Caofeidian Harbor Dispatch and Management Information System Design

- Group A -

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1. Executive Summary

Caofeidian (CFD) is located at the southern coast of Tangshan and the central area of Bohai Bay. Approved by the State Council of the People's Republic of China, modern logistics is one of the five major industries included in the CFD Industrial Zone Development Plan. Being part of the supply chain, harbor dispatch and management operation plays an essential role affecting the economy of CFD. Based on an initial interview with our client, the CFD Government, the need for the Harbour Dispatch and Management Information System (HDMIS) has been identified as a high priority aiming to improve the harbor traffic efficiency and safety.

The project started by conducting background research on CFD, logistic operations, port management and the related information system (IS). Within the scope of this project, our team investigated the current vessel traffic situation and operation flows through a residential trip to CFD and on-site interviews with stakeholders. Understanding the current challenges in CFD harbor dispatch operation, we found that the complicated information flow and manual operation process could be improved by the application of IS. Based on past academic researches, case studies on leading ports around the world and Business Process Reengineering (BPR) principles, we recommend the HDMIS should be a centralized platform to simplify the operation, improve information sharing and increase the controllability of the port operations. Facilitating the information flow between the upstream and downstream should benefit the overall efficiency of the supply chain. On the management level, the HDMIS could provide also statistic figures to evaluate operation performance and provide decision support for port development planning. Finally, an implementation action plan is presented as a guideline for CFD government to implement the system successfully.
2. Overview of the consulting project

2.1. Background of Caofeidian

Approved by the State Council of the People's Republic of China, the CFD Industrial Zone Development Plan includes the five major industries, namely modern logistics, steel, petrochemical, equipment manufacturing and high-tech industry. Additionally included are the power, desalination, construction materials and environmental protection related industries, as well as the information, finance, tourism and modern service industries in order to develop a circular economy system. The total investment will reach five trillion RMB by the end of 2030.¹

CFD harbor feature

The CFD port is a rare deep-water harbor site in China. It is the only deep-water harbor in the Bohai Sea and is closely located to the Bohai Sea groove, which is a -25 meters deep natural water channel. The -25m isobath is about 500 meters away from the shore. There is also a -30m depth region of about 6 km length and 5 km width, which allows the construction of large berths with expected capacities larger than 250,000 tons. Via the Bohai Strait the region is connected to the Yellow Sea. Between CFD and the hinterland, there is a large intertidal zone with 450 square kilometers of shallow riverbank connected to the land, which is a good natural condition for industrial development.²

¹ www.caofeidian.gov.cn
² Caofeidian Government, 2010 (presentation)
CFD Industrial Zone organizational chart

Our client of this project is the CFD government, represented by the Industrial Zone Administration Committee. Under the CFD government, the Port Command Center is responsible for the port development. Also, different port companies manage terminals in the CFD port. One of the port companies is solely owned by CFD government (Tangshan Caofeidian Port Co., Ltd.) and manages the general cargo terminal. The CFD organization is illustrated in the following organizational chart.

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3 Caofeidian Government, 2010 (presentation)
Current condition of the CFD port

In the CFD port construction plan, sixty 300,000 tons berths, fifty 100,000-150,000 tons berths and two hundred 50,000-80,000 tons berths are planned to be constructed. Terminal types include mineral, coal, crude oil, liquefied natural gas, liquid chemicals, general cargo and container terminals. Upon completion of these terminals, the annual port throughput is expected to reach more than 500 million tons. By July 2010, the mineral, crude oil, coal and general cargo terminals are operating under the management of different companies.\(^4\)

\[^4\] www.caofeidian.gov.cn
Harbor dispatch operation

Water transportation is one of the essential modes in modern logistics. Harbor dispatch operation is the core process in the port logistic operation directly affecting the port throughput. In order to achieve higher efficiency and safety level, harbor dispatch planning has to consider not only the logistic flow of goods, the terminal conditions, and weather, but also the source of goods, transportation capacity, loading and unloading speed, etc. To develop a holistic and practical harbor dispatch plan scientifically, operators have to keep up with the most recent multiple information sources and make decision according to the new developments in the industry. 

