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Optimizing the work flow of outsourcing container transshipment in Rotterdam

by

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Abstract

The main objective of this paper is to investigate the possibility of optimizing the sea-sea container transshipment work flow in Port of Rotterdam from the perspective of shipping lines agent. The analysis of workflow including the main activities from container loaded on the deep sea vessel from the loading port until to the container load on the feeder vessel. The work flow evaluation has been performed by applying the PERT/CPM methodology based on the time required of each activity. The relationship between the activities and time required of activities has been defined and estimated according to the face-to-face interview with daily operating staff in transshipment department in Cosco Container Lines (Netherlands). B.V. The purpose of evaluation is finding the critical path in the transshipment work flow that the shortest ideal total time completion for container transshipment process. After the critical path has been found, in order to improve the critical path and realize it in reality work, the critical path will be rescanned by the sophisticated operating staff. It has been found the uncertain activities such as checking and repairing the container are usually the critical activities in the work flow and they are highly affect the total time completion of container transshipment. Secondly, it has been found that dynamic relationship between container ready time on terminal and feeder vessel departure time also affect the performance of container transshipment. It also has been found the high volume of container transshipment in summer has led the overload of operating staff is another reason that increases the total time completion of transshipment and reduces the efficiency in the reality work.

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List of Abbreviations

CPM	Critical Path Method
COD	Change of Destination
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
ETA	Estimated Arrival Time
ETD	Estimated Departure Time
IMO	International Maritime Organization
IRIS	Integrated Registration Information System
PERT	Program Evaluation and Review Technique
SSS	Short Sea Shipping
TEU	Twenty Foot Equivalent

Chapter 1 Introduction

1.1 Research Background & Aim of Thesis.

Port of Rotterdam is the biggest port in Europe, as the gateway of Europe, many shipping lines operating firms choose Port of Rotterdam as the main transshipment port in Europe. There are huge amount of cargo have been transshipped in Port of Rotterdam every year. Nowadays, in order to get the lower transport cost per unit, the size of deep sea vessel has been steadily increased. The depth and width of Malacca Strait and Panama Canal will be increased in soon future and it will allow the larger size of deep sea vessel be shipping cross the ocean . Therefore the constraint of depth of deep sea vessel will be extended and it will have major implications for the structures of world and European container transshipment. Cause of high technology development, the number of crew on the deep sea vessel is also decreasing. These reasons led the cost of per unit decreasing and caused the economics of scale and the demand of transport by sea increase steadily. Secondly, the number of call ports for deep sea vessels is decreasing and the development of hub-and-spoke system attracts larger volumes to lower cost per unit. Meanwhile, because of the containerization allows rapid transits from factory to customers, it has many advantages such as more quick and efficient operation; it also reduces damage / pilferage / handling cost and claim. Containerization is becoming standardization for cargo transportation, more and more cargo are going to be delivery by container, because it can be easily interchanged with any kinds of inter-modal transport, such as the trucks, trains and ships. Due to these reasons, the container transshipment volume rapidly grows up every year at every main port in the world. Transshipment operation becomes one of the key points to develop advantages in cost efficiency, reliability and responsiveness for the whole supply chain. Inter-modal transport could be defined as cargos transfer from origins to destinations by more than one transportation mode. The combination can be among between truck, train, barge, feeder and deep sea vessel. The critical factor for choosing the transshipment modes would be having challenges in trade-off between cost and transit time. Compare with other transportation mode, seaborne or short sea transport is the most economical mode. Because shipping by sea "has been considered the most environmentally friendly mode. One of the main advantages is that it occurs far from congested housing areas and requires a minimal amount of energy in relation the amount of cargo transported."(Unifeeder annual review 2009). Therefore, many shippers and consignees prefer to choose the sea-sea transshipment for their containers

"In Europe, many developed countries has their own ports, all containers were handled in 146 container ports and 84% of the volumes were handled in the very few and large hub ports. The concentration tendency is obvious, but these hubs are turning points in a dense feeder transport network connecting a large number of origin or destination ports in the region, which stimulates further growth."(Jennie Thalenius and Kaj Rehstrom, 2002) Port of Rotterdam as the biggest gateway port in Europe, there are huge amount containers need to be transshipped through the port of Rotterdam, based on the forecasting, the volume is steady increase in recent years. Most of shipping line companies has settled their local agent in Rotterdam, the main foundation of these local agents is to operating the transshipment processes effectively. During the transshipment process, there is a set of activities. “The sequences of activities are set up make sure one activity follow the end of another activity to start. The network structure and sequence influence the performance of the process. For example, in the shipping process, the delivery of complete information before the vessel arrival will affect the port operation and feeder connection.”(Anupindi Ravi et al. 2006). Each activity is related and depends on other activities, if the cargo flow or information flow among the relevant parties is not clearly understood in a timely manner, the problems will be easily happened and affected the performance of container transshipment.

This research will be based on the author’s internship in the Cosco shipping lines agent in Rotterdam, through the interview with the operating staff in transshipment department in Cosco and the attending their daily work to probe into the shipping lines’ container transshipment activities in reality workflow in Port of Rotterdam. This study will analyze the current situation and possible solutions by using the PERT/CPM methodology to measure the activities in the daily works. The contribution of this research is expected to figure out the key activities in transshipment workflow and find the applicable critical path to stabilize the transshipment handling performance in Cosco transshipment department.

1.2 Project Scheduling (PERT/CPM)

1.2.1 Overview

The Program (or Project) Evaluation and Review Technique and CPM (Critical Path Method) are management science methodology that designed to analyze and represent the tasks involved in completing a given project, especially the time required to complete each task, and identifying the minimum time required for complete the total project.

1.2.2 History of PERT/CPM

In 1957, the Critical Path Method (CPM) was developed by Mr. Du Pont as a network model for project scheduling. CPM is a deterministic method that uses a fixed time estimate for each activity to find the critical path for the network.

PERT was developed in the late 1950’s for the U. S. Navy for planning and control of the Polaris missile project and the emphasis was on completing the program in the shortest possible time. The Program Evaluation and Review Technique (PERT) is a methodology that evaluates the work flow by build network of work flow. PERT usually used for optimizing the work flow to getting the shortest completion time by organize the manpower, materials, time and cost. The PERT network descripts the relationships between each activity in the work flow. It’s provides the full view of the work flow and helps the operating staff to determining the critical activities in the work flow.

Terminology (David R. Anderson et al, 2007)

- Program evaluation and review technique (PERT): A network-based project scheduling procedure
- Critical path method (CPM): A network based project scheduling procedure.
- Activities: Specific jobs or tasks that are components of a project. Activities are represented by nodes in a project network.
- Immediate predecessors: the activities that must be completed immediately prior to start of given activities.
- Project network: A graphical representation of a project that depicts the activities and shows the predecessor relationships among the activities.
- Critical path: The longest path in a project network.
- Path: A sequence of connected nodes that leads from the start node to the finish node.
- Critical activities: The activities on the critical path.
- Earliest start time: The earliest time an activity may begin.
- Earliest finish time: The earliest time an activity may be completed.
- Forward pass: Part of the PERT/CPM procedure that involves moving forward through the project network to determine the earliest start and earliest finish times for each activity.
- Latest start time: The latest time an activity may begin without increasing the project completion time.
- Latest finish time: The latest time an activity may be completed without increasing the project completion time.
- Backward pass: Part of the PERT/CPM procedure that involves moving backward through the network to determine the latest start and latest finish time for each activity.
- Optimistic time: The minimum activity time if everything progresses ideally.
- Most probable time: The most probable activity time under normal conditions.
- Pessimistic time: The maximum activity time if significant delays are encountered.
- Expected time: The average activity time. $T_E = (O + 4M + P) \div 6$
- Beta probability distribution: A probability distribution used to describe activity times
- Slack: The length of time an activity can be delayed without affecting the project completion time
- Crashing: The shortening of activity times by adding resources and hence usually increasing cost.

1.2.3 Implementation

There are six steps for PERT/CPM:

1. Define the network and all of its significant activities. The network should have only one single start activity and one single finish activity.
2. Define the relationships between the activities. Make sure which activities must be immediate predecessor and which must follow others.

3. Draw the “network” of work flow including all the activities. Each activity should have unique event numbers. Solid arrows are used for connect two activities from immediate predecessor to follow activities.
4. Define time required and/or cost estimation for each activity.
5. Calculating the longest time completion path through the network. This is the critical path for work flow
6. Using the network to plan, schedule and control the work flow.

1.3 Literature Review

This section provides a brief overview of the majority of the literatures published and relevant with regard to the sea-sea container transshipment in Rotterdam and also the applying PERT/CPM methods to workflow.

1.3.1 Literature on Applying PERT/CPM to Workflow

Duk-Ho Chang, Jin Hyun Son, Myoung Ho Kim (2002) described their workflow model by using the workflow queuing network. They have proposed a method systematically to determine the critical path under the workflow model and gave an overall example that showed how their method workable.

Heinz Pozewunig, Johann Eder and Walter Liebhart (1997) introduced a concept for time management of workflow systems. It consisted of within a workflow, checking time constraints and monitoring time at run-time. They have extended the net-diagram technique PERT to support the structures that usually found in workflows. They also implemented it in their workflow management system.

Jin Hyun Son, Jung Sun Kim and Myoung Ho Kim (2001) presented a method to find out the critical activity which delay the total completion time directly affects the overall processing time of a workflow from a set of critical activities. They also developed a method to determine the minimum number of servers for the critical activity such like this activity should be finished without delay for a given input arrival rate.

Jin Hyun Son, Jung Sun Kim and Myoung Ho Kim (2005) described their workflow model with a set of workflow management that able to provide sufficient power to express the models of business processes. They also have proposed a systematic method of identifying the critical path for a given workflow schema. They have proposed method that based on queuing theory because operational characteristics of the workflow schema can be modeled by an M/M/1 queuing network.

Johann Eder et al. (1999) described how the time information can be gotten from the workflow definition. They have proposed PERT for calculating internal activity deadlines with the goal of meet the overall deadlines during process execution. They translated the workflow description into a PERT-diagram that showed the time when each activity has to be satisfied the overall time constraints of the workflow at a specific state. Their work enabled process managers to plan workflows along the time dimension and also to be alerted about potential time error.

Li-Chuan Lee et al. (1999) investigated whether PERT/CPM can be used to realize similar outcomes with pulmonary lobotomy patients. The PERT/CPM was used to analyze variances from the clinical path way. A network flow diagram was used to determine whether sequential relationships existed between activities and clinical outcomes in the care process. Based on their findings, a critical pathway was developed detailing daily goals for the patients and care team.

Partick Weaver (2006) briefly introduced the history of scheduling methodology development. It includes the history of PERT/CPM development. He also discussed the changing role of the scheduler.

Ravi Anupindi et al. (2003) viewed operation management in terms of design, control and improvement of business processes and use the process view as the unifying paradigm to study operations. They introduced three important management measures of process performance – flow time, flow rate, and inventory-and discussed the relationship among them.

Seung-Hyun Rhee, Hyerim Bae and Yeongho Kim(2004): proposed a methodology of executing business processes efficiently by introducing the PERT/CPM techniques in the workflow management systems. They developed a method that for calculating the critical path and slack time in workflow processes. Then, they developed a dispatching rule that can guide task performers to prioritize their tasks to increase the efficiency of all the process.

Wlodzimierz Dabrowski and Rafal Hryniow (2008) have proposed a new approach to workflows that was based strictly on object model and simulates a PERT net behavior. The modeling processes as objects with formal attributes and behavior could solve all problems introduced by Petri nets and its successors.

Zeki Karaca and Turgay Onargan (2007) presented a new application of the CPM and the workflow schema in the marble-processing industry. Based on the idea of finding the critical path of workflow, this study investigated the network diagrams of marble processing plants. Their study also proved that the CPM technique could effectively in the design of new process.

1.3.2 Literature on Container Transshipment and Feeder Service

A.C. Paixao and P.B. Marlow (2002) analyzed the strengths and weaknesses of short sea shipping. It concluded that the strengths of SSS include geographical advantages, financial advantages, knowledge/skill-based/human resources advantages, energy advantages, environmental advantages. This study has proposed a list of measures for overcome SSS disadvantages. Some of the measures have been implemented and others led the delay of SSS development.

Alfred J. Baird (2006) evaluated and compared locations of competing seaport with a given region as the optimal location for international container transshipment activity.

He mainly focused on the container transshipment hub locations in northern Europe region. He concluded that the optimal container transshipment location must offer a combination of low mainline ship deviation cost and low average feeder ship cost. The findings from his study demonstrated that none of the existing hub terminals in northern Europe able to offers an optimal location from which to serve the main transshipment markets.

Alfred J. Baird (2002) estimated and compared the costs of transshipment in North Europe with the multiport and direct call service. He concluded that the low container handling cost and high productivity of offshore transshipment terminals can offer the operating and capital cost advantages. His result indicated that further developments of offshore transshipment hub terminals may provide low-cost container transfer for large vessels.

APEC Transportation Working Group and Inha University (2007) analyzed the advantages of SSS for Ports' efficiency and environmental protection. They suggested that Asia-Pacific region should develop SSS for reduced logistic costs and improve environmental protection to further utilization of underused seaports in the region. This paper can be the reference for Europe SSS development.

Giovanni Ridolfi (1999) analyzed the containers transshipment and intra-regional distribution of containers in Mediterranean Sea region. He concluded that Mediterranean ports have advantages and able to benefit from transshipment trade and intra-regional shipments. In order to get those advantages, it requires much greater economic cooperation and political dialogue among all nations around the Mediterranean Sea.

H. Arjen van Klink and Geerke C. van den Berg (1998) investigated the critical factors for generate the scale of economies for major seaports in Europe improve. It also analyzed the way of operate intermodal transport with numerous destinations cost effectively with high frequency. They focus on Rotterdam and Northern Italy as the gateway of Europe. They suggested developing new intermodal transport markets beyond their traditional hinterlands like sea-sea or sea-rail transshipment.

Hans Moonen et al. (2005) analyzed the container transshipment by barges in Port of Rotterdam. This paper described an industry workshop by using the software named beer game, it was used to evaluate the current manual planning. It illustrated the need for joint planning and information sharing in supply chains. In order to improve the barge handling efficiency, they concluded that Port of Rotterdam needs such a system like beer game.

Iris F.A. Vis*, Rene de Koster (2002) showed an overview of transshipment of containers at a container terminal. They described all sub processes and planning at container terminal. They also discussed the decision problem for all types of material handling equipment at container terminal. At the end, they briefly discussed the mathematical programming models and simulation models for solve the decision problem at container terminal.

Jennie Thalenius and Kaj Rehstrom(2002) summarized the structure, competitiveness and driving forces in the port and shipping market for containers in Northern Europe and Baltic Sea. They have presented three reports; the second is "The North European Maritime Container Feeder Market" with comments about research and methods, findings regarding port statistics and discrepancies between sources, the database tool, structures and driving forces in the regional feeder market.

Joseph J.M. Evers and Ronald De Feijter (2003) used the case of the Maasvlakte Harbour area of Rotterdam. It analyzed whether each terminal should be equipped with its own service stations for feeder shipping or whether pooling of the facilities would be more effective. They examined the service station in terminal for feeder ships. Based on their simulation results, they concluded that a centralized service is preferable and able to attracting 70% of the market potential.

Ken Chih (2003) introduced IRIS-2 system in OOCL, he presented the Background and Goals of develop the IRIS-2 system. He also listed the benefits for OOCL that caused by using IRIS-2. At the end, he concluded that IT becomes a strategic advantage of OOCL by using IRIS-2.

Koi Yu (Adolf) Ng (2006) used the container transshipment in Northern Europe as a case study; it investigated the factors that affecting port attractiveness from a port user's perspective. It concluded that monetary cost is not the only component in explaining port attractiveness. Other factors like time efficiency, geographical location and service quality should also be taken into consideration. In terms of geographical location, Rotterdam also possesses competitive edges in serving this market.

M. Stratos Papadimitriou and Manfred Zachcial (2001) presented two reports to introduce and analysis the economical and policy oracles for developing the short sea shipping in Europe. They briefly introduce the current situation of short sea shipping in Europe in 2001, such as the main characteristics of short sea shipping in Europe, advantages and obstacles for developing the short sea shipping. They also analyzed the influence of policy for short sea shipping development. They have overviewed the short sea shipping in Europe. This study can be used as reference for analysis the current situation of short sea shipping in Europe.

Ocean Shipping Consultants Ltd. (2009) analyzed the import/export and transshipment in east Baltic transit markets. Ongoing and planning investment projects were reviewed in detail. It also has forecasted the container port demand and capacity and resulting supply/demand balances in 2020.

Peter M. Schulze and Alexander Prinz (2009) used SARIMA model and the Holt-winters exponential smoothing approach forecasted the container transshipment in Germany. Their result indicated the strong growth for German container transshipment handling, it can be the reference for forecasting the container transshipment in Netherland.

Peter T. Leach (2009) concluded that although the volume of containers passing through the Port of Rotterdam dropped, but the share of container volume transshipped through the port rose. The rise in the share of transshipped containers corresponds with the rise in the number of feeder services in 2009 and the specialized feeder services providers such as Unifeeder and Team Lines has expanded their Rotterdam volumes considerably as they started more feeder services to and from the Baltic.

Unifeeder Annual Review (2009) briefly introduced the characteristics of feeder service and short sea shipping service in North Europe regional. The containerization of cargo is increasing and the positive environmental and safety aspects of seaborne trade in north Europe. It concluded that feedering is closely connected to the expansion of global trade, it is in position to take over from road transport as the favored mode for intra-European trade.

1.3.3 Summary of Literature Review

Based on the detailed review of the related literatures, no references have been found referring to the use of the PERT/CPM in the container transshipment workflow. But there are sufficient literature proved that the PERT/CPM is a widely applied technique in workflow management.

