported containers, exported containers and transit containers. In order to improve the utilization rate of ground resources and the loading and unloading efficiency of the yard, the containers should be stacked according to different stacking plans. Under normal conditions, the exported containers can be piled into 4 or 5 layers, which is convenient for container trucks to operate. The stacking height of exported containers is usually 4 layers regarding of the loading operational efficiency. For transit containers, because that they may be transitted before loading, they are usually stacked to three layers, which can reduce the transposition rate and improve the

operational efficiency of ships.

4. Classify the containers in yard timely

Staff in container terminal should classify the boxes in the yard timely, transferring and collecting to reduce the unreasonable transposition during loading, increasing the loading efficiency. Container transference refers to the pre-loadi ng work, exerted customs boxed work, transference work within the transit area and other field work. Among them, the classification principle of the exported containers is to cluster the containers into different categories according to the ship's name, the voyage, the destination port and the tonnage. The staff also needs to control the specific number of boxes in a certain area, making the containers a proper distribution to avoid lowering the operational efficiency. The classification work in the yard is very necessary. If the ship need to change the berth repeatedly to unload the bulk cargoes, the inefficient classification will lower the operational efficiency, even influent the smooth flow of the whole quay.

5. Control the Transposition in Yard

The yard staffs stack the containers according to different ports and different tonnages. The staff then make some adjustment in accordance with actual condition, thus to make the piling plans of exported boxed more reasonable, to reduce the transposition rate. Since the times and orders of cargo owners are all random, to avoid the boxes beneath being picked in advance, the port need to strengthen the communication with customers and make an appointment, reducing the transposition rate. The port need to have a consecutive classification of containers, collecting those sporadic boxes to some specific area, making the imported containers always a comparatively concentrated condition. During unloading, put those imported containers of same ship into these areas to the greatest extent. Under these

circumstances, earlier unloading cargoes can be delivered at an earlier time comparing with the later unloading cargoes. When the owner picks up his cargo in the yard, the container amount at yard is relatively small, this improve operational efficiency of quay.

6. Improve the Turnover Rate of Containers in the yard

If the utilization rate of ground remains very high in a continued period of time, the reason is because of the low turnover rate of containers within the yard. To improve the turnover rate, we can shorten the receiving time, control the stacking time of imported containers, reduce the utilization of the ground and keep the transportation flow fluently. To connect with the yard outside the port, transfer the imported containers outside or directly deliver the unloaded containers outside to reduce the actual pressure of the yard is also an ideal way.

6.3 Countermeasures of berth system

According to the problems exist in Tianjin port container terminal, the author raises the countermeasures as follows:

1. The berth planner should strengthen the communication with the ship company. , the planner should also have a basic knowledge of the structure in cabin and find out if the ship has single-slide structure before arrive anchorage.

2. The berth planner should distribute the berth allocation reasonable.

3Lower the storage height reasonable

There are three kinds of containers in terminal: import container export container, transitional container. The storage plan should consider the category of the containers.

In practical, import container storage height is 4-5 layers that can be left easily by trucks. Export container storage height is 4layers normally. Experiment shows that transit box is easy to produce temporary transit before shipment, so storage height is no more than 3 layers.

4. Sorting the containers in yard off timely

Yard planner should sort and arrange the containers in yard timely to reduce container transposition. For example, the principle for export container is to storage it by ship's name/voyage/terminal/tonnage. The containers should not be storage in one zone. In another words, the containers could not be too concentrated, which would cause truck jam and reduce the efficiency.

6.4 Countermeasures for Single Ship System

Confronting with the existing influential problems of single ship system in container terminal of Tianjin Port, we put forward a series of countermeasures.

1. Improve the Transportation Quality

Before the cargo distribution, the single ship planer needs to check the Checklist carefully and repeatedly to ensure that whether the case number of containers meet with actual boxes and no manifest are similar with the case number of containers with manifest but no actual boxes. If similar case numbers are discovered, the staff has to check it immediately to avoid the cargo transportation problems due to the errors of manifest or information input.

2 Make a Reasonable Distribution Plan

Before cargo distribution, the single ship planer has to ensure whether the ship is

mooring at starboard or portside, thus ensuring the distribution direction. When two or more operating lines are at work simultaneously, the containers from same area cannot be loaded by two quayside cranes at the same time, because it may cause congestion within the yard, retaining the container delivery and lengthening the waiting time of cranes. When picking up containers in the yard, if the weight tolerance of vertical adjacent can be 5 tons within the stowage compartment, and 3 tons above the stowage compartment, then there is no need to obey the principle of "heavy boxes below light boxes" restrict. Picking up containers at the same area can greatly reduce the container transposition in the yard, avoiding the unnecessary move of yard cranes. Besides, when collecting containers in the yard, the yard crane can prevent a operation high above the ground, reducing the accidental risks.