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5 Caofeidian Government, 2010 (presentation)
6 Yong, 2010
CFD Vision

CFD’s vision is to become a central port hub, connecting major inland cities with China’s neighboring countries, such as Korea. The port aims to position itself as follows.\(^7\)

- A collection and distribution centre for energy, minerals and bulk goods in China
- China's new industrialization base
- China's commercial energy reserve base
- A demonstration of circular economy in China

2.2. Problem Statement

In order to achieve its vision of becoming a major hub port in China, the CFD government aims to increase port operation efficiency, to lower operation costs and to ensure harbor safety. The first two goals can be interlinked by stating that for example fully utilized assets increase efficiency while operational costs are reduced. Likewise harbor safety is interlinked with the goal of reducing costs as safe vessel traffic within a port reduces operational costs due to fewer accidents and operation-related incidents.

The CFD port efficiency is measured by comparing the targeted port throughput with the actual throughput. In the first quarter of 2010, the CFD port throughput reached about 25 million tons, which is an increase of 80.7% compared to 2009.\(^8\) Despite this enormous growth rate, in the CFD port throughput forecast the total expected throughput for the year 2010 was estimated to reach 143 million tons.\(^9\) To meet this target, an average of 35.75 tons per quarter must be reached this year. According to the current situation, the port is under pressure to manage harbor traffic and to serve the need of the terminals. The delays of vessels and related inefficiencies have been identified as major

\(^7\) Caofeidian Government, 2010 (presentation)
\(^8\) www.caofeidian.gov.cn
\(^9\) Caofeidian Government, 2007
reason for not meeting the throughput target. Therefore, in order to achieve the expected throughput target, improving the harbor operation efficiency has become a high priority issue. In 2009, the port management officially stated that they had identified improved water channel management as major source of an increase in throughput capacity.\textsuperscript{10} As the port is planned to further significantly expand in the future, and therefore the operational activities are expected to increase and become more complex, vessel traffic management is essential to success. Additionally, harbor safety is a critical issue in every port and is likely to gain importance with an increasing size of the port.

2.3. Project Scope and Objectives

The project focuses on vessel traffic efficiency and includes the design of a HDMIS blueprint. Our project objectives are to provide CFD with recommendations that will reduce vessel delays within the port area, improve the information flow within the port management as well as with external stakeholders, and maximize harbor safety. By implementing specific system requirements, we aim to support the CFD port to exceed its annual throughput target.

2.4. Approach and Methodology

Following the project scope and objectives, we have been performing in-depth analysis of secondary data on the topic and of the needs of our client. Through the application of analytical tools, such as flowcharts, the Fishbone Diagram and “Business Process Re-Engineering (BPR)”, we identified key challenges in the current management performance and operational processes. In addition, the analysis of best global practices

\textsuperscript{10} \url{www.caofeidian.gov.cn}
has been valuable for making recommendations through benchmarking. Finally, the collection of primary data through a residential trip and surveys conducted in Caofeidian enabled us to formulate tailored recommendations for our client.
3. Research Outcome and Summary

3.1. Literature review

The following main findings from the literature review are highly relevant to this project and have been taken into consideration for the problem analysis and the final recommendations.

**Differentiation over cost leadership strategy**

The competition among ports in China is a competition on price. Ports aim to attract shippers by offering lower prices, which generally led to lower profitability and hindered port development so far.\(^{11}\) Research conducted on the strategy choice of port logistics enterprises also showed that price has become one of major threats to the development of regional port logistics in China. Instead of choosing a price leadership strategy, a non-price competing differentiation strategy can be seen as being more effective to bring positive development to the individual port company, the industry as well as to the regional economy.\(^{12}\)

**Regionalization of port brings higher capacity for the region**

Traditionally, ports in China only focused on self-development. A recent study has introduced a “regionalization” phase in port and port system development to address current port-related challenges such as congestion, growing costs, limited handling capacity and additional traffic burden generated by un-collaborated ports.\(^{13}\) Focusing only on their own local area, the ports inside the region lacked effective operation and caused repetitious construction and substantial waste.\(^{14}\) It can be assumed that ports located within the same region could increase higher overall competitiveness with better

\(^{11}\) Xu Jianhua, 2004
\(^{12}\) Feng Xue-jun & Yan Yi-xin, 2005
\(^{13}\) Notteboom, T. & J-P Rodrigue, 2005
\(^{14}\) Xu Jianhua, 2004
resource utilization through better collaboration.