In some studies, it has been proven that sea-sea container transshipment volume in port of Rotterdam has increased steadily. Some researchers investigated the port selection, intermodal transport, efficiency of transshipment terminal, cost of transshipment and feeder services market. Most of researchers pay attention to the main angle of vision in this field, but no articles have been found to meticulous analyze the workflow in transshipment department. Due to this regard, this study aims to propose an application of PERT/CPM for optimizing the workflow of the sea-sea container transshipment in Rotterdam.

1.4 Structure of Thesis

This thesis consists of six chapters. In the introduction chapter, it offers an introduction to the research background and aim of this study. It introduces the methodology (PERT/CPM) and also briefly presents the reviews on related literature on workflow of outsourcing sea-sea container transshipment. Following the introduction chapter, the chapter 2 will deeply describe the characteristic and trends of sea-sea container transshipment in Port of Rotterdam. In chapter two, based on the author's internship in transshipment Department, it introduces the activities of daily work and the functions of management information system (IRIS). Chapter 3 highlights all the activities in transshipment department in Rotterdam and mentions the general difficulties in the daily work of container transshipment. According to the analysis of Chapter 3, Chapter 4 will apply the PERT/CRM to measure the activities in work flow and gets the critical path at the end of chapter. The results and analysis are provided in Chapter 5, in order to improve the critical path and realize it in business reality, the critical path will be rescanned and adjusted by the sophisticated operating staff in transshipment departament. Finally, Chapter 6 will summarize the result and draws a conclusion that including the research limitations and the recommendations for the further study. The Figure 1-1 shows the structure of the thesis.

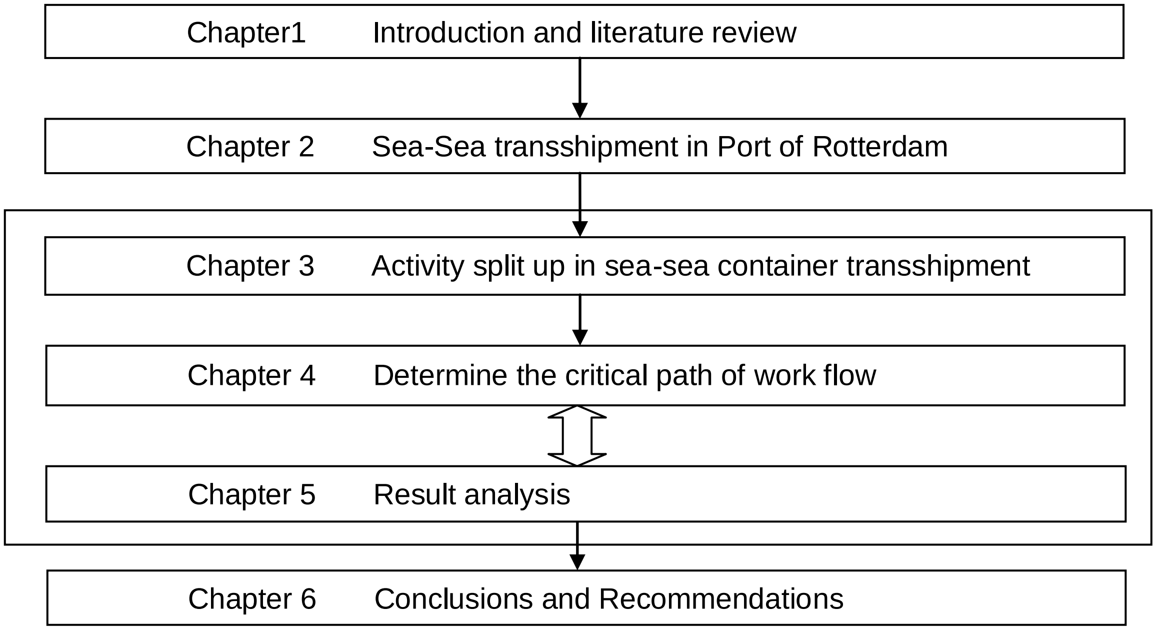

Figure 1-1: structure of thesis
Source: Own elaboration

Chapter 2 Sea-sea Transshipment in Port of Rotterdam

2.1 Characteristic and Trends

Since the end of the nineteenth century, as a port city, Rotterdam has made Netherlands to an important trading nation in the modern times. Port of Rotterdam as the biggest container port in Europe, it is far outstrips the other ports in Europe. As a hub port, there are huge amount containers have been transshipped through Port of Rotterdam every year. There are around 9 million TEUs passing through the Port of Rotterdam (Maurits Van Schuylenburg, 2010). As shown in Figure 2-1 below, around 1.85 million TEUs have been transshipped by sea in Port of Rotterdam.

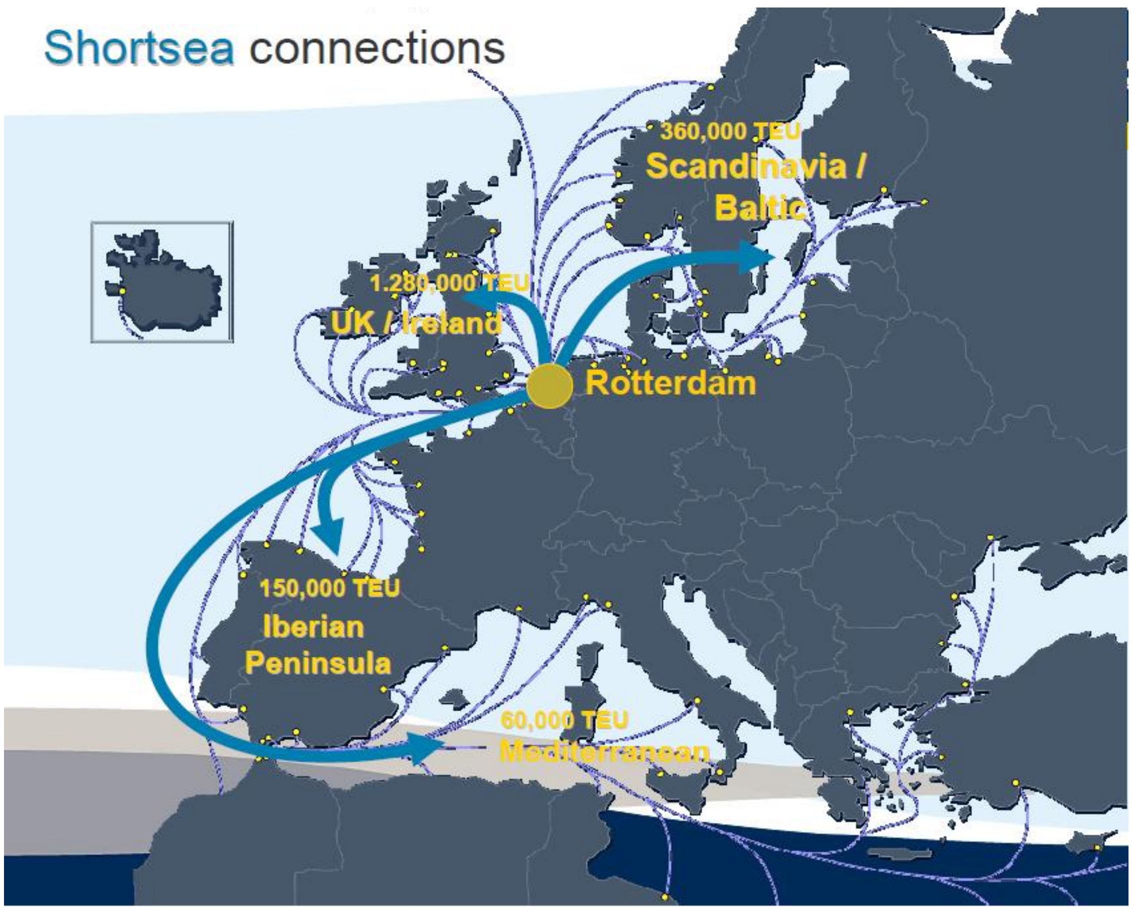

Figure 2-1 Short Sea Connection
Source: Maurits van Schuylenburg, 2010

There are three critical factors that led Port of Rotterdam to be the biggest sea-sea transshipment port in Europe. At first, “Europe has a coastline in excess of 67,000 Kilometers and most of its industrial and production centers located on the coastline.” (A.C. Paixao and P.B. Marlow, 2002). The final destination is the most important factor for choosing the transshipment modal, the Figure 2-1 shows that most of highly developed countries are located on the costal line of Europe continental, most of containers arrived in Port of Rotterdam are going to those countries. Therefore, sea-sea transshipment is more convenience than inland transshipment. If the final destination is UK, Ireland, Finland, Sweden or Norway the inland transport is not available for those destinations, the sea-sea transshipment will be the only choice. Secondly, the deep-sea vessel size increasing and the hub-spoke system reduce the number of call ports, more and more containers will not be delivered to the final destination directly but to the hub port and then transshipped to the final destination. Therefore, as the first and last call port, there will be huge amount containers transshipment in Port of Rotterdam. “As one of the world’s busiest deep-sea hubs, Rotterdam served by many world’s largest deep-sea shipping lines, most of these lines, in turn, operate own or outsourcing feeder services to smaller European ports.” (The Irish Maritime Development Office, 2005). At last, due to the huge amount container transshipment demand, if the sea-sea and inland modal are both available for the final destination, then choose the most economic inter-modal transport will attracts much attention for shippers and consignees. The transshipment services generally include ship, rail, train and truck, the cost is quite different, truck usually is the most expensive and short-sea ship is always the lowest. Someone may calms that there are difficulties and uncertain in the shipping control, but compare with the deep-sea shipping, the short sea shipping keeps the advantage of low cost but reduced the difficulties and uncertain. It is steadier and also speedy for container transshipment.

As mentioned before in first chapter, sea-sea transshipment is most environmentally friendly mode. It is far from congested housing areas and requires a minimal amount of energy in relation the amount of cargo transported. In recent years, the environmental threats posed by transport grow increasingly sensitive. The environmental regulation becomes tighter than before, such as nitrogen oxides and sulfur oxides. “In terms of greenhouse gases, the emission levels resulting from seaborne transports are among the lowest of any commercial transport mode. At 10-15 grammes per ton-kilometer, it is lower than rail (20-40 g/tkm), trucking (50-90 g/tkm) and aviation (670/870 g/ktm)”(Unifeeder annual review, 2009). In this view, the environmental regulation will be tighter in the soon future and more container transshipment demand will shift to the sea-sea mode.

“Using the sea-sea transshipment modal as an alternative means of freight movement reduces not only the number of trucks that daily congestion on the road or rail, but also associated social costs, which cannot be removed or reduced unless huge investments in infrastructure are made at the expense of more social cost.”(A.C. Paixao and P.B. Marlow, 2002). Unlimited capacity is another advantage that it has being able to use the sea 7 days per week for day to night. Certain countries are imposing timetable restriction on driving hours during the night and at weekends, such as France, Portugal and Spain, while others are introducing tax schemes, a traffic tax payable as a function of distance travelled and the number of days of staying in a particular country. The road and rail mode networks requires huge investments not only to build both the road surfaces and the railway lines but also additional tunnels and bridges whereas ports are the only land area or physical space required by sea-sea modal.

The financial crisis and the subsequent recession have had a serious negative impact on the turnover of short sea operators. By the end of 2009 a slight recovery could be registered. Although the throughput of the Port of Rotterdam was decreased in 2008, the Rotterdam Port Authority issued that “the share of container volume transshipment through the port rose to 30 percent from 28 percent in 2008”. (Peter T. Leach, 2010) The volume was shifted from Port of Hamburg, because of the lower terminal rate and the draft of Port of Rotterdam is deeper than Port of Hamburg. The port authority issued that the rise in the share of transshipment containers led the rise in the number of feeder services in 2009, such as Unifeeder and Team Lines, they increased feeder lines from Rotterdam to the Baltic.

“Transshipment is the fastest growing segment of the container port market, resulting in significant scope to develop new transshipment terminal capacity to cater for future expected traffic flows.”(Alfred J. Baird, 2006) After the economic crisis, the shipping volume is rise again, “On virtually a global basis, development of new style ‘offshore’ transshipment hubs therefore appears to be the container shipping industry’s answer to changing demands posed by handing larger vessels and increase trade flows. Such a hub has yet to be built in Northern Europe, this being to a very large extent a reflection of continued state funding of port development at traditional port locations on the continent.”(Alfred J. Baird, 2002), therefore, the port of Rotterdam needs extras space for new large-scale activities. The Port of Rotterdam Authority is building the Maasvlakte 2 to create a new location for port activities and industries in the North Sea. The project will extend the port out to sea by approximately 1,000 hectares of industrial area for deep-sea related customers in chemicals, new industry and container handling along with associated distribution services. The Maasvlakte 2 will provide more space for container transshipment. Compare with other hub ports in Europe, Port of Rotterdam has more space to be extended. It can be predicted that Port of Rotterdam will get more market share from the steadily increased container transshipment volume in Europe. Also “the continued improvements in port productivity would serve to increase even further ship size optima for all routes” (Alfred, J. Baird, 2002) Figure 2-2 shows the extension plan for most hub ports in Europe. It may too optimize for Port of Rotterdam, but it shows the trend at least.

2.2 Outsourcing Sea-sea Container Transshipment

Traditional container movements are on port-to-port basis. However, demand of door-to-door services by shippers has been increase. In order to be able to provide reliable and fast services, deep-sea carriers extended their service to more kinds of inter-modal services. Few of them operate by themselves, at the same time, most deep-sea carriers integrated with other transshipment services operators and get a combination of long-term contracts based on their shipping lines. In terms of sea-sea transshipment, some of deep-sea carriers operate their own feedering services, so called in-house feedering. Others outsource sea-sea container transshipment to the feeder service operators

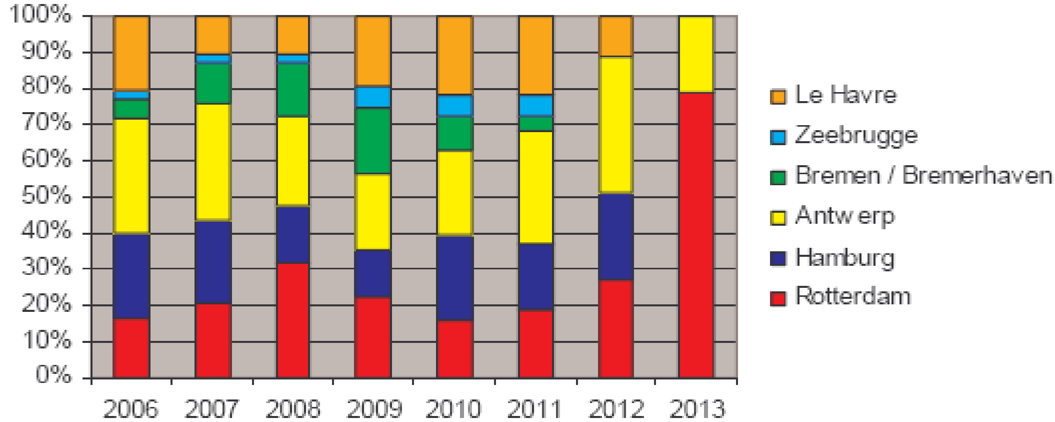

Figure 2-2 Extension plan H-LH ports
Source: Maurits van Schuylenburg, 2010

Use Cosco Europe as a case study, Cosco is one member of CKYH alliance. CKYH includes Cosco, Hanjin, K-Line and YangMing. CKYH does not own their feeder fleets in Europe, therefore, in order to provide the shipping service to most small ports in Europe, they have sign long-term freight forwarding agreements with different short-sea shipping operators. Base on those long-term freight forwarding agreements, deep-sea carriers could keep their cost steadily at a relative low level, and also meet the requirements for the shippers. From the other hand, it's good for the feeder service operators to develop more effective ways to cooperate with deep-sea carriers. The combination created value for both parties and it enhanced competiveness for both parties and fully meets the requirements of their customers.

Feeder service market in Port of Rotterdam is kind of Monopolistic Competition Market. There are not too many companies in this market, each of them are focusing on the markets of different areas. Once the alliance sign the long-term agreement with feeder service operator, each final port will be only served by one feeder service operator. The appendix Table A-1 shows the different final ports that served by different feeder service operators. It shows that Unifeeder is the biggest firm in this market, "Unifeeder own 44 vessels that from 700TEUS to 1500TEUS" (Unifeeder vessels list, 2010), their service reaches 12 countries in the North Europe. The second one is Team-Lines, it focuses on the Ports in South Europe, especially in Spain and Portugal. Other feeder operators mainly serviced to 1-2 countries.

Conclusion of outsourcing feeder service: Generally, outsourcing service makes the deep-sea carriers mainly concentrate on their core business. In the present scenario, it's more flexible and lower cost for deep-sea carriers. Usually, the feeder vessel's schedule is 2-3 times/week, the vessel size is around 1000 TEUS, the shipping capacity can be calculate that equal to approximately 5000 TEU/week. The feeder vessel carries containers for several clients and it also serve the local customers by providing the short sea shipping service. Hence, it makes possible to operate on a larger scale and at a more stable and high capacity utilization rate. The benefits cause by lower transport cost per unit will pass to both parties. The demand of transshipment of one alliance is relatively much less. Therefore, if the alliance operates the sea-sea transshipment by themselves, the vessel may be sailed maximum 1 time/week only. The cost of per container transshipment will be much higher than outsourcing the feeder service. On the other hand, the benefit is really depends on the volume of transshipment. Based on the communication with the department manager of transshipment department in Cosco, due to the transshipment volume from Port of Rotterdam to St. Petersburg increased, CKNY alliance has concerned to use own feeder vessel to serve themselves. Consequence, it can be concluded that if volume of transshipment demand increase steadily, when the demand reach the high capacity utilization rate, it will be workable to own the feeder vessels by deep-sea carriers. The cooperation between deep-sea carriers and short-sea carriers will become the competition.