3. Improve the Sense of Responsibility of Distributors

The single ship planer needs to check carefully when receiving the checklist, being cautious to manifest exchange, being clear to the transitional port of containers, and knowing the order of ports of call to avoid the situation of congestion. Besides, the planer has to have a communication with central dispatcher to unify the order of operating line, distribute the work volume reasonably and avoid the repetitive operation.

6.5 Countermeasures of mechanism system problems

To improve the efficiency of mechanical system of container terminal in Tianjin Port, we need to take some countermeasures.

1. Quayside crane improvements

Now the container terminals of Tianjin Port use the single truck operation mode,

which lengthens the waiting time or the unloading time of container trucks. If we take the double trucks operation mode, which is to transfer the boxes to a certain zone by one truck and transport it to the trailer by another truck. In this way utilization rate of trailers will be improved, as well as the operational efficiency of ships.

2. Trailer Improvements

Each trailer can drag two 40-feet container trays or four 20-feet container trays. The quayside crane and yard crane can equipped double 40-feet lifting appliances, thus the loading and unloading efficiency can doubled

ChapterⅦ Conclusion and Prospect

The competition among modern container terminals is not only the wrestle armed by hardware, but also boxing in the efficiency of loading and unloading. The rate of loading and unloading is influenced by colossal facts, such as gate system, yard system and berth system as well as single plan system. All these elements form the process of operation in container terminals, and slight humps in this process may adversely affect the efficiency. Therefore, in developing economy, promoting product quality, personnel should not ignore any of them; if they are aspire to enhance the rate of loading and unloading.

As we know, there are four general explanations in attempting to elaborate the existences of human being and other creatures in this world: Lamarck’s theory about inheritance of the acquired characteristics, intelligent design, Creationism and Charles Darwin’s evolutionism. Evolutionism seems leaping ahead from rest of the

theories by expounding that the creatures of this planet are evolved by the natural selection, however, like scientists, the actually never observe the neutron, electron and proton, but inferred their existences by the reflections on the whiteboard via the help of nanography. So there is no certain thing can really be proved, technically, but we do sort of have the best-bet of it.

So being a student, I understand my point is just one side of the ultimate definitive answers for the blue print of future of TPCT. Admittedly, I may or may not be too pessimistic about the present condition. Thus I concede to the idea that my view is just one angle of the unfathomable stands. And I am willing to accept comments and beneficial ideas, also I understand if anyone from now on has the intention of using my arguments will be welcomed and granted. I look forward to having further comments and improvements. In a nutshell, my dissertation apparently is the manifest of my view which certainly has its limitation, so do feel comfortable in commenting me, thus I can improve it.

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Appendix 1: Example of container bill checklist in TPCT

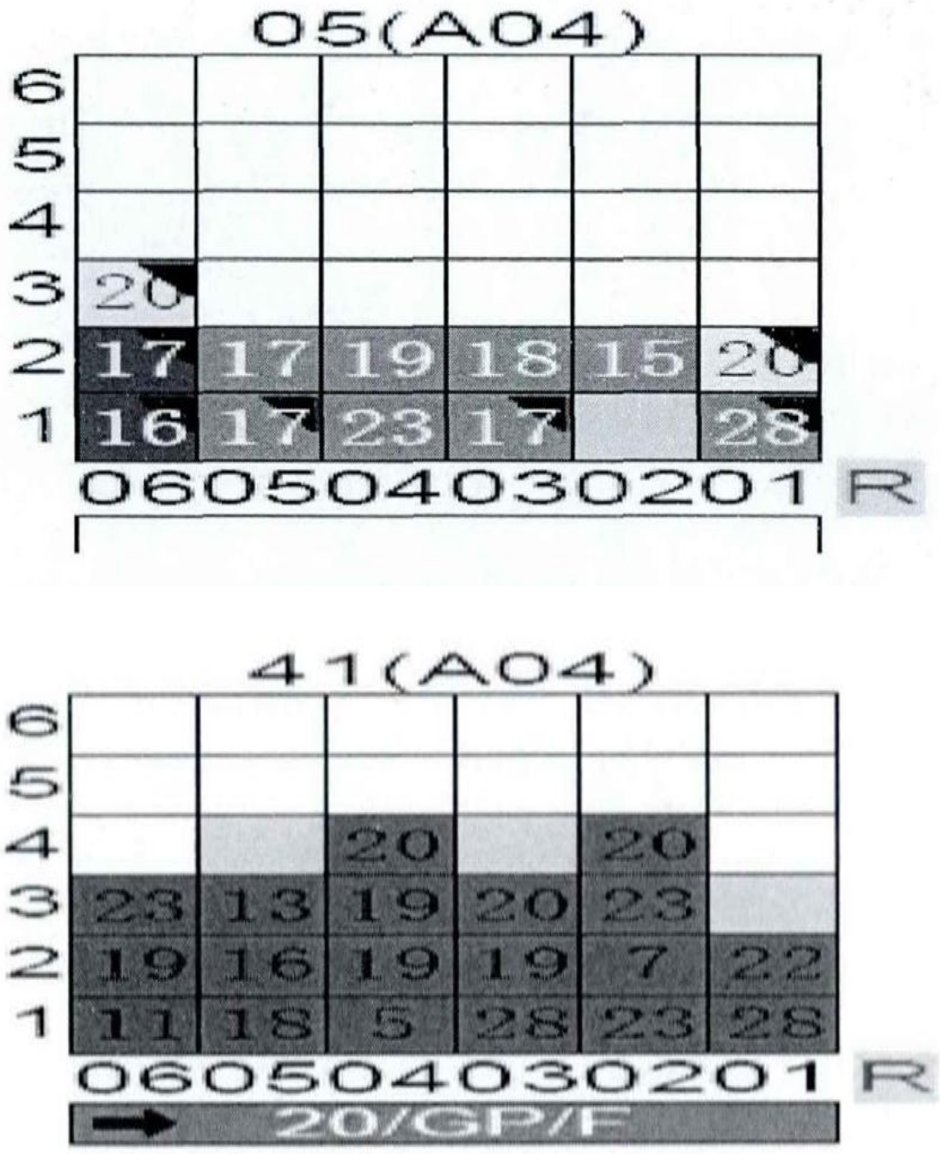
Fit to window width and enable scrolling