**Systematization on logistic process enables integration on the supply chain**

Most of the ports in China only focus on the construction of their own hardware and software. The development of ports is thus relatively independent which results in the low efficiency of integrative utilization of ports’ resources. The systematization and effectiveness of logistics as a whole should be considered, which did not only can bring effective cooperation among ports and different logistics parties but might also bridge the logistics process between China and the international standard. For instance, the adoption of international standard on EDI (Electronic Data Interchange) can be an example to systematize the information flow between organizations.

**Information Technology (IT) enables information transparency and process optimization**

A report on supply chains in China suggests that the distribution and logistics sector in China is typically slow to adopt new technologies due to the complexity and daunting investment requirement of setting up an integrated IT platform. It recommends using IT as a differentiator to help making optimal decisions, linking the whole supply chain from the beginning to the end and increasing the product movement visibility.

**Existing challenges of modern logistics development in China**

A research study on “Informatization” development of the modern logistics industry suggests that IT is the core element to improve the competitive advantage of the modern logistics through increasing logistics efficiency, lowering error rate, reducing stock level, lowering the cost and extending the logistics function in the supply chain. However, it also states the several main challenges of modern logistics development in China.

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15 Xu, 2004
16 Bolton & Wei, 2003
Because the whole supply chain can cover multiple organizations and locations, standardization and the collaboration among multiple organizations and locations are essential to maintain the IS. But the lack of collaboration between organizations, difference in resource and technological level between developed and underdeveloped areas inhibited the “Informatization” development in China. To change the situation, the literature suggests that governments take over the role as facilitator of collaborations between parties in the supply chain, develop the standard for information exchange and encourage expertise in the logistics area. 17

Literature Review Summary

As a summary, the review of academic journals gave the inspiration for designing a HDMIS in order to help CFD to reach its port operation goals. Although vessel dispatch operation in the harbor is only one part of the supply chain, the information flow between upstream and downstream parties is crucial and needs to be highly efficient. Also, a differentiation strategy by providing value-adding service is recommended to keep the competitive advantage and long-term sustainability. For upstream and downstream parties in the supply chain, a HDMIS should share the information related to harbor dispatch operation to optimize the whole logistic process. Aligning with the trend of regionalization, an HDMIS should also share the same standard of information exchange as the neighbour ports in order to be ready for future integration. In additional to the technology part, governments should also encourage the cooperation between process stakeholder to apply IT on logistics process, unify data exchange standards and retain expertise for continuous development in future.

17 Zhong, Liao & Cui, 2007
3.2. Case Studies

The analysis of best global practices was developed keeping in mind similarities with CFD terminals and some international ports that are currently in a competitive ranked position. This analysis helped us to gain knowledge about the effect competitive systems have in their daily activities and their influence in gaining a sustainable position within the industry.

Firstly, there is a trend among competitive ports to improve existing information systems related to vessel traffic systems. Sydney Port, for instance, enhances its current Vessel Traffic Information System, provided by Sofrelog, a French provider, who develops high performance maritime applications including port traffic control, waterway management and control, coastal surveillance, range monitoring and combined sea and land border surveillance.\(^{18,19}\) Moreover, Sofrelog has presence in many major international port operators with more than 70 systems installed in more than 50 countries around the world. In addition, it is significant to mention that the current VTS service provider of the CFD Port Management is an Atlas Electronik system\(^{20}\), a German provider who additionally offers the development of a database to manage all relevant information regarding vessels and related harbor processes. Atlas Elektronik has recently merged with EADS Defence & Security (the major investor of Sofrelog)\(^ {21}\) in order to strengthen their position in the global maritime security market. Therefore, the importance of this case study is relevant for our recommendations to CFD based on the fact that this service provider is currently used by our client.

Secondly, the Port of Rotterdam is currently one of the top ranked ports around the

\(^{18}\) www.sofrelog.com
\(^{19}\) www.sydneyports.com.au
\(^{20}\) www.atlas-elektronik.com
\(^{21}\) www.sofrelog.com
world due to following activities taken that strengthen their competitive position. Additionally, the Port of Rotterdam and the Port of Amsterdam\textsuperscript{22} agreed to merge their respective logistics information systems into a single and common web-system called Portbase\textsuperscript{23}, where all stakeholders can exchange information easily and efficiently even though each different stakeholder has its own service system with customized services. According to port authorities, through the merge of information systems, both ports achieve better service provision, more rapid throughput times, fewer mistakes and overall lower costs. This strategy is playing a key role in port logistics networks as the exchange of data between port authorities and agencies such as customs is simplified.\textsuperscript{24} However, the limitation of this case study is the lack of information due to the fact that statistics and relevant quantitative data are not available, as the system has just been recently been implemented. Therefore, the importance of this case study is undertaking notice about the trend in international ports within a region to merge logistics systems helping streamline operations and cost saving for the parties involved. In addition, the analysis of the tugboat and pilotage service in the Port of Rotterdam helped us as a benchmark due to its efficiency and transparent rules to gain access to the service.\textsuperscript{25}