2.3 Cargo Flow and Information Flow

The full sea-sea container transshipment procedure in Rotterdam mentioned in this study is from container loaded to deep-sea vessel to unload to Port of Rotterdam, then to load to feeder vessel. In case of container transshipment in Port of Rotterdam, there are three main parties work on this full procedure, they are shipping lines agent, terminal operator and feeder operator. During work flow of this full procedure, the three parties' cooperation is highly affected to the performance of sea-sea transshipment in Rotterdam. For further explanation, the three parties' cooperation is based on information flowing and information sharing. In the transshipment work flow, the Netherlands customs and Inspection Agent are in charge of container checking by random selecting. Therefore, the smoothness of checking activities done by Netherlands customs and Inspection agent are also affect the performance of sea-sea transshipment in Rotterdam.

In the full procedure, it includes a couple of activities that related or depended on each others. The information communication connected the each activity in this procedure. If look at the full procedure, it looks like a network, the starting point is loading container form export port, the ending point is loading container on the feeder vessel. To look into the connection among the terminal operator, shipping lines agent and feeder operator, shipping lines agent is the information controller in this full procedure. The shipping lines agent usually signs the long term contract with the terminal operator and the feeder operator, the shipping lines agent is the client of them. Therefore, in order to make the full procedure smooth, the shipping lines agent has responsibility to provide the correct information for every container to other parties on time. At the same time, the shipping lines also has right to change the requirements based on the shippers or consignee's request. In consequence, if the performance of sea-sea container transshipment procedure needs to be controlled and improved, firstly, we should focus on perspective from shipping lines agent.

The shipping lines' deep sea vessels mainly sail from Far East and unload to terminals in Rotterdam. After that, the feeder operator provides the transshipment service to deliver the containers to neighbor countries. From the perspective of shipping lines agent, in order to understand current operations, potential confusion and complex environments, first step is to understanding the activities in the work flow. In the full work flow, it includes the cargo flow and information flow. Cargos are moved from port of loading, deep-sea vessel transport, transshipment port, and terminal operation in berth, checking by customs or security agents, stack, and load on the feeder vessels. However, the complexity actually exists in the connection between each two points. Various information, documents, and persons involved keep the process connective. The cargo flows could be regarded as the physical action after invisible communication and information exchange. The shipping lines agent seems to be the communication centers to distribute, receive, and updated information. Therefore, the data exchanged between shipping lines agent and terminals operator and feeder operator should be accurate and timely, which depends on the correctness of original input and the information efficiency of different information management systems. The timing to update also influences the smoothness in the information flow, such as the change of ETA and ETD from shipping lines or the COD from shippers.

In the information flow, Email and EDI are the main date exchange method among shipping lines agent, terminals operator, port authority, customs, security agents and feeder operators. Email and EDI have disadvantages with more transaction time, data re-entry, and human errors. For improving the performance of information communication, Cosco started to use IRIS system to management their whole world information communication. The flowing section explains what IRIS system is and how it works for Cosco. The flowing chapters will further discuss the activities in sea-sea container transshipment work flow.

2.4 IRIS-2 System in Cosco Container Lines

Information system can increase the cost efficiency and responsiveness in a supply chain. Well-integrated information and communication systems provide the information sharing of vessel schedules, terminal handling and transshipment. “It can deliver correct information earlier to reduce uncertainties for liner operators and transshipment operators.”(Crainic and Kim, 2007) Information system also can provide tracking system for better transparency to their customers.

IRIS-2 system is an integrated information system own by OOCL, it was launched in 1999. “That’s a lot of information to keep tracking in an online system; information that can be shared and accessed by many people in different office around the world” (Gemstone Systems, Inc. 2007) It directly affecting the operation by providing the dynamic online information. “IRIS-2 is able to coordinate information used by employees and business application across the entire company. Tracking container movements and cost is necessary in order to make operations more efficient. Enabling rapid customer response was critical in growing revenue opportunities and winning business from competitors.” (Gemstone Systems, Inc. 2007) Figure 2-3 shows the IRIS-2 system function diagram.

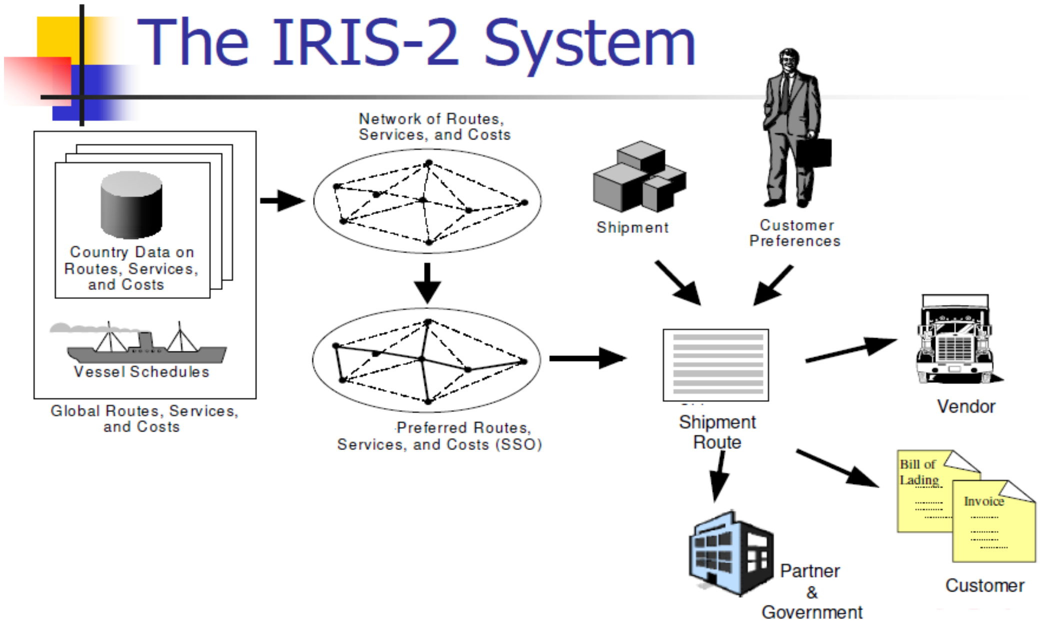

Figure 2-3 The IRIS-2 system
Source: Ken Chih, 2003

OOCL also makes IRIS-2 available to other shipping companies in addition to using it. With rapid shipping industry development in China, as the biggest shipping company in China, Cosco was facing the challenge to handle more and more transaction every year. An advanced information system is quite necessary for Cosco. IRIS-2 is kind of ERP system, for using the ERP system, most company like to design their own ERP system, but it usually take a very long design period. Based on the research, Cosco decided to use IRIS-2 system that own by OOCL. From 2001, OOCL has licensed IRIS-2 to Cosco. Before using the IRIS-2, EDI system was using for Cosco, EDI is an integrated electronic data interchange system, it only can handle couple thousands transaction every day. IRIS-2 can handle much more than this and also provides more detailed information for every transaction. Based on the original IRIS-2 system, Cosco IT group has adjusted it and made it more fixable for Cosco. It almost can provide all information for shipment cycle. Figure 2-4 shows the shipment cycle.

Cosco already used the IRIS-2 around 8 years, during the 8 years, the handling volume was rapidly increased but number or employees was keep slowly increase. After using the IRIS-2 system, the employee efficiency has risen 20 percent since implementation of IRIS-2, it measured by shipping tonnage per headcount.

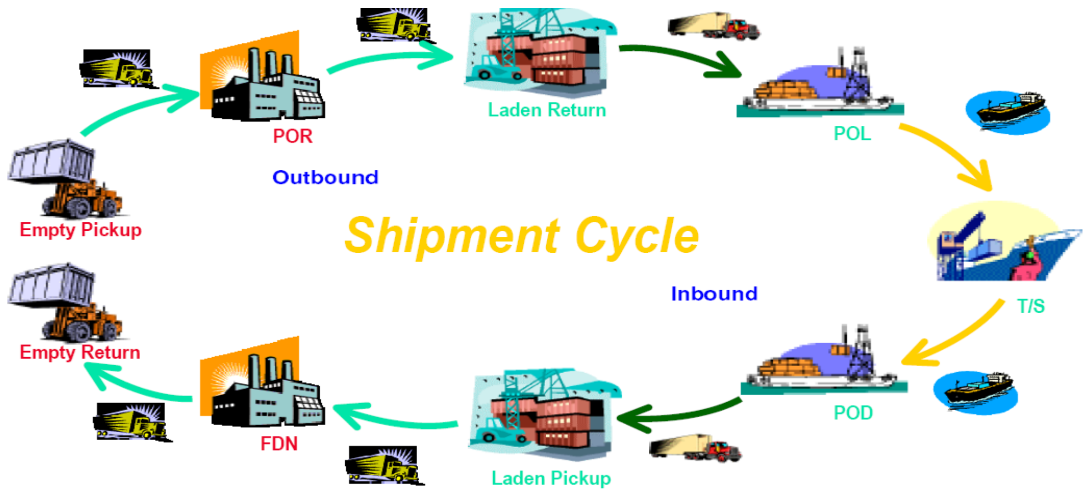

Figure 2-4 Shipment cycle
Source: Ken Chih, 2003

Off-site disaster recovery system: after using the IRIS-2 system, the operating becomes really depends on the system, therefore, build the off-site disaster system is obviously important. At the end of 2002, Cosco built the off-sit disaster recovery server around 40 kilo meters far from their main server. The system back up all transaction information from the main server automatically. It could replace the main server within 20 minutes if the main server not working well. The disaster recovery system protects the computer operations from a variety of disasters.

2.5 Chapter Conclusion

In this chapter, it analyzed the characteristics and trends of sea-sea container transshipment market in Europe. Based on the analysis, it can be forecast that the volume of sea-sea container transshipment will be increase in the future in Europe. As the biggest port in Europe, Port of Rotterdam has more space to be extended and with deeper draft than other ports. It should attract more shipping lines agent choose Port of Rotterdam as a transshipment port. Therefore, from the shipping lines' perspective, increase the performance and optimizing the workflow of sea-sea transshipment in Port of Rotterdam will attract more attention in the future.

This study is focuses on the analysis of work flow in Cosco's transshipment department, in this chapter, author further discussed the advantages and disadvantages of outsourcing feeder service, the cargo flow and information flow of sea-sea container transshipment based on the case of Cosco, and also briefly introduced foundation and advantages of the IRIS 2 system that using for Cosco information management. In this chapter, it introduced who are the main parties in the work flow, how they cooperate to each other and how can they communicate to each other. Through the analysis of those topics, we can understand the current situation of work flow in sea-sea container transshipment. The following chapter will probe into the practical control in transshipment work flow from the perspective of shipping lines agents.

Chapter 3 Activity Split Up in Sea-sea Container Transshipment

As mentioned in pervious chapter, there are a couple of parties integrated in the transshipment work flow that affects the performance consistency in transshipment process. The obvious scenarios for process inefficiency are container delay, idleness, or accrual expense. The complicate working environment further led to difficulties in controlling transshipment process. Therefore, if the shipping lines agent wants to optimize the work flow, firstly, they have to very clear with the activities in the work flow. At the begging of this chapter, the author is going to split up the activities in sea-sea container transshipment in Rotterdam by before and after the deep sea vessel arrival port of Rotterdam. It includes the content of the activities and mentions which party that work on it. This chapter will also briefly introduce the relationship between the each activity and the time constraints. To understand the activities, besides having a review of open literatures, the main methodology taken in research is face-to-face interview with relevant staff in Cosco who are involved directly or indirectly in container transshipment operating on daily basis. The full process will break into few parts and analysis in the following sections. The unit in the work flow is defined as one deep sea vessel.

3.1 Activities Before Deep Sea Vessel Arrive Port of Rotterdam

- Cosco shipping lines agent in NL checks manifest: when the container load on the deep sea vessel from loading port, the specification for each container is available on the IRIS system, the information are shared for all branches in the world. Each manifest includes the all container's information on the same deep-sea vessel, indeed, the information for the containers that need to be transshipped will forward to transshipment department. The operating staff in the transshipment department in charge to check original data and forward the manifest to Dutch Customs. This activity usually started before 7-10 day before the deep sea vessel arrival Port of Rotterdam and takes around 1 day. Checking manifest is the first activity in the sea-sea container transshipment work flow, all other activities will be start after the manifest has been checked. The Table A-2 shows the template of manifest.

- Select container for inspection by Dutch Customs: After the Dutch Customs received the manifest from shipping lines agent, the Dutch Customs will select the container of inspection randomly, and it usually around 7% of total volume and the percentage may increase in the soon future. After selected by Dutch Customs, Dutch Customs will inform the shipping lines agent that which container will be selected. There are two kinds of inspection, they are scan (x-ray) inspection or physical inspection. This activity usually takes 2 days and it has to be done before 1 day before the deep sea vessel arrival Port of Rotterdam.

- Select container for inspection by Inspection Agent: The Inspection agent will also receive the Manifest that forward from Dutch Customs. Based on the information they received from Dutch Customs, the Inspection Agent will select the container for inspection which have dangerous goods or food stuff, and then they will inform the shipping lines agent that which container will be selected. This activity usually stared after the Inspection Agent receives the information from Dutch Customs and it takes around 1 day. It has to be done before the deep-sea vessel arrival.

- Sending discharging list to Terminal Operator: at least 24 hours before the deep-sea vessel arrival, the shipping lines agent has to send discharging list with all container detail information on the coming vessel to the terminal operator. The discharging list is automated created by IRIS system. Base on the window schedule, the terminal operator will arrange the unloading schedule for coming vessel, the deep vessels usually have the priority for schedule arranging. After arranged, the terminal operator will inform the shipping lines agent. This activity usually will be done before the deep sea vessel arrival.

- Prepare the transshipment container list: the operating staffs in transshipment department start the administrative action for handling transshipment for each coming deep sea vessel. The Manifest from IRIS 2 system will be transfer to Microsoft Excel document. The transshipment container list should include all the details, such as the container with IMO cargo or dangerous cargo should be mentioned in the transshipment container list and all the documents related should be prepared. This activity usually started around 7 days before the deep sea vessel arrival and takes around half day.

- Pre booking the feeder service: after the transshipment container list prepared, the operating staff in transshipment department start to contact with feeder operator by phone or email to pre booking the container slot. At this time, each container just like the passenger that with different final destination. All of them are still not ready for transship, but based on the forecasting ready date at terminal, each of them will be book with the earliest departure feeder vessel. The feeder vessel usually departed within 7 days after the deep vessel arrival. The slot requirements also have to be mention at this time. Such as the size of container, the reefer container and the uncovered container. This activity usually followed the pervious activity and it also takes around half day.

3.2 Activities After the Deep Sea Vessel Arrive Port of Rotterdam

- Unloading the deep sea vessel: after the deep sea vessel arrive the transshipment port, the terminal operator provides the unloading service for each deep sea vessel arranged by the unloading schedule. The terminal operator will stack the container base on the foresting dwell time and the destination of each container. This activity usually takes 1-2 days base on the volume of container on the vessel. The unloading the deep sea vessel is the first activity after the deep sea vessel arrived, after the containers have been unloaded, the inspection by Ducth Customs and Inspection agents will be arranged, and the checking and repairing for the damaged container also can be start after this activity.

- Checking the container by Dutch Customs: after the container unloaded, base on the inspection request from the Dutch Customs, the shipping lines agent will arrange the inter-modal transport to deliver the container to the checking area appointed by Dutch Customs. This activity usually take 2-4 days, after checking by Dutch Customs, the shipping line agent have to arrange the inter-modal transport to take the container back to the stacking area.

- Checking the container by Inspection Agent: same with the checking by Dutch Customs, after the container unloaded, the shipping lines agent will arrange the inter-modal transport to deliver the container to the checking area appointed by Inspection Agent. This activity usually take longer time that around 3-7 days, after checking by Inspection Agent, the shipping lines agent also have to arrange the transport to take the container back to the stacking area. Few times, after the container checked by Dutch Customs, it has to be check by Inspection agent again, but it is the very unique scenarios, this kind of scenarios are not going to be concentrate in this study. Therefore, when we doing the test of the activities in the work flow, the checking the container by Dutch Customs is not the Immediate Predecessor of checking the container by Inspection Agent.

- Checking and repairing damaged container: after the container unloaded, during the dwell time from the actual discharge from deep sea vessel to the actual loading on the feeder vessel. It's the time for checking and repairing the damaged container. The checking and repairing time usually less than the dwell time, but occasionally, the container is heavy damaged, the shipping lines agents have to arrange another container for reloading the cargo. This activity usually takes 3-6 days based on the damaged level of container. Theoretically, the damaged may also request to be check by Dutch Customs or Inspection Agent, but based on the interview with the daily operating staff in transshipment department in Cosco, it rarely happened in the reality work. Therefore, the relationships between the repairing damaged container and the checking container by Dutch Customs or Inspection Agent can be ignored.

- Create the job order and sent to feeder operator: after the checking by Dutch Customs or Security Agents and done of repairing the damaged container. If the container is fine, it becomes ready to be transshipped. The shipping line agent will sent the official job order by email for confirm the container slot on the feeder vessel, it usually same with the pre booked feeder vessel. If one container is blocked by Dutch Customs or Inspection agent, all the containers comes with one bill of lading will hold up, until the container released. Therefore, in the few times, the job order will be different with the pre booking schedule. In order to make the transshipment procedure go smoothness, as mentioned before, all required document will be attached with the job order. This activity usually takes about 1 day.

- Loading the container on the feeder vessel: this is the last activity in the sea-sea transshipment workflow. After the terminal operator confirms the loading list with the feeder operator and shipping lines agent, the container will be load on the feeder vessel. The feeder vessels usually have the fixed sailing schedule for one destination, according to the distance to the final port and the volume of demand, it always has 1-2 times per week. This activity takes around half day, because the size of feeder vessel is maximum 1500 TEU. After the container load on the feeder vessel, the duty for operating staff in transshipment department is done. If there is any problem after the containers loaded on the feeder vessel, the Cosco agent of the final port will contact with them by email or IRIS 2 system.