舱单核对表（三单核对表）

船名/航次: MSKSNG/1204　　日期: 2012/02/29 14:31:10

提单号	拼箱	箱号	卸货港	箱型	尺寸	总重	场位	收据	箱状态	危等	联合国	备注
有舱单无场位												
556432193A	√	MSKU9944748	DEBRV	HC	40	20343	A0455042	Y	在场			
556432193B	√	MSKU9944748	DEBRV	HC	40	840	A0455042	Y	在场			
556432193C	√	MSKU9944748	DEBRV	HC	40	1414	A0455042	Y	在场			
583549660		UTTU2416404	DEBRV	TK	20	27300		Y	预报 6.1		2674	
583549792		MRKU6014055	MYTPP	GP	20	13300		Y	预报 6.1		1544	
583586934		MSKU6631984	NLROT	GP	40	25104		Y	预报 5.2		3104	
583586935		MRKU8002169	NLROT	GP	20	15164		Y	预报 5.2		3107	
583586936		PONU0195187	NLROT	GP	20	17736		Y	预报 5.2		3107	
583586937		MAEU6191534	DEBRV	GP	40	25500		Y	预报 5.2		3104	
601936802		PONU0757690	GBFXS	GP	20	15511		Y	预报 3		1993	
663501964A	√	MSKU6564847	DEBRV	GP	40	22800	A0450061	Y	在场			
663501964B	√	MRKU0085600	DEBRV	GP	40	24805	A0450053	Y	在场			
	√	MRKU0702121	DEBRV	GP	40	24805	A0450043	Y	在场			
663592546		MSKU5086433	MYTPP	GP	20	15730		Y	预报 5.1		3005	
有舱单无收据												
555689947		MRKU6691904	DEBRV	GP	20	25300	B0451033	N	在场			
		MSKU3004941	DEBRV	GP	20	25300	B0507061	N	在场			
556359586		MSKU8460965	GBFXS	HC	40	23857	A0454063	N	在场			
556359591		MSKU1123850	NLROT	HC	40	23857	B0470042	N	在场			
556359769		PONU7686049	GBFXS	HC	40	23857	B0510061	N	在场			
		TCKU9034764	GBFXS	HC	40	23857	A0454062	N	在场			
556359769		TCNU8616174	NLROT	HC	40	23857	B0418032	N	在场			
556376829		TCLU5538553	DEBRV	HC	40	15332		N	预报			
556432193D	√	MSKU9944748	DEBRV	HC	40	9155	A0455042	N	在场			
567978858		GATU8660165	DEBRV	HC	40	7520	B0442042	N	在场			
		MSKU7552667	DEBRV	GP	20	4036	B0507053	N	在场			

Appendix 2: Example of mix piling plan in TPCT



Appendix 3: Example of release permits in Tianjin Port Alliance International Container Terminal

天津港联盟国际集装箱码头有限公司三单核对结果清单（可放行清单）

船名航次: MSKSNG / 1204 电话: 传真: 日期: 2012/02/29 14:31:31

已核对(舱单有 -场站收据有-场地有)

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556359900	556365659	556376036	556424236
556372112	556372413	556372129	556372130
556372401	556372402	556372192	556372494
556373559	556374574	556374672A	556374672B
556374673	556374679	556374603	556374604
556374694	556374702A	556374702B	556374703A
556374703B	556374704	556374712	556374715
556374717	556374745	556374762	556374763A
556374763B	556374763C	556374763D	556374765A
556374765B	556374766	556374768A	556374768B
556374777	556374779	556374782	556374783
556374787A	556374787B	556374792	556374809
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