Thirdly, Dalian Port was ranked 8\textsuperscript{th} in total cargo volume throughput in China\textsuperscript{26}. In August 2008, Dalian Port started to launch their MIS named Dalian VTS Vessel Management Information System\textsuperscript{27}. Although the detailed system specification are not available to the public, we have studied the IS based on the system manual from the

\textsuperscript{22} www.portofrotterdam.com
\textsuperscript{23} www.portbase.com
\textsuperscript{24} www.porttechnology.org
\textsuperscript{25} www.portofrotterdam.com
\textsuperscript{26} http://aapa.files.cms-plus.com (American Association of Port Authorities)
\textsuperscript{27} www.moc.gov.cn (Maritime Safety Administration of China)
Marine Bureau\textsuperscript{28} and shipping companies/agencies\textsuperscript{29}. The system operates as a centralized platform serving multiple parties participating in the port operation. By using the registered login account, different parties could access a particular set of online service through the web-based system. While the benefit of the IS had not been evaluated scientifically, the approach of Dalian Port still can become a reference for CFD to develop the IS for port operation improvement.

Fourthly, current incidents, such as the oil spill close to Dalian Port, demonstrate that the development and implementation of a risk management policy and contingency plan to secure important components of the port facility supports port management to mitigate risk, i.e. potential damage of the port infrastructure is critical to harbor safety. Leading ports use tools for environmental management, such as monitoring and analyzing potential impact of chemical, oil or gas spills, which helps to add more capabilities to the contingency plan. For instance, at Dalian Port one of China’s largest oil terminals was recently affected by an oil spill, which caused not only severe traffic problems and the shutdown of operations of the main oil facilities, but also caused an economical impact to third parties. As a consequence, Dalian Port shares fell 5 percent in the stock market.\textsuperscript{30} \textsuperscript{31} Therefore, the importance of creating and implementing a risk management policy based on updated information gathered from information systems support port management to protect port infrastructure and to manage potential hazards due to unexpected events. Finally, the Port of Hong Kong, Shanghai Port and the Hualien Port are best practice examples for how real-time data can be used in port operations to improve vessel traffic

\textsuperscript{28} http://218.56.38.183:8080/vts/download.jsp?file=shuoming.pdf (Maritime Safety Administration of China)
\textsuperscript{29} http://218.56.38.183:8080/vts/download.jsp?file=agent.pdf (Maritime Safety Administration of China)
\textsuperscript{30} www.businessweek.com
\textsuperscript{31} www.news.yahoo.com
flow.

After all, the case studies help to understand how ports around the world achieved a leading position. This knowledge is highly valuable to formulate recommendations for CFD port as ideas and approaches could be adopted by CFD.

3.3. On-site Interviews

3.3.1. Interview outlines

We held five on-site interviews with three relevant stakeholders of this project: the Industrial Zone Administration Committee representing the CFD Government, the VTS Command Center (VTS CC) under the Marine Bureau and the Tangshan Caofeidian Port Co. Ltd. running the general cargo terminal in CFD. By interacting with actual operators in CFD Port, the scope of this project has become more focused. We also had understood more on the operation difficulties and complicated relationships between stakeholders. Therefore, issues regarding current operation will be addressed, upon which system requirements then can be further generated in the following parts of this report.

3.3.2. Interview objectives

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<td>Administration &amp; Management</td>
<td>• Identify all the users and related stakeholders of the HDMIS</td>
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<tr>
<td>Management Committee</td>
<td>• Understand the expectation on the HDMIS from the system owners’ point of view including the functionalities.</td>
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<tr>
<td>VTS Command Center</td>
<td>• Determine the format and means of information exchange between the HDMIS and its vital external stakeholder.</td>
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<td>• Understand working procedures in order to identify inefficiencies and discover means of connection between ongoing HDMIS and</td>
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3.3.3. Interview outcome

Missing element in port management

The characteristics of the CFD Port (comprehensive construction and multi-organizational involvement) have determined its bottom-up development style. At this stage, our client the CFD government, does not have control over all entities and parties that are involved in the port operation.