3.3 Observed E-Mail Communication Difficulties During the Full Process

According to the face-to-face interview with the daily operating staffs in the container transshipment department in Cosco. They complained that the most time consumption activity in their daily work is deal with lot of email. They summarized that there is around one third of their daily work is read and reply the emails and each of them received around 80-150 emails every day. It quite obvious that dealing with email is a special activity integrated in the sea-sea container transshipment work flow. It is not an immediate predecessor for any activity, but the operating staff has to deal with it from the begging to the end in the transshipment work flow. Due to the time consumption, it also may delay the progress of container transshipment.

To understand the E-Mail communication difficulties, firstly, we should clear with classification of the e-mails which they received daily. Figure 3-1 shows the percentage of sender of email.

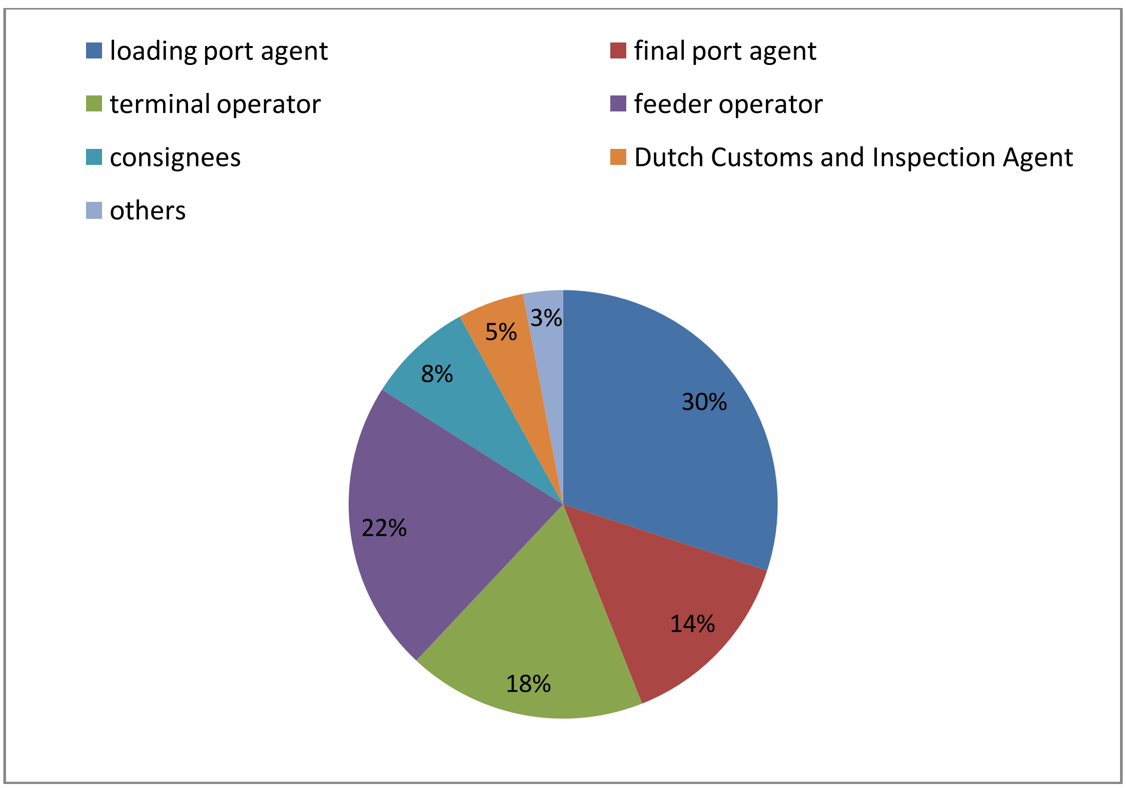

Figure 3-1 Percentage of sender of email
Source: research information from transshipment department in Cosco, 2010

The figure 3-1 illustrated that the most email they received comes from agent in the loading port, the reason of that is the agent in the loading port usually communicated with the shippers and consignees directly, they received the request from the shippers and consignees and forward to the shipping lines agent in Rotterdam, such as the change of final destination cause by the changing of demand, request to clearance the container from Port of Rotterdam because they like to arrange the transportation by themselves, and so on. This is the main part of email they received and usually have to take action to deal with them, and sometimes, there is not enough time for them to reaction for the requests. This kind of email led more related email communication to other parities in the container transshipment process.

We also can classify the emails to the reference information and action information. "The reference information is information that is not required to complete and action, it is information that you keep in case you need it later. The action information is information you must have to complete and action. Action information is stored with the action, either on your to-do list or your calendar."(Sally McGhee, 2010) The operating staff received amount of reference information through email, if we can say reading the action information email is for improving the quality of shipping service, but reading the reference information email is kind of non-value-adding activity in the container transshipment process. Based on the interview, as much as 40% of their email is reference information only. Such amount of reference information emails cost couple hours to each operating staff every day. In order to improve the performance of transshipment process, organized the email system and reduce the time consumption of email communication should attract more attention to the shipping lines agent.

3.4 Challenges and Difficulties During the Transshipment Process

Human errors and computer defects:

- Incorrect data result from human errors or computer system has been made from daily work and it is avoid less. Most of time, the wrong or incomplete shipment data are provided by the third parties. All those errors could hamper and delay the process of transshipment and increase handling cost or problem solving time in later periods. This implies that more volume and more manpower are necessary to work on the accuracy and timeliness of data, figures, and numbers if the computer systems of all relative parities are not good enough to provide the correct and complete information.

- High volume of data transmission with different business parties are done through EDI and email. The EDI and email communication usually time consumption because of the involvement of several parties and different systems. The problems could come from different sub-system in EDI transfer or the non-customized user interface.

- When a container is held up by the Dutch Customs or Inspection Agent for inspection or other purpose, the Dutch Customs or Inspection Agent's request is served by e-mail, sometimes may causes problems in handling the transshipment container. More manual involvement in the information communication increases the risk of missing critical or time-sensitive data. As an example, the container which should be held up in the terminal but may put on the feeder vessel already. Besides the customs' penalty for this kind of mistakes, the recall of containers to the original unloading port causes the shipping line agent to spend additional time and resources on non-value activities, which also indirectly influence the smoothness of a transshipment work flow.

Inefficient operation:

- Late information from agent in loading port, shippers and consignees, such as the alteration in bill of lading or the change of destination, create problems, especially when the alternation is done without prior consultation with relevant departments. It makes the carrier always does not have enough time to taking necessary action on time. Moreover, some shippers and consignees regard the deep sea shipping as floating service that they can alter everything at any time which causes trouble in the cargo handling. Based on face-to-face interview with operating staff in transshipment department in Cosco, they have the regulation that every request should be informed 3 days before the arrival of transshipment port, but actually, there are still many request comes to them with urgent title. It makes trouble for them, even sometimes it is already too late to be changed, it still time consumptions for deal with the problems.

- Because of congestion in Port of Rotterdam, the terminal operator always provides the priority to the deep sea vessel, but every feeder operator and barge operator also tries to secure berth for their vessel operation, the capacity of the berth still may not enough for them. Sometimes, feeder operator gave false ETA and ETD of feeder vessel to shipping lines agent, which make the port congestion more serious and also affect on the performance of sea-sea container transshipment. After the Maasvlakte 2 can be used, the problem could be solved, but it may lead more containers transshipped in different terminals.

- As mentioned before, the operating staff usually deal with many emails every day, it almost cost one third of their daily working time. Most of emails they received are for the reference only, but it takes long time to read them. It also delay the smoothness of container transshipment work flow.

- Transship container in different terminal: The physical cargo flow sometimes increase the document requirement between parties. Sometimes, the transshipment container has to be deliver to another terminal for connect the feeder shipping. The container moved from one terminal to the other terminal requires additional document processing. The inter-terminal transshipment takes additional time for transshipment process, which creates extra workload and makes discouraging people's willingness to handle this kind of shipment, leading to another issue on the control of containers.

- The huge volume for few destination ports: cause of the import quota or some economic reason, the volume of container transshipment for few ports is larger than other ports, such as St. Petersburg. The container slots on the feeder vessel is limited, there are not enough slots for all containers that comes from the same deep sea vessel to transship together. The shipping lines agent may arrange few of them transshipped first with urgent request or hold up all containers to wait for next feeder vessel.

- Containers blocked by government authorities: the container sometime blocked by Dutch Customs or Inspection Agent for certain purposes, such as the document verification or cargo inspection, etc. This affects the transshipment planning and delays the shipment and the time cost is always uncertain.

3.5 Chapter Conclusion

In this chapter, through many times of face-to-face interview with operating staff in transshipment department, base on the understanding of the explanation of daily work by the operating staff, the detailed information for each activity in the work flow of sea-sea container transshipment in Port of Rotterdam have been summarized, it including the time required, duty of party and the relationship between the each activity. We also discussed the general difficulties in the transshipment work process, these difficulties affect the smoothness of container transshipment work flow. Especially the e-mail communication difficulty during the daily work, because we found most of operating staff complained that the huge amount e-mail communication is most time consumption activity in their daily work. It is not an immediate predecessor for any activity but it integrate into the full container transshipment work flow and increase the workload for operating staff.

The summarized information can make us understand the current operating situation in the container transshipment work flow and provide a platform to finding the space that can be improving. The following chapter will apply the PERT/CPM methodology to find the critical path of transshipment work flow by using the information in this chapter.

Chapter 4 Determining the Critical Path of Work Flow

The pervious chapters give the overview of the current operating situation for sea-sea container transshipment. It makes us to understand the activities in the daily work flow and the difficulties in the process. In order to figure out the appropriate approaches in performance improvement, based on the understanding of the interview research and open literature review, this chapter will apply PERT/CPM methodology to test the activities in the transshipment work flow. Therefore, relevant concepts of activities control will be showed in this chapter. This chapter will focus on the perspective of shipping lines agent, and use the daily work in transshipment department in Cosco as a case study. The purpose of the testing is highlights the non-value-adding activities and areas for possible improvements.

4.1 Description of Net Work of Transshipment Work Flow

"Breaking down a process into its component activities, identifying their interrelationships, and viewing them graphically help to enhance our understanding of the total process." (Ravi Anupindi，2003). A process flowchart is a network that shows the activities, information structure and relationship between each activity. In the work flow network, the activities are represented by rectangles and the relationships between any two activities are represented by solid arrows.

There are many activities in the sea-sea container transshipment process, this study will focus on the main activities with time buffers. In the first step, the time required for each activity will not be given, because it also based on the analysis of uncertain activities and the calculation of estimated average time for some of them. For that reason, firstly, only the description of activities and the relationships between each activity will be list down. Base on the understanding of face-to-face interview with daily operating staff in transshipment department in Cosco, the description of activities have given in Chapter 3.The activities in the transshipment process are shown in Table 4-1.

Using the immediate predecessor information given in Table 4-1, we can construct a graphical representation the transshipment work flow. Figure 4-1 depicts the net work of transshipment work flow. The activities correspond to the nodes of the network (drawn as rectangles) and the arcs (the line with arrows) show the precedence relationships among the activities. This network may help the operating staff visualize the activity relationships and proved a basis for carrying out the PERT/CPM computations.

Activitiy	Description of Activity	Immediate Predecessor
A	Checking manifest by shipping lines agent and forward to the Dutch Customs	7 days before arrival
B	Dutch Customs random selecting the container for inspection and inform the shipping lines agent	A
C	Inspection Agents random selecting the container for inspection and inform the shipping lines agent	B
D	Unloading the containers from deep sea vessel	A
E	Container inspection by Dutch Customs	B.D
F	Container inspection by Inspection Agents	C.D
G	Prepare the transhipment containers list	A
H	Pre booking the feeder service	G
I	Checking and repairing damaged container	D
J	Create the job order and send to the feeder operator	E.F.H.I
K	Loading the container on the feeder vessel	J

Table 4-1 Activity list for sea-sea container transshipment
Source: Own elaboration

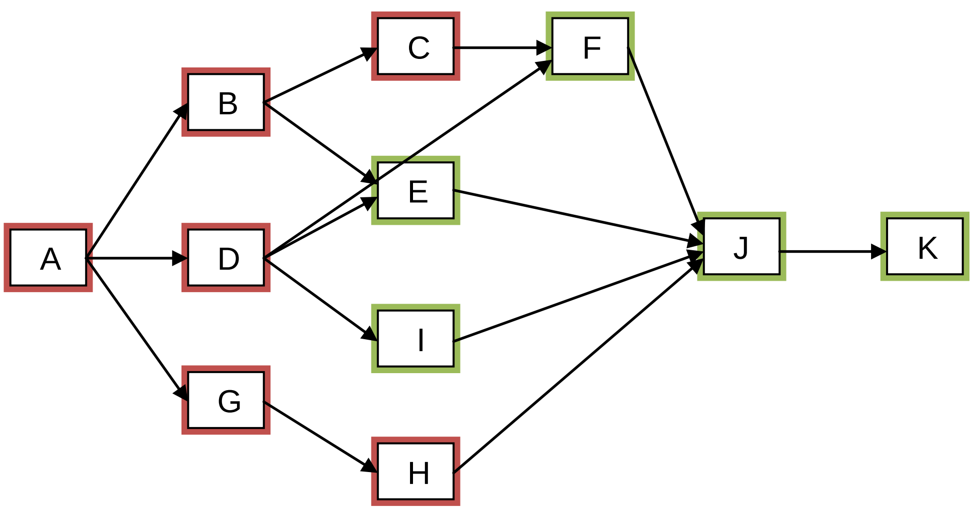

Figure 4-1 Network of transhipment work flow
Source: Own elaboration

Remarks of work flow network:

1. In Figure 4-2, the activities in the red rectangles represent the activities before the deep sea vessel arrive port of Rotterdam; the activities in the green rectangles represent activities after the deep sea vessel arrive port of Rotterdam.

2. The activity A that Checking manifest by shipping lines agent and forward to the Dutch Customs do not have any immediate predecessor in the work flow network, and it can be started as soon as the Cosco agent in Rotterdam received the

manifest from the Cosco agent in loading port. It usually started 7 days before the deep sea vessel arrival Port of Rotterdam.

3. The activity A is the immediate predecessor of activity D that unloading the container to the terminal. But the activity D can't be start immediately after activity A, because the Cosco shipping lines agent in Rotterdam ask the operating staff start activity A 7 days before the deep sea vessel arrival and leave the leisure time for other activities, it means that the activity D will be started after 6 days of completion time of activity A. Therefore, the activity B, C, G and H usually have been done before the activity D start. In order to fill the time required of activity D into the PERT/.CPM methodology in the following section, we assume that the time required of activity D equals to 2 days plus 6 days.
4. With regard to regulation issued by Rotterdam Port authority that the activity B, C has to be done before the deep sea vessel arrive the Port of Rotterdam. Therefore, there is a time constraints for doing the backward pass through the work flow, the latest finish time for activity C should be before the deep sea vessel arrival the port of Rotterdam, it means the latest finish time for activity C should be the 7th day in the transshipment work flow.

5. With regard to the activity H, there is not a regulation for the time constraint, but per booking the feeder service usually has to be done before few days of sending official job order to the feeder operator. The feeder vessel sailing with its own schedule, it usually has 2-3 times a week, the pre booking the feeder service few days before its departure is quite necessary and usually done before the deep sea vessel arrival. The further discussion will be show in the next chapter.

6. In chapter 3.1, we have defined the sending discharging list to terminal operator as one activity in the work flow of sea-sea container transshipment, but it was not showed in the figure above. Because the work flow is focus on the activity relationships between each activity and showed the activity with time buffer. The discharging list is automated created by IRIS system and it will send to the terminal operator by agent in the loading port. Therefore, although this activity is done during the transshipment process but it's not effect on other activities. So, it is not in the work flow.

7. The work flow shows that the activity J (creating job order and send to the feeder operator) only can be start after the container checked by Dutch Customs or Inspection Agent and also the damaged container has been repaired. In logic, if the container is not ready, sending the job order may have the risk that the container can't catch the feeder schedule. But in the reality daily work, based on the experience of ready time forecasting, the operating staff in the transshipment department usually send the job order to the feeder operator before the container is ready, it has benefit to catch the earliest feeder schedule but trade off with the risk of miss the feeder schedule cause by certain reason, and it have to be rebooking the feeder service, then the transshipment will be delay. Therefore, for make sure the relationships between each activity are clear, we assume that the activity J should be start after the E,F,I,H were done. The next chapter will further discuss this issue.

8. In the network of transshipment work flow, checking by Dutch Customs or Inspection Agent and repairing the damaged container are Immediate Predecessors for sending job order to feeder operator. In the reality transshipment work flow, not all the containers have to be checked and only a few containers were damaged. As mentioned before, only about 7-10% containers will be checked by Dutch Customs or Inspection Agent and also a very few containers will be damaged during the shipping process. Indeed, most of container are ready for transship after they have been unloaded to the terminal. In order to make all the transshipment containers can apply to this work flow network, we initially assume that the checking and repairing are Immediate Predecessors for sending job order to feeder operator in the transshipment work flow.

4.2 The Uncertain Activities in the Work Flow

After we have developed the work flow network, we need the information on the time required for complete each activity. This information is going to be use in the calculation of the total time required to complete the sea-sea container transshipment in Port of Rotterdam. In the workflow, such as the checking the manifest, selecting container for inspection by Dutch Customs or Inspection Agent, unloading the container, prepare the transshipment container list, pre booking the feeder service, send job order and loading the container may have the operating staff's experience and historical data record to provide accurate activity time estimates. The required time for those activities is not affect by other parties and usually without too much variance. It will be shown in flowing sections. However, for inspection by Dutch Customs or Inspection Agent and repairing the damaged container may quite difficult to be estimate and the time required is based on the situation of each container. In the reality work, the required times for those activities are usually uncertain and better to be described by a range of possible values rather than by one specific estimated time. Therefore, the uncertain activity times are estimated by random variables with associated probability distribution.

As introduced before in the first chapter, each uncertain activity needs to obtain three time estimates.

- Optimistic time (a): The minimum activity time if everything progresses ideally.
- Most probable time (m): The most probable activity time under normal conditions.
- Pessimistic time (b): The maximum activity time if significant delays are encountered.

Based on the interview with operating staff in transshipment department in Cosco, the optimistic, most probable, and pessimistic activity time estimates in days for activity E.F and I are list down in Table 4-2.

Activity	Optimistic(a)	Most Probable(m)	Pessimistic (b)
E	2	3	4
F	3	5	7
I	3	4	6

Table 4-2: Activity time estimates
Source: research information from transshipment department in Cosco, 2010

According to the formula of average estimate time for the activity, we can calculate that the average estimate time for activity E.F and I as follows:

$$T = (a + 4m + b)/6$$

We denoted that T_E, T_F, and T_I are average estimate time of E. F.I

$$T_E = [2 + 4(3) + 4] / 6 = 3$$
$$T_F = [3 + 4(5) + 7] / 6 = 5$$
$$T_I = [3 + 4(4) + 6] / 6 = 4.16 \text{ approximately equal to } 4$$

“With uncertain activity times, we also can use the variance to describe the variation in the activity time values. The variance of the activity time is given by the formula:” (David R. Anderson et al, 2007)

$$\delta^2 = [(b - a)/6)]^2$$

Using the above formula, we can calculate that the variance of time required for activity E, F and I, We can find that the difference between the pessimistic estimated time and the optimistic estimated time greatly affect the value of variance. The large differences in these two values will reflect a high degree of uncertainty and variation in the activity time required. The following section is going to determining the critical path for transshipment work flow, the high degree of variation of critical activities will lead the variation in the total time completion, but if the variation in the noncritical activities, it usually has no effect on the total time completion. The Table 4-3 summarized the results of the expected times and variances for all uncertain activities in the transshipment work flow.

Activity	Expected Time (days)	Variance
E	3	0.11
F	5	0.44
I	4	0.25

Table 4-3: Expected times and variances
Source: Own elaboration

After we estimated the average time for uncertain activity, we have ability to calculate the completed time for the sea-sea container transshipment in Port of Rotterdam.

4.3 The Forward Pass through the Work Flow

To determining the critical path for the work flow, the first step is making the forward pass through the network. Because the forward pass refers to the critical factors that the earliest start time and earliest finish time for optimizing the work flow. The purpose of calculate earliest start time and earliest finish time able to provide the information for operating staff that how can they start the activities as soon as possible and leave leisure time to the following activity. Therefore, for test the forward pass, we have to begin with finding the earliest start time and earliest finish time for all activities in the work flow.

Based on the interview with operating staff and estimate, we already got the time required estimated for each activity in the container transshipment work flow, the Table 4-4 shows the time required for all activities.

Activity	Time required	Immediate Predecessor
A	1 day	7 days before arrival
B	2 day	A
C	1 day	B (done before arrival)
D	2+6 day	A (6 days after A has been done)
E	3 day	B.D
F	5 day	C.D
G	0.5 day	A
H	0.5 day	G (done before arrival)
I	4 day	D
J	1 day	E.F.H.I
K	0.5 day	J

Table 4-4: Time required for transshipment activity
Source: Own elaboration

With the figures in Table 4-4, we can start to find the earliest start time and earliest finish time. For instance, activity A doesn't have any immediate predecessor in the work flow, it can be start as soon as the operating staff receive the manifest from the agent in the loading port. So, we can set the earliest start time for activity A equal to 0, with the time required for activity A is 1 day, we can calculate that the earliest finish time for activity A is EF=ES+T=0+1=1.The earliest start time for activity B that follow the activity A is 1, and the earliest finish time for activity B is EF=1+2=3. According to the relationship of each activity, we can use the rule to determine the earliest start time and earliest finish time for each activity. Then, we can construct a graphical representation the transshipment work flow including the earliest start and earliest finish times in the node. The Figure 4-2 shows work flow of the sea-sea container transshipment in Port of Rotterdam with the ES and EF for each activity.

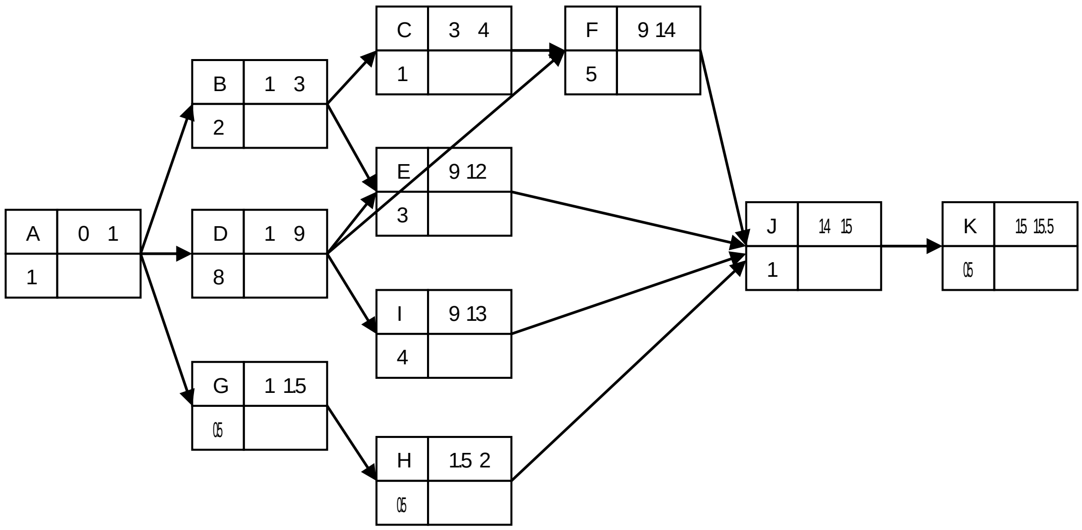

Figure 4-2 work flow with ES and EF for each activity.
Source: Own elaboration

Note: the earliest finish time for activity K that the last activity in the work flow is 15.5 days. Therefore, we can conclude that the total completion time for sea-sea container transshipment in Port of Rotterdam is 15.5 days. In the transshipment work flow, there are 7 days before deep sea vessel arrival and 8.5 days after deep sea vessel arrival.

4.4 The Backward Pass through the Work Flow

Continue with the forward pass through the work flow, the next step for finding the critical path is making a backward pass through the work flow. Based on the pervious calculation, the container transshipment can be done in 15.5 days, it means the latest finish time is 15.5 days for activity K. "The latest finish time for an activity is the smallest of the latest start times for all activities that immediately follow the activity"(David R. Anderson et al, 2007) Once the latest finish time for an activity is know, the latest start time for this activity can be calculated by the formula LS=LF-T. For instance, the required time for activity K is 0.5 day, thus, the latest start time for activity K is LS=15.5-5=15 days, then we can calculate that the latest start time for activity J is LS=15-1=14. However, if there is more than one activities follow one activity, such as the activity D, it is the immediate predecessor for activity E, F and I, we have to choose the smallest latest start time for activity D, that is 9 days from activity F. We can use the rule to determine the latest start time and latest finish time for each activity. Then, we can construct a graphical representation the transshipment work flow including the latest start and latest finish times in the node. The Figure 4-3 shows work flow of the sea-sea container transshipment in Port of Rotterdam with the LS and LF for each activity.

Remarks:

1. The latest finish time for activity C has to be 7 days.
2. The latest finish time for activity H has to be 7 days.

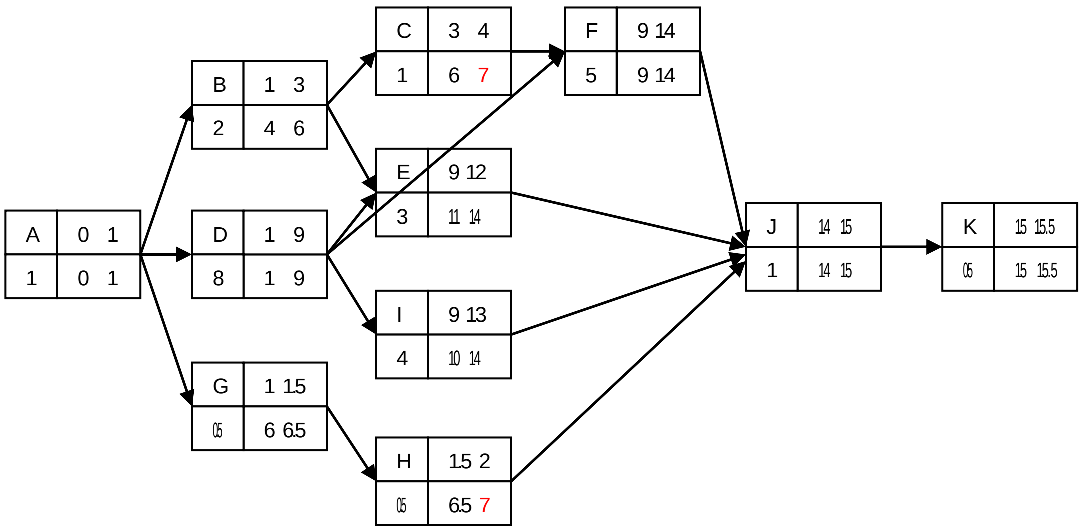

Figure 4-3 work flow with LS and LF for each activity.
Source: Own elaboration

4.5 Calculation of the Slack Time

After we have completed the forward and backward pass through the work flow, we are able to determine the slack time for each activity. “The slack time for each activity indicates the length of time the activity can be delayed without increasing the project completion time.” (David R. Anderson et al, 2007) The formula for calculate the slack time is:

$$\mathrm{Slack} = \mathrm{LS} - \mathrm{ES} = \mathrm{LF} - \mathrm{EF}$$

If the latest start time is same with the earliest start time, it means the activity cannot be delay, it has to be start immediately after its immediate predecessor (s) is ready. Otherwise, if the latest start time is different with the earliest start time, this activity could be hold up until the latest start time. The time completion of work flow will not be change.

According to the Figure 4-3, the Table 4-5 develops the detailed information for start time and finish time of all activities in the sea-sea container transshipment in Port of

Rotterdam and we are going to use the information to determining the critical path in the following section.

Activity	ES	LS	EF	LF	Slack Time
A	0	0	1	1	0
B	1	4	3	6	3
C	3	6	4	7	3
D	1	1	9	9	0
E	9	11	12	14	2
F	9	9	14	14	0
G	1	6	1.5	6.5	5
H	1.5	6.5	2	7	5
I	9	10	13	14	1
J	14	14	15	15	0
K	15	15	15.5	15.5	0

Table 4-5: Activity schedule
Source: Own elaboration

4.6 Determining the Critical Path

Based on the above analysis and calculation, we already got the full information for transshipment work flow, the next step is determining the critical path for the work flow. “The critical path algorithm is essentially a longest path algorithm. From the start node to the finish node, the critical path identifies the path that requires the most time.” (David R. Anderson et al, 2007) If one activity doesn't have the slack time that the earliest start time and latest start time are same, this activity should be the critical activity in the transshipment work flow. Using the information in the Figure 4-7, we can find the activity that the slack time is equal to zero. Therefore, those activities, such as activity A, D F, J and K, are critical activities. They can’t be delay, they should be start immediately after their immediate predecessor, and otherwise, the completion time for container transshipment will be increase. In other words, the operating staff has to make more attention on those activities, completing them on time are more important than other activities for keeping the smoothness of container transshipment work flow.

According to the Table 4-5, we can determining the critical path formed by nodes A-D-F-J-K is the critical path in the sea-sea container transshipment work flow in Port of Rotterdam. The other activities in the work flow are noncritical activities and can be hold up until their latest start time. The Figure 4-4 shows the critical path in the container transshipment work flow.

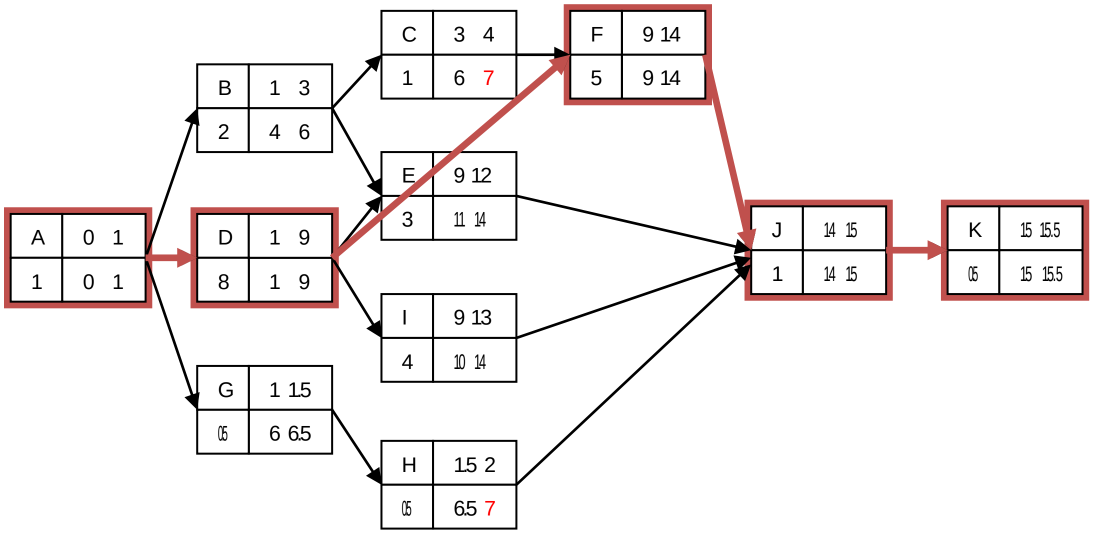

Figure 4-4 Critical path
Source: Own elaboration

4.7 Chapter Conclusion

The purpose of this chapter is determining the critical path for make clear the work flow in transshipment department. In this chapter, we have apply the PERT/CPM methodology in the analysis of the container transshipment. Using the description for the all activities and the relationship between them that introduced in the Chapter 3, we have drawn a network for transshipment work flow based on the immediate predecessor of each activity in this chapter. We also estimated the time required for each activity including the uncertain activity. After that, we have made the forward pass and backward pass through the network to get the earliest start time, latest start time, earliest finish time and latest start time for each activity and calculated the total time requirement for container transshipment. At the end of this chapter, we calculated the slack time for each activity and determining the critical path in the work flow of container transshipment.

The testing is base on the information form interview of operating staff in transshipment department in Cosco. The information is from the experience and daily record of the operating staff. The shipping lines agent (Cosco) seems like the controller in this activity work flow, they provides the data to other parties and connected other parties in the network of work flow. Some activities are done by them, but some of activities are done by other parties. Therefore, the time required for some activities are uncertain, we can make probability estimated only. And for make the relationship clear between each activity, there are also some assumptions before the testing of the PERT/CPM. In the reality daily work, it should be more factors are affecting on the determining critical path, because every small change of the activity, such as the time required or the immediate predecessor, will affect the whole network of work flow. In order to improve the critical path, the following chapters will rescan the critical path by sophisticated operating staff.

Chapter 5 Result Analysis

In chapter 4, we already got the ideal critical path in container transshipment work flow by using PERT/CPM methodology. There are many assumptions and estimation during the evaluation. We can't expect it is workable in the reality daily work properly at this moment. In the reality daily work, it should be much more sub activities and potential factors in the transshipment work flow affect on the performance of container transshipment process. In order to make the critical path workable for container transshipment reality daily work, in this chapter, the critical path will be rescan by sophisticated operating staff and going to be analyzed and adjusted. The assumptions of the relationship between each activity and the potential factors that affect the determining of critical path will be further discussed.

5.1 The Uncertain Activity Determined the Critical Path

Overview the critical path, the Figure 4-4 shows the critical path is formed by activity A-D-F-J-K, obviously, it goes along the line of checking the Container by the Inspection Agent. The reason of that is the container checking by the Inspection Agent usually takes 3-7 days and the estimated averaged required time of activity F is 5 days, it is longer than other activities' estimated time required that after the container has been loaded to the terminal. In the theory of determining CPM, the activities with longer time consumption are always the critical activities for decided the direction of critical path. In the container transshipment work flow, after the container has been loaded to the terminal, the second longest time required activity is repairing the damaged container, and the third longest time required activity is checking the container by Dutch Customs. All of them are uncertain activities. The Figure 5-1 circles the uncertain activities by green oval.

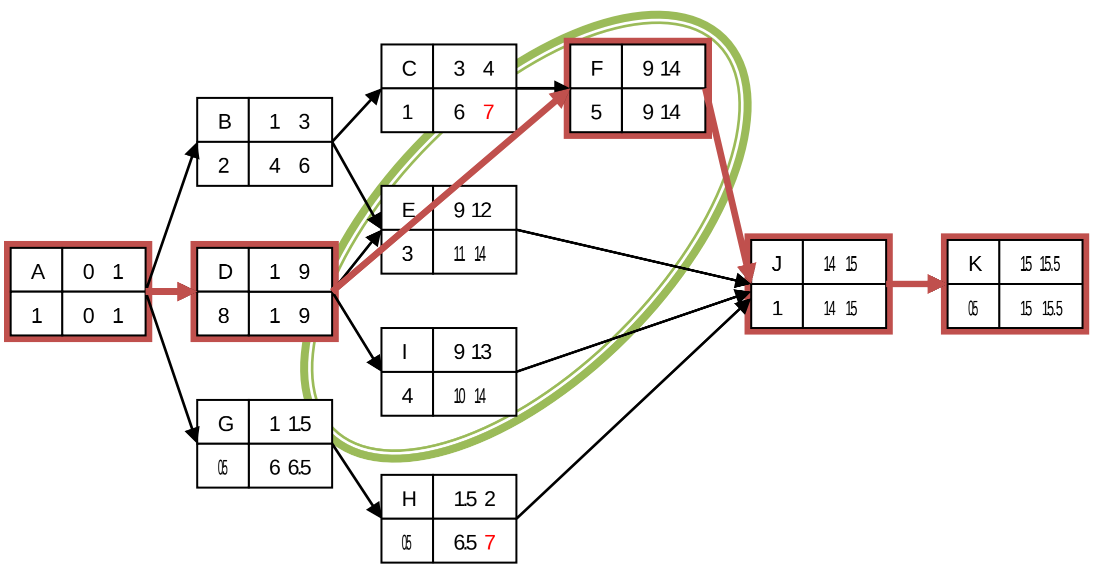

Figure 5-1 uncertain activity in the work flow
Source: Own elaboration

From the Figure 4-8, we can found that these three activities own the same Immediate Predecessor that is unloading the container to the terminal, and all of them are the Immediate Predecessors for sending the job order to the feeder operator. It means that the relationship between these three activities is they are not depending on each others; they are juxtaposed to each others.

Based on the research, The Figure 5-2 shows the percentage of the situations after the container has been loaded to the terminal.

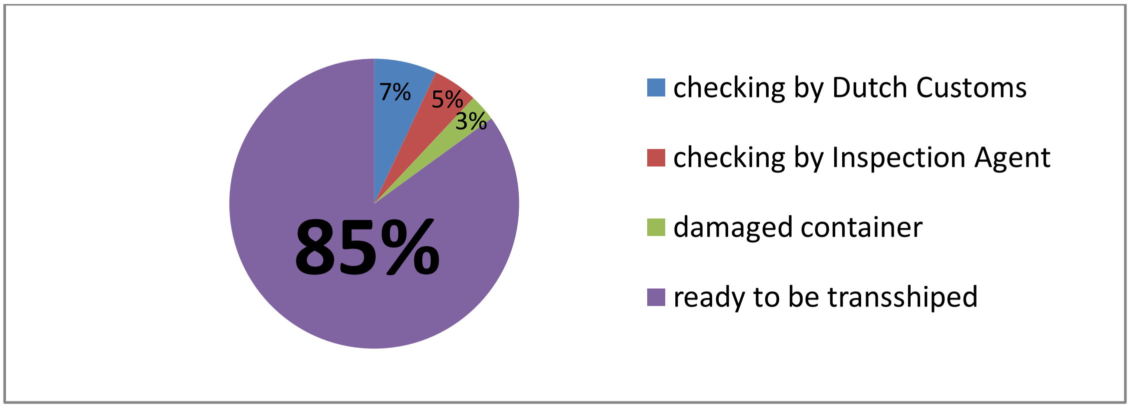

Figure 5-2 Percentages of situations of containers
Source: Own elaboration

Therefore, there is a doubt in determining the checking container by Inspection Agent as a critical activity. Because in the reality container transshipment process, there are only 5% containers will be selected by Inspection Agent. If the container has not been selected, the time consumption of this activity will be equal to zero. Assume the activity F from the network of work flow can be removed, the critical path will be changed immediately. After it is removed, the activity of repair the damaged container will becomes the critical activity, but unfortunately, the percentage of damaged container is also quite small with 3% only. Same as the activity F, assume the activity H also can be removed from the work flow, the activity of checking container by Dutch Customs will becomes the critical activity.

Obviously, the above three activities with longest time required after the container has been loaded to terminal have three characteristics:

1. All of them are noncompulsory activity in the transshipment work flow. In this study, the author is trying to determining the critical path that can be applied with most of situation for container transshipment. But we are facing the trade off that whether the noncompulsory activity has to put into the work flow. The critical path for the transshipment work flow varies depends on the situation of each container. There are 15% of container will be hold up cause of checking or repairing, the activity that hold up the container usually are the critical activity in the critical path, the time required of these activities is the critical factor to decide the total completion time for container transshipment in Port of Rotterdam.

2. Compare with the activities of checking and repairing, checking container is arranged by Dutch Customs or Inspection Agent, the required time is according to the situation of each container. The shipping line agents cannot get involved into the checking activity, after they have been informed by Dutch Customs or Inspection Agent; they have to arrange the transportation for the container to the checking area appointed by Dutch Customs or Inspection Agent. After that, the only thing they can do is waiting for the checking completion. Repairing the container is the activity arranged by the shipping lines agent themselves. It also difficult to control the time required for repairing the container. The time required depends on the level of damaged; the container will be replaced or repaired.

3. These three activities are juxtaposed to each others, in the reality container transshipment; it rarely happened that two of them occur on the same container, if it happened, it will be a very special case and the container will be hold on the terminal very long time, this kind of case will be not be discussed in this study. Therefore, although the time required for them are uncertain and long, but actually, the variance of time required of these activities not affect on the critical path determining, because they must be the critical activity if they occurred, their time required effect on the total time required directly.

As we mentioned before, the estimated time required of uncertain activities has variation. Due to the uncertain activities are always the critical activities in the transshipment work flow, the variation of uncertain activities in the critical path can causing the variation in the total time completion.

We can conclude that uncertain activities highly affect the critical path and the total time required for the transshipment process. In order to optimizing the work flow of container transshipment, improve the ability to control the uncertain activities should be quite important for shipping lines agent, such as estimate of time requirement accurately and get information as earlier as possible.

The Figure 5-2 illustrated that there are around 85% of containers will be ready to transshipped after they have been loaded to the terminal.

◆ The question is: Does the critical path also fit if the containers do not have to be checked or repaired?

Assuming that all of noncompulsory activity can be removed, the network of container transshipment work flow without the uncertain activities will show in the Figure 5-3. We can calculate that the total completion time for sea-sea container transshipment in Port of Rotterdam will be reduced from 15.5 days to 10.5 days

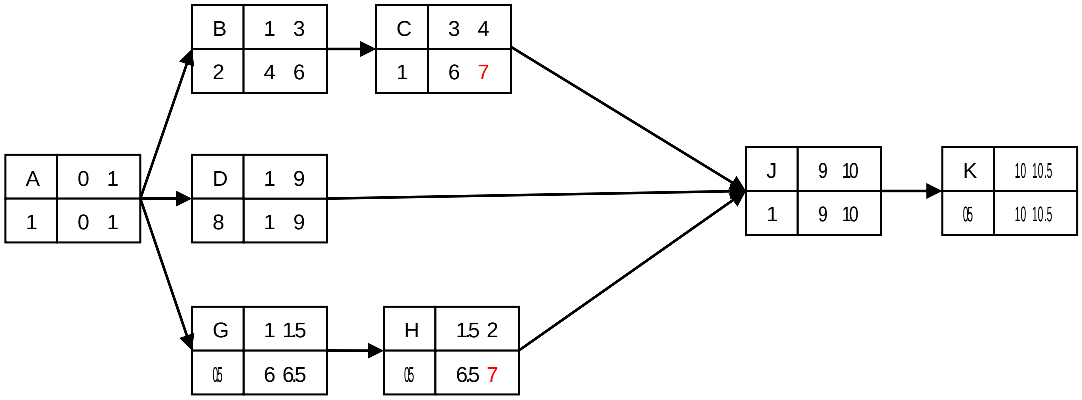

Figure 5-3 work flow without uncertain activities
Source: Own elaboration

In the Figure 5-3, if we can remove all uncertain activities in the work flow, the critical path will be formed by nodes A-D-J-K. The critical path will be ideal work flow for the containers that don't have be checked or repaired. In this assumption, the activity D (loading the container to the terminal) is the Immediate Predecessor for activity J (sending job order to feeder operator). The activity J usually takes one day. In this work flow, the slack time of activity G and H are 5 days, and the slack time for activity J and K are zero day. We can calculate that the interval between per booking to the departure of feeder vessel is from 3-8 days (K_{LS}-H_{EF} and K_{LS}-H_{LF}). During this 3-8 days, the deep sea vessel arrival the port of Rotterdam and loading the container to the terminal. There is enough time to per booking the earliest feeder departure date. Ideally, after the activity D has been done that container has been load to the terminal, the activity K will be start that load the container to the feeder vessel. So, the activity of sending job order is possible to be shifted to before the deep sea vessel arrival.

Therefore, in order to reduce the dwell time for the containers that don’t have to be checked and repaired, as we mentioned before, in the reality work, the operating staff always send the job order for confirm the container slot before the deep sea vessel arrival. Consequently, the critical path will be changed, the critical path will becomes A-D-K; the activity D will not be the immediate predecessor for activity J and the activity J has time constraint that has to be done before 7 days of deep sea vessel arrival Port of Rotterdam. The interval between per booking to the departure of feeder vessel becomes 2-7 days and the total completion time could be reduced to 9.5 days. The time should be also enough to per booking the earliest feeder departure date. The slack time still have 5 days, when is the best time to make per booking the feeder container slot should attracts more attention for reducing the total completion time for container transshipment.

Based on the above analysis, how to catch the nearest feeder departure date is another potential factor that affects the performance of container transhipment work flow in Port of Rotterdam. The following section will further discus the impact of feeder schedule on the transhipment critical path.

5.2 The Best Time of Booking the Feeder Vessel Container Slot

Based on the demand of sea-sea container transshipment by feeder vessel in Port of Rotterdam, the feeder vessel is not ready for loading the container every day. The Table A-4 shows the schedule of feeder vessel in August, 2010. It shows that departure schedule for every destination is 1-2 times per week. It means there are around 4-7 days gap between every departure date. The demand in summer is usually higher than other season, the schedule would be even less in the winter. Consequently, the interval between the per booking feeder service to loading the container on the feeder vessel should be around 4-7 days, or even may be more than that. When container is ready to be transshipped, if the earliest departure date in the schedule is missed, the dwell time will be increased around 4-7 days. The length of dwell time is the important factor of performance of container transshipment.

The pervious section analyzed that there are two kinds of situation for container transshipment, they should be discussed separately.

1. The container is ready for transshipped after it has been loading on the terminal. For this kind of container, the ready time on the terminal is relatively easy to be forecasting. The critical path without the uncertain activities will be used. For catching the earliest departure date, the operating staff in the transshipment department usually sends the official job order and required documents to the feeder operator before the deep sea vessel arrival Port of Rotterdam. In the reality work, if the pre booking departure date at the second day after deep sea vessel arrival, the operating staff have to send the job order immediately after they receive the information that confirm there isn't any container on this bill of lading will be checked by Dutch Customs or Inspection Agent. If the container has been selected by Dutch Customs or Inspection Agent. The operating staff usually has to change the pre booking date.

2. The container has to be checked or repaired. If the container has to be checked or repaired, the original critical path has to be used. The official job order usually will be send after the container is ready to be transshipped. As we mentioned before, the interval between each departure date is around 4-7 days. And the time required for the longest uncertain activity that checked by Inspection Agent is maximum 7 days. Therefore, the activity of pre booking can be hold up until to the latest start time.

The ideal situation for the sea-sea container transshipment is after the container is ready to be transshipped on the terminal, the activity of loading the container to the feeder vessel will be started immediately. For pursuing the ideal situation, the experience is highly necessary and may need the methodology to calculate the best time for booking the feeder vessel container slot.

5.3 The Reality Daily Container Transshipment Operating

According to record form the Cosco shipping lines agent in Rotterdam, there are 25-30 deep sea vessel arrival Port of Rotterdam every month and around 10% of containers have to be transshipped by feeder vessel. They arranged 3-4 staffs in-charge the sea-

sea container transshipment and their daily work is support by other departments. They divided the work by vessels, each staff has to deal with 6-7 deep sea vessel per month. Even the critical path without uncertain activities also required minimum 9.5 days. Therefore, most of time, the operating staff have to deal with more than 2 deep sea vessel at same time. The total time required for completion the container transshipment will be overlap added. In order to follow the critical path, most of activity has to be hold on until the latest start time.

As we introduced in chapter 3, there is a kind of difficulty that late information from agent in loading port, shippers and consignees, such as the alteration in bill of lading or the change of destination, create problems, especially when the alternation is done without prior consultation with relevant departments. If most of activity has to be hold on until the latest start time, it will lead that the operating staff doesn't have enough time to deal with change of the bill of lading. Otherwise, the time of completion has to be delay. The Figure 5-4 shows the time required of container transshipment after the container has been loaded to the terminal from first half year of 2010 in Cosco.

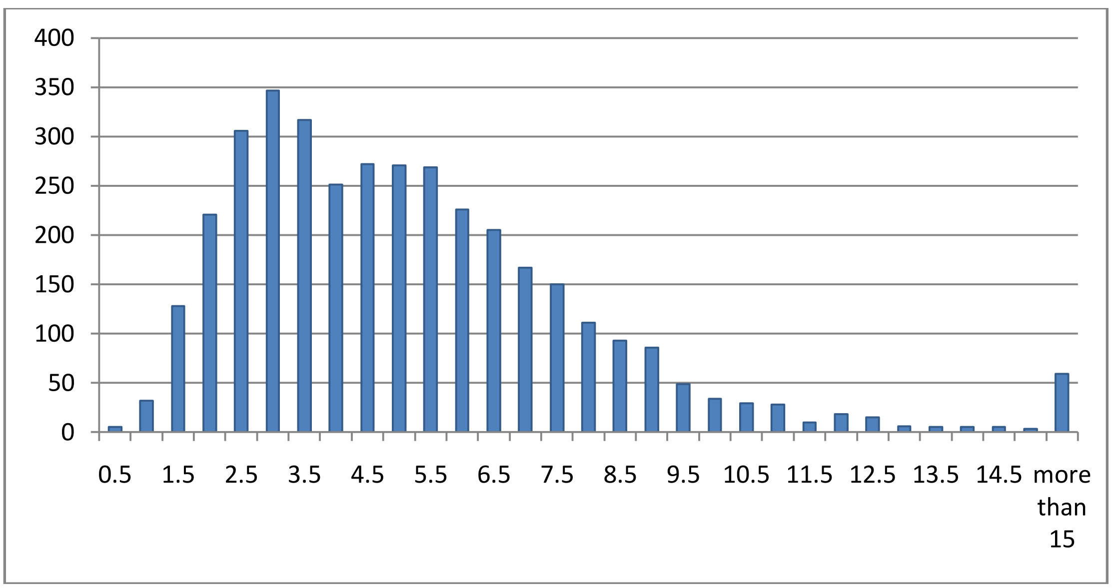

Figure 5-4 time required of container transshipment
Source: Transshipment department Cosco, 2010

In Figure 5-4, X-axis represents the average time required of container transshipment of bill of ladings, it's the time required after the container has been loaded to the terminal. Y-axis represents the frequency of each time required.

Table 5-1 shows the descriptive statistics of average time required of container transshipment.

Mean	5.033709
Median	4.46
Mode	5.08
Standard Deviation	3.309724
Sample Variance	10.95427

Table 5-1: Descriptive statistics of average time required
Source: Transshipment department Cosco, 2010

Base on our analysis, the time required with uncertain activities after the container has been loaded to the terminal is 6.5 days and the time required without uncertain activities after the container has been loaded to the terminal needs 0.5 day only. Obviously, the reality time required is longer than the ideal time required. There are should be two main reasons. The first reason is difficult to connect the time of ready to be transshipped to the time of feeder vessel departure date. The second reason is some of activities in the work flow have been delay that exceed the latest start time.

5.4 Chapter Conclusion

In this chapter, the potential factors that affect the applying the critical path have been further discussed. The ideal critical path has been rescanned by the sophisticated operating staff in the transshipment department in Cosco. They agreed with the critical path that we got by using the PERT/CPM methodology. But there are three main difficulties to apply the ideal critical path into the reality work. Firstly, the container transshipment work flow with uncertain activities, the uncertain activity usually the critical activity in the critical path, they are difficult to be estimated and controlled. Secondly, due to the schedule of feeder vessel, the feeder vessel is not ready for loading the container every day, it is difficult to defined the best time for per booking the feeder vessel container slot and sending the job order to the feeder operator. At last, the large amount of work load in the summer makes difficulty to follow the critical path by 3-4 operating staff, the activity usually has to be delay that exceed the latest start time. Based on these difficulties, the next chapter will summarize the analysis and provide some suggestions.

Chapter 6 Conclusions and Recommendations

6.1 Conclusions

The main objective of this thesis is to investigate the possibility of optimizing the work flow of sea-sea container transshipment in Port of Rotterdam from the perspective of shipping lines agent. The full container transshipment process has been defined that form the container has been loaded on the deep sea vessel to the container load on the feeder vessel. Based on the open literature review and face-to-face interview with operating staff in transshipment department in Cosco, the main activities in the transshipment work flow have been decrypted. In order to find out the most efficient work flow for container transshipment daily operating, the activities have been evaluated by applying the management science methodology that called Program Evaluation and Review Technology and Critical Path Method.

Through the PERT/CPM analysis, the critical path has been found and also the optimistic total time required for completed the container transshipment has been calculated. Compare the reality work flow and the critical path, they are very similar to each others. Before the evaluation of transshipment work flow by PERT methodology, I expected that I could find out a more efficient critical path for improving the reality transshipment process, but the result is they are doing very well already and following the same critical path in the reality daily work. From another standpoint, if compare the result of the total completion time in the critical path and the figures in the reality work, it indicates that the reality container transshipment time required is longer than the ideal total completion time. Therefore, we can conclude that there should be inefficiencies in container transshipment. The three possible reasons have been summarized.

First, as the result of the critical path, the uncertain activities in transshipment work flow highly affect the direction of critical path, such as the checking the container by Dutch Customs or Inspection Agent and repairing the damaged container. Once the uncertain activity has occurred in the transshipment process, it must be the critical activity in the critical path and the total completion time is vary depends on the time required of uncertain activity.

Secondly, due to the relationship between the time required of uncertain activity in the transshipment work flow and feeder vessel departure schedule are dynamic, finding the best time for per booking the feeder vessel container slot and confirm it is also quite important to control the total completion time for container transshipment and reduce the dwell time.

Lastly, because the research is doing in the summer period, it’s usually the peak time for the container transshipment from Far East to North Europe. The workload is relatively higher than other seasons. Most of time, each operating staff in transshipment department has to deal with more than two deep sea vessel, the total completion time is overlapped to each others. There are also some requests of change, such as the final destination or port of clearance. In order to follow the activity in the critical path, other activities in the work flow always have to be hold until the latest start time or even have to be delay. Therefore, it is really difficult to reach to optimistic total completion time for container transshipment.

In summarize, in order to reduce the total completion time for container transshipment. There are few suggestions can be provided:

1. Reduce and control the time required of uncertain activity by estimated the time required accurately and get information as earlier as possible. For instance, build the data record of time required for uncertain activity such as checking and repairing, the estimation of time required of uncertain activity can be more accurate in the soon future.

2. Reallocated the relationship between the shipping lines agent and feeder vessel operator, sharing the information transparently to each other and reduce the bullwhip effect in the supply chain. Try to connect the ready time of transshipment container and departure time of feeder vessel more effectively.

3. In order to follow the critical path absolutely, increase the number of operating staff in transshipment department also can be an option. But applying this suggestion has to be face trade off with the labor cost and benefits. We should leave this to the leading level to decide it.

6.2 Research Limitations

The results and the conclusions of this thesis have to be considered in the limitations of the research. This is a thesis for one year master program graduation. It has the specific time constraints and done by one person. Therefore, the manpower and material for this thesis are limited. Cause of the time limitation, most of things can't be done perfectly, such as literature review, research of reality work, data collection, and methodology selection. Even the subject of the thesis also has more space to be deeply considered. The main limitations will be list down.

1. Literature Review: cause of the time limitation, the time for literature review at the beginning of writing the thesis is limited. The general back ground of container transshipment in North Europe may not be fully reviewed, the fully understand of the research back ground could be very helpful for getting broad view of research. Secondly, it should be more open literatures could be found that able to approve the PERT/CPM is fit for evaluate the network of work flow, and also more experience and ideas of using PERT/CPM could be used as source of reference.

2. Research of reality work: for the research of reality daily operating work, it combined with the internship in transshipment department and the face-to-face interview with the daily operating staff. The process of sea-sea container transshipment seems simple, but actually, it is quite complicate and including many variables in the reality work. The short term internship and verbal interview may not enough to fully understand the process of container transshipment, and also difficult to define the activity accurately. This thesis has defined the main activities in the process only, it should be some sub-

activities haven't been discussed carefully and they may affect the result of the evaluation.

3. Data Collection: this thesis is analyzed the transshipment work flow from the perspective shipping lines agent, most of data is collected from the Cosco shipping lines at Rotterdam. The data from agent in loading port, terminal operator and feeder operator is quite insufficient. If these insufficient information could be collected, the estimation of time required for each activity in the work flow should be more accurate. It will lead the result of evaluation more efficient.

4. Methodology selection: cause of the knowledge limitation of author and the time limitation, the PERT/CPM is the only methodology has been used in this thesis. Due to the limitation of PERT/CPM, any misunderstanding of the building the net work of work flow will directly affect on the result of the evaluation. As we mentioned before, the limitation of understanding of reality work and shortage of discussion of sub-activity may reduce the feasibility of the critical path in the reality work.

Last but not least, due to the insufficient understanding and knowledge of container transshipment, there are a couple of hypotheses and estimations during the evaluation haven't been proof in the reality daily work. Secondly, the critical path got by using the PERT/CPM hasn't been proof is workable in the reality daily work, it's only can be a suggestion at this moment and there should be a lot of potential difficulties in apply it in the reality work.

6.3 Recommendations for Further Research

Due to the research limitations, in order to optimizing the sea-sea container transshipment work flow, there are some recommendations for further research.

This thesis analyzed the container transshipment work flow from the perspective of shipping lines agent. In addition, due to the container transshipment process involved many parties, in order to optimizing the supply chain of the container transshipment, it is also worth further research to transshipment work flow from the perspective of other parties, such as the feeder operator, terminal operator and the shipping lines agent in the port of final destination.

There are many kinds of inter-model transshipment could be used in Port of Rotterdam, this thesis is focus on the sea-sea container transshipment, the work flow of sea-truck, sea-train and sea-barge transshipment also worth for the further research. The comparison between each kind of transshipment is also recommended.

As the biggest hub port in Europe, not only the huge amount of container has been transshipped in Port of Rotterdam, there are also large amount of other kinds of cargo have been transshipped in Port of Rotterdam. For the recommendation of further research, other kinds of cargo such as tankers, bulks and Ro-Ro (Roll-on/Roll-off) also worth to research. The net work of transshipment work flow could be used as reference and the critical path will varies depends on the kind of cargo.

At last, only using the PERT/CPM methodology to evaluate the work flow of transshipment is the research limitation in this thesis, the recommendation for the further research is using other methodology to evaluate the work flow or use others as support methodology for proof the PERT/CPM.

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Appendices

Table A-1 Final ports served by different feeder service operators

Port	Country	Feeder
AARUS	Danmark	Unifeeder
COPENHAGEN	Danmark	Unifeeder
GRIMSBY	Danmark	Unifeeder
TALLINN	Estonia	Teamlines
HELSINKI	Finland	Unifeeder
KOTKA	Finland	Unifeeder
RAUMA	Finland	Unifeeder
BELFAST	Ireland	Xpress
CORK	Ireland	Xpress
DUBLIN	Ireland	Xpress
KLAIPEDA	Latvia	Imcl
RIGA	Latvia	Imcl
BERGEN	Norway	Unifeeder
BREVIK	Norway	Unifeeder
FREDRIKSTAD	Norway	Unifeeder
HAUGESUND	Norway	Unifeeder
KRISTIANSAND	Norway	Unifeeder
LARVIK	Norway	Unifeeder
MAALOAREY	Norway	Unifeeder
MOSS	Norway	Unifeeder
OSLO	Norway	Unifeeder
TANANGER	Norway	Unifeeder
GDANSK	Poland	Imcl
GDYNIA	Poland	Imcl
GDYNIA	Poland	Imcl
SZCEECIN	Poland	Imcl

LEIXOES	Portugal	Teamlines
LEIXOES	Portugal	Teamlines
LISBON	Portugal	Teamlines
ST.PETERSBURG	Russia	Unifeeder
BILBAO	Spain	Teamlines
BILBAO	Spain	Teamlines
GIJON	Spain	Xpress
GIJON	Spain	Xpress
VIGO	Spain	Teamlines
GEFLE	Sweden	Unifeeder
GOTHENBURG	Sweden	Unifeeder
HELSINGBORG	Sweden	Unifeeder
STOCKHOLM	Sweden	Unifeeder
AALESUND	UK	Unifeeder
GRANGEMOUTH	UK	Unifeeder
GRANGEMOUTH	UK	Unifeeder
IMMINGHAM	UK	Feederlink
SOUTHSHIELDS	UK	Feederlink

Source: Data from Transshipment department Cosco Rotterdam, 2010

Table A-2 The template of manifest.

FREIGHT MANIFEST (OUTBOUND)

REPORT ID:

TOKEN:
RUN DATE:
VERSION:

SERVICE:
VESSEL: SHIP FLAG:
VOYAGE: NAME OF MASTER:
SAIL DATE:

PLACE OF RECEIPT:
PORT OF LOAD:
PORT OF DISCHARGE:
PLACE OF DELIVERY:

CUSTOMER INFORMATION	MARKS& NUMBERS	NUMBER OF PACKAGES/ DESCRIPTION OF GOODS	WEIGHT/	R.TON	(BASIS)	RATE P/	FREIGHT	CUR

B/L NUMBER: REF:
SHIPPER:

CONSIGNEE:

NOTIFY PARTY:

ALSO NOTIFY PARTY:

CONTAINER NUM	SEAL NUM	SZTY	NUM OF PACKS	TRAFFIC	REMARKS	WEIGHT

“LIST OF EACH CONTAINER”

Source: Transshipment department Cosco Rotterdam, 2010

Table A-3 feeder schedule for august 2010

North Sea container lines

	Hamburg/ Bremerhaven - Services	Hamburg/ Bremerhaven - Services	Rotterdam - Services	Rotterdam - Services	Rotterdam - Services	Rotterdam - Services	Rotterdam - Services
Date	Celina	Anna	Emma	North Express	Clarissa	Tina	Carina
Updated	20.08.2010 09:01:29	19.08.2010 08:42:31	19.08.2010 13:36:46	20.08.2010 08:40:45	20.08.2010 08:14:53	20.08.2010 08:39:44	20.08.2010 08:43:34
Week 33 AU 1 Mo G 6 n	Rotterdam	Rotterdam	Rotterdam	At Sea	Rotterdam	Salten	Mosjøen
17 Tue	Rotterdam	Rotterdam	Rotterdam	Hamburg	Rotterdam	SaltenRørvik	Mosjøen
18 Wed	At Sea	Rotterdam	At Sea	Hamburg	Rotterdam	Trondheim (orkanger)	Mosjøen
19 Thu	Ålesund - Skutevika	Egersund	TanangerHaugesundHåvik	Bremerhaven	Rotterdam	HøgsetÅlesund - SkutevikaFlorø	Mosjøen
20 Fri	Ålesund - SkutevikaÅlesund - FrigocareIkornnes	EgersundTanangerHaugesundBergen	BergenFlorø	TanangerHaugesund	Rotterdam	Husnes	At Sea
21 Sat	At Sea	BergenFlorøMåløy	Svelgen	BergenFlorøÅlesund - FrigocareÅlesund - Skutevika	At Sea	At Sea	At Sea
22 Sun	At Sea	Måløy	Sauda	Ålesund - Skutevika	At Sea	Rotterdam	At Sea
Week 34 AU 2 Mo G 3 n	Hamburg	At Sea	At Sea	SandnessjøenSalten	Trondheim (orkanger)	Rotterdam	Rotterdam
24 Tue	Bremerhaven	HamburgBremerhaven	Rotterdam	Salten	Mosjøen	Rotterdam	Rotterdam
25 Wed	At Sea	Hamburg	Rotterdam	Trondheim (orkanger)Holla	Mosjøen	TanangerKvinesdal	Rotterdam
26 Thu	Ålesund - Skutevika	Tananger	Rotterdam	HollaHøgsetSunndalsøra	Mosjøen	BergenFlorø	Rotterdam
27 Fri	IkornnesÅlesund - SkutevikaÅlesund - Frigocare	BergenHaugesundKnarrevik	Rotterdam	Ålesund - SkutevikaÅlesund - FrigocareFlorø	At Sea	SvelgenMåløyÅlesund - Skutevika	At Sea
28 Sat	At Sea	Florø	Rotterdam	BergenHaugesundHåvikSauda	At Sea	Ålesund - Skutevika	At Sea
29 Sun	At Sea	At Sea	Rotterdam	SaudaRotterdam	At Sea	At Sea	Trondheim (orkanger)
Week 35 AU 3 Mo G 0 n	Hamburg	At Sea	Rotterdam	Rotterdam	Rotterdam	Salten	Mosjøen
31 Tue	HamburgBremerhaven	Hamburg	Rotterdam	Rotterdam	Rotterdam	Trondheim (orkanger)	Mosjøen
1 Wed	At Sea	Bremerhaven	At Sea	Rotterdam	Rotterdam	SunndalsøraHollaHøgset	Mosjøen
2 Thu	Ålesund - Skutevika	At Sea	HaugesundTanangerHusnes	HaugesundImmingham	Rotterdam	Ålesund - Skutevika	Mosjøen
3 Fri	IkornnesÅlesund - SkutevikaÅlesund - Frigocare	BergenHaugesundTanangerKnarrevik	BergenFlorø	MåløyÅlesund - Skutevika	At Sea	At Sea	At Sea
4 Sat	At Sea	FlorøMåløy	SvelgenSauda	Ålesund - Skutevika	At Sea	At Sea	At Sea
5 Sun	At Sea	At Sea	Sauda	At Sea	Trondheim (orkanger)	Rotterdam	At Sea
Week 36	Hamburg	Bremerhaven	Rotterdam	Salten	Mosjøen	Rotterdam	Rotterdam

SEP 6 Mon							
7 Tue	HamburgBremerhaven	HamburgBremerhaven	Rotterdam	Trondheim (orkanger)	Mosjøen	Rotterdam	Rotterdam
8 Wed	At Sea	Hamburg	At Sea	SunndalsøraHollaHøgset	Mosjøen	At Sea	Rotterdam
9 Thu	Ålesund - Skutevika	At Sea	HaugesundTananger	Ålesund - SkutevikaÅlesund - Frigocare	Mosjøen	Måløy	Rotterdam
10 Fri	IkornnesÅlesund - SkutevikaÅlesund - Frigocare	BergenHaugesundTanangerKnarrevik		At Sea	At Sea	Ålesund - Skutevika	At Sea
11 Sat	At Sea	FlorøMåløy		At Sea	At Sea	Ålesund - Skutevika	At Sea
12 Sun	At Sea	At Sea		Rotterdam	At Sea	At Sea	Trondheim (orkanger)
Week 37 SEP 13 Mon				Rotterdam	Rotterdam	Salten	Mosjøen

TEAMLINES

TEAM LINES Deutschland GmbH & Co. KG
Schedule Update week 28 to 31

28.07.2010 15:35

			Norway / Gothenburg / Spain				Sweden / Finland / Denmark				Poland / Baltic States				Finland		Russia		Spain / Portugal						
			GOTLAND	HANNI	WEGA	JANA	ELISABETH	Ice Bird	PANTONIO	PENGALIA	EL TORO	EL TEMERARIO	ELUSIVE	DS BLUE WAVE	A LA MARINE	EMOTION	Empire	Elysee	Götaland	Vega Stockholm	WMS Harlingen	Pagola			
TEU			822	658	749	974	658		698	698	1118	1118	660	698	1440	1440	1440	1400							
Service			NOR 1		SPA1 / NOR 3	SPA1 / NOR 3	SWE 3		SWF 1 / DSW 1	SWF 1 / DSW 1	POL 3	POL 2	BAL 1	BAL 2	FIN 1	FIN 1	RUS 1	RUS 1							
	FR	23. 07.	HAM	GDY	KRS		AHU		GVX	OSL			BRV	RIX	HEL		TLL	HAM	VGO				23. 07.	FR	
	SA	24. 07.	HAM/BRV	GDY/GDN	RTM	ANR		SCZ	RAU	KRS	GDY	BRV/HAM	HAM	KLA		RIX	STP	RTM					24. 07.	SA	
	SU	25. 07.			RTM	RTM	BRV/HAM			BRV	GDN	HAM			RTM		STP	RTM			RTM		25. 07.	SU	
	MO	26. 07.	GOT	HAM	ANR	RTM	HAM	HAM	BRV	HAM				HAM	RTM	HEL/KTK	STP	HAM	ANR			LIS	26. 07.	MO	
	TU	27. 07.	OSL/OSS	HAM				HAM	HAM	HAM	RTM	GDY	TLL	HAM	RTM	STP			RTM			LEI	27. 07.	TU	
30	WE	28. 07.	BVK		BIO	GOT	NRK	FRC	HAM		RTM	GDN	TLL	BRV	HAM	STP			RTM				28. 07.	WE	30
	TH	29. 07.	GOT	CPH	BIO	OSL	STO		AAR	TKU			SCZ		HAM	KTK	HAM		RTM		LEI		29. 07.	TH	
	FR	30. 07.	HAM	GDN/GDY		OSS	AHU		GOT	GVX	GDY	BRV/HAM	BRV	RIX		HEL	HAM	TLL			VGO	SOU	30. 07.	FR	
	SA	31. 07.	HAM/BRV	GDY	ANR	RTM			OSL	RAU	GDN	HAM	BRV/HAM	KLA	RIX		RTM	STP				RTM	31. 07.	SA	
	SU	01. 08.			RTM	RTM	BRV/HAM		BRV							RTM	RTM	STP				RTM	01. 08.	SU	
	MO	02. 08.	GOT	HAM	RTM	ANR	HAM	HAM	HAM	BRV	RTM	GDY		HAM	HEL/KTK	RTM	HAM	STP	LIS		ANR		02. 08.	MO	
	TU	03. 08.	OSL/OSS	HAM				HAM	HAM	HAM	HAM (5)	GDN	TLL	HAM / BRV	STP	HAM	HAM		LEI		RTM		03. 08.	TU	
31	WE	04. 08.	BVK	GOT	GOT	BIO	NRK	FRC		HAM		SCZ		BRV	STP	HAM					RTM		04. 08.	WE	31
	TH	05. 08.	GOT	KRS	OSL/OSS	BIO	STO		TKU	CPH/AAR	GDY				KTK			HAM			RTM	LEI	05. 08.	TH	
	FR	06. 08.	HAM	OSL	KRS		AHU		GVX	GOT	GDN	BRV	BRV	RIX	HEL	RIX		HAM	SOU			VGO	06. 08.	FR	
	SA	07. 08.	HAM/BRV		RTM	ANR			RAU	BRV		HAM	HAM	KLA		HEL	STP	RTM	RTM	RTM			07. 08.	SA	
	SU	08. 08.		BRV	RTM	RTM	BRV/HAM			BRV/HAM	RTM				RTM		STP	RTM	RTM (4)	RTM			08. 08.	SU	
	MO	09. 08.	GOT	HAM	ANR	RTM	HAM	HAM	BRV	HAM	RTM	GDY		HAM	RTM	KTK	STP	HAM			LIS	ANR	09. 08.	MO	
	TU	10. 08.	OSL/OSS	HAM				HAM	HAM	HAM	HAM	GDN	TLL	HAM / BRV	HAM	STP		HAM			LEI	RTM	10. 08.	TU	
32	WE	11. 08.	BVK	GOT	BIO	GOT	NRK	FRC	HAM			SCZ		BRV	HAM	KTK						RTM	11. 08.	WE	32
	TH	12. 08.	GOT	KRS	BIO	OSL/OSS	STO		CPH/AAR	TKU	GDY				HAM	KTK/HEL	HAM			LEI		RTM	12. 08.	TH	
	FR	13. 08.	HAM	OSL		KRS	AHU		GOT	GVX	GDN	BRV	BRV	RIX		HEL	HAM			VGO	SOU		13. 08.	FR	
	SA	14. 08.	HAM/BRV		ANR	RTM			BRV	RAU		HAM	HAM	KLA	RIX		RTM	STP			RTM		14. 08.	SA	
	SU	15. 08.		BRV	RTM	RTM	BRV/HAM		BRV/HAM		RTM					RTM	RTM	STP			RTM		15. 08.	SU	
	MO	16. 08.	GOT	HAM	RTM	ANR	HAM	HAM	HAM	BRV	RTM	GDY		HAM	HEL/KTK	RTM	HAM	STP		ANR	RTM	LIS	16. 08.	MO	
	TU	17. 08.	OSL/OSS	HAM				HAM	HAM	HAM	HAM	GDN	TLL	HAM / BRV	STP	RTM	HAM			RTM		LEI	17. 08.	TU	
33	WE	18. 08.	BVK	GOT	GOT	BIO	NRK	FRC		HAM		SCZ		BRV	STP	HAM				RTM			18. 08.	WE	33
	TH	19. 08.	GOT	KRS	OSL/OSS	BIO	STO		TKU	CPH/AAR	GDY				KTK	HAM		HAM		RTM	LEI		19. 08.	TH	
	FR	20. 08.	HAM	OSL	KRS		AHU		GVX	GOT	GDN	BRV	BRV	RIX	HEL			HAM			VGO	SOU	20. 08.	FR	
	SA	21. 08.	HAM/BRV		RTM	ANR			RAU	BRV		HAM	HAM	KLA		RIX	STP	RTM				RTM	21. 08.	SA	
	SU	22. 08.		BRV	RTM	RTM	BRV/HAM			BRV/HAM	RTM				RTM		STP	RTM				RTM	22. 08.	SU	
	MO	23. 08.	GOT	HAM	ANR	RTM	HAM	HAM	BRV	HAM	RTM	GDY		HAM	RTM	HEL/KTK	STP	HAM		LIS	ANR	RTM	23. 08.	MO	

FEEDERLINK

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WEEK 33

	WESTERN TRADER	ETA	ETS	KOMET III	ETA	ETS	CLONLEE	ETA	ETS	CIMBRIA	ETA	ETS
SUN 15-Aug	TEESPORT 10WES095TERO ROTTERDAM	2300	0100	SOUTH SHIELDS 10KOM087SSFX	0001	0600	SOUTH SHIELDS 10CLL091SSRO	1400	2200			
MON 16-Aug	ROTTERDAM 10WES096ROFX 10WES096ROTE 10WES096ROGM		1900	FELIXSTOWE departed	0100	1200	TEESPORT 10CLL091TERO IMMINGHAM 10CLL091IMRO	0100 1700	0200 2359	ROTTERDAM	0400	
TUE 17-Aug	FELIXSTOWE 10WES096FXTESSGM 60841	0200	1000				ROTTERDAM	1600		ROTTERDAM 10CIM088ROSS 10CIM088ROGM		2300
WED 18-Aug	TEESPORT 10WES096TEGM GRANGEMOUTH	0400 1900	0700	FELIXSTOWE 10KOM089FXTESSGM 61102	0100	2300	ROTTERDAM			SOUTH SHIELDS 10CIM088SSGM 10CIM089SSRO	1900	2359
THU 19-Aug	GRANGEMOUTH 10WES097GMFX		0600	TEESPORT 10KOM089TEGM	1700	2200	ROTTERDAM 10CLL092ROIM 10CLL092ROSS 10CLL092ROGM		1200	GRANGEMOUTH	1100	
FRI 20-Aug	FELIXSTOWE 61118	0800		SOUTH SHIELDS 10KOM0897SSGM GRANGEMOUTH	0100 1400	0400	IMMINGHAM 10CLL092IMGM TEESPORT 10CLL092TEGM SOUTH SHIELDS	0200 1800 2300	0600 2000	GRANGEMOUTH 10CIM089GMRO		0600
SAT 21-Aug	FELIXSTOWE 10WES098FXSS 10WES098FXTE		0700	GRANGEMOUTH 10KOM090GMFX		0600	SOUTH SHIELDS 10CLL092SSGM GRANGEMOUTH	1800	0600	ROTTERDAM	1200	
SUN 22-Aug	TEESPORT 10WES099TEFX SOUTH SHIELDS 10WES099SSFX	0100 0900	0600 1600	FELIXSTOWE	2359		GRANGEMOUTH 10CLL093GMRO		0600	ROTTERDAM 10CIM090ROSS 10CIM090ROTE 10CIM090ROIM		1200
MON 23-Aug	FELIXSTOWE 10WES100FXRO 61122	1000	2200	FELIXSTOWE 10KOM091FXTEGM 61105		2300	ROTTERDAM	1200		SOUTH SHIELDS 10CIM091SSRO TEESPORT 10CIM091TERO	0800 1700	1400 2200
TUE 24-Aug	ROTTERDAM 10WES101ROFX 10WES101ROTE 10WES101ROGM	0700	2200	TEESPORT	1700		ROTTERDAM 10CLL094ROSS 10CLL094ROGM		1200	IMMINGHAM 10CIM091IMRO	1000	1500
WED 25-Aug	FELIXSTOWE 10WES101ROTESSGM 61389	0700	2300	TEESPORT 10KOM091TEGM GRANGEMOUTH	2200	0600	SOUTH SHIELDS 10CLL094SSGM GRANGEMOUTH	0800 2200	1200	ROTTERDAM	0600	
THU 26-Aug	TEESPORT 10WES101TEGM	1700	2200	GRANGEMOUTH 10KOM092GMFX		1200	GRANGEMOUTH 10CLL095GMRO		1200	ROTTERDAM 10CIM092ROIM 10CIM092ROSS 10CIM092ROGM		1200
FRI 27-Aug	SOUTH SHIELDS 10WES101SSGM GRANGEMOUTH	0100 1400	0400	FELIXSTOWE 61391	1400		ROTTERDAM	1800		IMMINGHAM 10CIM092IMGM SOUTH SHIELDS 10CIM092SSGM	0200 2000	0800 2300
SAT 28-Aug	GRANGEMOUTH 10WES102GMRO		0600	FELIXSTOWE 10KOM093FXSSTE		0700	ROTTERDAM 10CLL096ROSS 10CLL096ROTE 10CLL096ROIM		2000	GRANGEMOUTH	1000	
SUN 29-Aug	ROTTERDAM	1200		TEESPORT 10KOM094TEFX SOUTH SHIELDS 10KOM094SSFX	0100 0900	0700 1800	SOUTH SHIELDS 10CLL097SSRO	1600	2200	GRANGEMOUTH		1200
MON 30-Aug	ROTTERDAM 10WES103ROSS 10WES103ROGM		1200	FELIXSTOWE 61392	1200		TEESPORT 10CLL097TERO IMMINGHAM 10CLL097IMRO	0100 1800	0600 2359	FELIXSTOWE 91393	1400	
TUE 31-Aug	SOUTH SHIELDS 10WES102SSGM	0800	1400	10KOM095FXRO ROTTERDAM	1400	0400	ROTTERDAM	1600				0700

UNIFEEDER

OPERATIONAL SCHEDULE FOR WEEK 33-36, UPDATED 19.08.2010 1330 hrs

Germany to Scandinavia, Poland and the Baltic States

Week	Date	AURA	AURORA	CHRISTOPHER	HENNEKE RAMBOW	HERCULES J	HERM	IDA RAMBOW	IDUNA	JOHANNA	JORK RELIANCE	NAVI BALTIC	STEFAN SIBUM	SVEN	WMS GRONINGEN	TONGAN	TBN 1	HOOGE	PERCEUS J
		822	868	1440	868	1036	750	1008	801	700	803	1425	1036	700	700	925			
WEEK 33	TH 19.08	HAM	-	-	-	HEL	SZZ	-	MSS	MMA	MMA	AAR	-	HAL	GOT	-	-	TLL	HAM
	FR 20.08	FRC	HAM	GDN/ GDY	BRV	RAU	-	GDY	OSL	BRV	GOT	HAM	HAM	-	HAM	-	-	-	-
	SA 21.08	AAR	HAM	-	HAM	-	HAM	GDN	LAR	HAM	CPH	HAM	BRV	BRV	BRV	HAM	-	-	-
	SU 22.08	BRV	BRV	-	-	-	BRV	-	-	HAM	BRV	BRV	-	HAM	-	HAM	-	-	-
WEEK 34	MO 23.08	HAM	-	BRV	-	BRV	-	HEL	BRV	GOT	HAM	-	-	AGH	GDY	RTM	-	-	-
	TU 24.08	HAM	OSL	HAM	HMN	HAM	CPH	KTK	HAM	AGH	-	-	KTK	MMA	KLJ	5)	RTM	-	TLL
	WE 25.08	FRC	-	-	HEL	HAM	CPH	-	-	HAM	FRK	RIX	KTK	HAD	SZZ	-	RTM	-	-
	TH 26.08	GOT	BRV	AAR	-	-	AGH	-	MMA	HAM	MSS	-	HEL	HAL	-	-	-	-	HAM
	FR 27.08	BRV	HAM	HAM	-	GDY	BRV	HAM	GOT	FRC	OSL	RAU	GDN/ GDY	-	HAM	-	HAM	-	-
	SA 28.08	HAM	-	HAM	HAM	GDN	HAM	BRV	CPH	AAR	LAR	-	-	BRV	BRV	-	-	-	-
	SU 29.08	HAM	-	BRV	BRV	-	HAM	-	BRV	BRV	-	-	-	HAM	-	-	-	-	-
WEEK 35	MO 30.08	HAM	HMN	-	-	HEL	GOT	-	HAM	HAM	BRV	BRV	BRV	-	GDY	-	LED/ plp	-	-
	TU 31.08	CPH	HEL	-	OSL	KTK	AGH	KTK	-	HAM	HAM	HAM	HAM	MMA	KLJ	-	LED/ plp	-	TLL
	WE 01.09	CPH	-	RIX	-	-	HAM	KTK	FRK	FRC	-	-	HAM	HAD	SZZ	-	-	-	-
	TH 02.09	AGH	-	-	BRV	-	HAM	-	MSS	GOT	MMA	AAR	-	HAL	-	-	-	-	HAM
	FR 03.09	BRV	HAM	RAU	HAM	HAM	FRC	GDN/ GDY	OSL	BRV	GOT	HAM	GDY	-	HAM	-	BRV	-	-
	SA 04.09	HAM	HAM	-	-	BRV	AAR	-	LAR	HAM	CPH	HAM	GDN	BRV	BRV	-	HAM	-	-
	SU 05.09	HAM	BRV	-	-	-	BRV	-	-	HAM	BRV	BRV	-	HAM	-	-	HAM	-	-
WEEK 36	MO 06.09	-	-	BRV	HMN	-	HAM	BRV	BRV	GOT	HAM	-	HEL	-	GDY	-	-	-	-
	TU 07.09	CPH	OSL	HAM	HEL	KTK	HAM	HAM	HAM	AGH	-	-	KTK	MMA	KLJ	-	-	-	TLL
	WE 08.09	CPH	-	-	-	KTK	FRC	HAM	-	HAM	FRK	RIX	-	HAD	SZZ	-	LED/ plp	-	-
	TH 09.09	AGH	BRV	AAR	-	-	GOT	-	MMA	HAM	MSS	-	-	HAL	-	-	LED/ plp	-	HAM
	FR 10.09	BRV	HAM	HAM	HAM	GDN/ GDY	BRV	GDY	GOT	FRC	OSL	RAU	HAM	-	HAM	-	-	-	-

UK / Benelux to Scandinavia, Poland and the Baltic States / Russia

Week	Date	UK: HERM J	UK: MERWEDIJK	UK: VEERSEDIJK	ALDEBARAN J	ANNE SIBUM	DORIS SCHEPERS	ENDEAVOR	HANSE SPIRIT	HANSE VISION	HEINRICH EHLER	INES BOLTEN	IRIS BOLTEN	JORK RULER	KRISTIN SCHEPERS	MARNEDIJK	SPICA J	VERA RAMBOW	Russia: AS FRANCONIA	BELUGA MEDITATION	BIANCA RAMBOW	CARAT	CERES	HELMUT	HERM KIEPE	NORDIC HAMBURG	PICTOR J
		698	700	698	974	1036	803	750	809	809	1425	974	974	803	803	700	974	1425	1036	917	868	889	889	868	1008	1036	925
WEEK 33	TH 19.08	-	TEE/ GRG	FXT	RTM	-	-	-	RTM	-	HEL	STO	RTM	KGD	GOT	FRK	OSL	RTM	-	SZZ	RTM	LED/ fct	-	LED/ plp	HAM	CPH	-
	FR 20.08	HAM	GRG	SSH	-	RTM	RTM	SZZ	-	ZEE	KTK	GVX	RTM	GDN/ GDY	CPH/ AGH	LAR	BVK	-	-	-	RTM	-	-	-	-	BRV	HAM
	SA 21.08	HAM	SSH	TEE	-	RTM	RTM	SZZ	-	RTM	-	RAU	RTM	-	AAR	-	KRS	-	-	-	-	-	RTM	-	-	HAM	-
	SU 22.08	FXT	RTM	GRG	RIX	RTM	-	KLJ	GDY	RTM	-	-	-	-	-	RTM	-	-	-	RTM	-	ZEE	RTM	-	-	HAM	-
WEEK 34	MO 23.08	IMM	RTM/ FXT	-	GDY/ GDN	-	OSL	-	GDY/ GDN	-	-	-	GOT	RTM	ANR	RTM	RTM	HEL	-	5)	KTK	RTM	-	HAM	LED/ fct	-	LED/ plp
	TU 24.08	TEE	FXT	RTM	-	-	MSS	RTM	KGD	CPH/ AGH	ZEE	ANR	-	RTM	RTM	-	RTM	KTK	-	-	LED/ plp	RTM	HAM	HAM	-	-	LED/ plp
	WE 25.08	GRG	IMM	RTM	-	-	KRS	RTM	GDN	GOT	RTM	RTM	STO	-	RTM	AAR	-	-	-	-	LED/ plp	-	-	RTM	-	LED/ plp	-
	TH 26.08	-	TEE/ GRG	FXT	RTM	HEL	-	RTM	GDY	-	RTM	RTM	GVX	CPH	-	MSS/ FRK	OSL	-	RTM	-	-	HAM	-	RTM	HAM	LED/ plp	-
	FR 27.08	HAM	GRG	SSH/ TEE	RTM	KTK	RTM	-	-	ZEE	-	-	RAU	AGH	SZZ	LAR	BVK	RTM	RTM	-	-	-	LED/ fct	-	RTM	-	BRV
	SA 28.08	-	SSH	GRG	ZEE	-	RTM	-	-	RTM	-	-	-	AAR	SZZ	-	KRS	4)	-	-	-	-	-	-	5)	-	HAM
	SU 29.08	FXT	RTM	GRG	-	-	-	GDY	RTM	RTM	-	RIX	-	-	KLJ	RTM	-	-	HAM	-	RTM	LED/ fct	-	-	-	-	HAM
WEEK 35	MO 30.08	IMM	RTM/ FXT	-	GOT	-	OSL	GDY/ GDN	RTM	-	HEL	GDY/ GDN	ANR	ANR	-	-	RTM	RTM	-	-	RTM	LED/ fct	ZEE	LED/ plp	-	-	-
	TU 31.08	TEE	FXT	RTM	-	ZEE	MSS	KGD	RTM	CPH/ AGH	KTK	-	RTM	RTM	-	AAR	RTM	-	-	-	RTM	-	RTM	LED/ plp	-	RTM	-
	WE 01.09	GRG	IMM	RTM	STO	RTM	KRS	GDN	-	GOT	-	-	RTM	RTM	RTM	LAR	-	-	LED/ fct	-	RTM	-	RTM	-	-	RTM	LED/ plp
	TH 02.09	-	TEE/ GRG	FXT	GVX	RTM	-	GDY	CPH	-	-	RTM	-	-	RTM	FRK	OSL	HEL	-	-	HAM	RTM	HAM	HEL	-	-	LED/ plp
	FR 03.09	HAM	GRG	SSH/ TEE	RAU	-	RTM	-	AGH	ZEE	RTM	RTM	-	SZZ	-	-	BVK	KTK	-	-	-	RTM	-	-	-	HAM	-
	SA 04.09	-	SSH	GRG	-	-	RTM	-	AAR	RTM	RTM	ZEE	-	SZZ	-	RTM	KRS	-	-	-	-	-	-	-	-	-	-
	SU 05.09	FXT	RTM	GRG	-	-	-	RTM	-	RTM	RTM	-	RIX	KLJ	GDY	RTM	-	-	ANR	-	-	HAM	LED/ fct	-	-	-	-
WEEK 36	MO 06.09	IMM	RTM/ FXT	-	ANR	HEL	OSL	RTM	ANR	-	-	GOT	GDY/ GDN	-	GDY/ GDN	-	RTM	-	RTM	-	LED/ plp	-	LED/ fct	HAM	-	LED/ plp	HAM
	TU 07.09	TEE	FXT	RTM	RTM	KTK	MSS	RTM	RTM	CPH/ AGH	-	-	-	-	KGD	AAR	RTM	ZEE	RTM	-	LED/ plp	-	-	HAM	-	LED/ plp	HAM
	WE 08.09	GRG	IMM	RTM	RTM	-	KRS	-	RTM	GOT	-	STO	-	RTM	GDN	LAR	-	RTM	-	-	-	LED/ fct	-	RTM	-	-	RTM
	TH 09.09	-	TEE/ GRG	FXT	-	-	-	CPH	-	-	HEL	GVX	RTM	RTM	GDY	FRK	OSL	RTM	HAM	-	HEL	-	RTM	RTM	-	-	RTM
	FR 10.09	HAM	GRG	SSH/ TEE	-	RTM	RTM	AGH	SZZ	ZEE	KTK	RAU	RTM	-	-	-	BVK	-	-	-	-	-	RTM	-	-	BRV	-

Source: (North Sea shipping lines, 2010)
(Feeder Link, 2010)
(Team Lines, 2010)
(Unifeeder, 2010)