Based on our interview with the representative of the Industrial Zone Administration Committee, it became clear that the CFD government had already identified that a HDMIS might improve port operations by centralizing information flows, shown in Figure 4.

![Figure 4: The missing element in port management](image)
Tracing interconnection between entities

A complete harbor dispatch operation process for incoming vessels is illustrated in Figure 5.

![Diagram of harbor dispatch operation process]

**Figure 5: Harbor Dispatch Operation Process for incoming vessels**

The harbor dispatch operation starts when a shipping company sends the vessel to the terminal according to the accomplishment of documentation and arranged timetable.
When a vessel crosses the reporting line, VTS system will automatically capture the vessel information given by AIS (Automatic Identification System). Inside the CFD port area, the VTS CC can give further guidance and communicate with vessels through VHF. The VTS CC is responsible for giving commands to vessels and managing their movement in the water channel. If there were any unexpected event such as poor visibility, strong wind or any accident, the VTS CC would take immediate action to maintain harbor safety. For example, vessels have to stop moving if the visibility is low or the wind is too strong. Instead of entering the water channel immediately, normally most vessels have to stay in anchorage waiting for instructions. Pilotage and tugboat services are compulsory for foreign vessels or any vessels new to CFD. The shipping company has to request the pilot and tugboat from those service providers beforehand and the VTS CC would be informed by the pilot and tugboat companies once they are ready to set off. On the other hand, dispatch operators in the terminals develop the terminal dispatch plan according to contracts and communication with shipping companies/vessels and then submit the dispatch plans to the VTS CC every four hours. The VTC CC thus makes the integrated dispatch schedule and broadcast to all relevant parties every four hours. Once a vessel has reached a berth, the corresponding terminal would notify the inspection parties such as customs, frontier inspection and commercial inspection etc. to start their operation. Loading or unloading activities will start only after the approval of these inspection parties. Lastly, consignees would arrange trucks to transport cargos placed in storage yard to their own warehouses.

**Identifying the business activities of entities and formats of existing information flow**

**Business activities of existing entities:**
- Shipping companies submit vessel information and documentations before vessels enter the berth.

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- VTS Command Center manages traffic flow by integrating harbor dispatch schedule every four hours, monitors traffic and guaranty security by employing AIS (Automatic Identification System), VHF technology (very high frequency), CCTV (Closed-circuit Television) and radar, provides information service such as weather forecast and danger reminder, and is able to response to disasters such as oil spill.

- Terminals are responsible for assembling and distributing cargo. During the process of fulfilling its targets, terminal companies are one vital nodes crossed by several information streams. They connect each with other entities to pass essential information forward and cluster diffused elements in the whole system.

- Inspection parties include Custom, frontier inspection and commercial inspection, etc. They are informed by the terminal companies once vessels reach the berth before any unloading activities initiates.

Six information streams:

- Between Vessel and VTS CC: Information flows between these two entities mainly focus on real-time communication. Any information is captured by the VTS system. Communication, at this stage, is the only paperless one throughout the entire document exchanging system.

- Between vessel/shipping company and pilotage and tugboat company: while staying in anchorage, vessels should apply for pilotage or tugboat service by email, telephone or fax, when they need to do so. The unified plan then will be forwarded back by paper work or email.

- Between vessel/shipping company and terminals: before crossing the water channel, shipping companies are required to transfer vessel information and expected arrived time, using email or fax, to terminal companies as well as fulfill other provision addressed by the contract.
• Between terminal and VTS CC: one essential element of traffic management is developing the integrated vessel movement schedule. It relies on the dispatch plans forwarded by terminal companies every four hours. The major methods of transmitting plans are fax and email. In the meanwhile, vessel information also needs to be passed by fax for operators in the VTS CC to compare with the information that has been captured by the AIS (Automated Identification System) and stored in database. At last, vessel movement schedule is available to be faxed back to terminals as well as announced in the Internet every four hours after combining useful information.

• Between terminals and pilotage and tugboat company: there is no formatted document transferred in this stage. The duplex telephone communication is only for notification purposes.

• Between terminals and inspection parties: this one-way connection by calling or emailing from terminal companies to inspection parties allows certain inspection executing departments to be informed on a timely basis; at the same time ensures it will not bring significant deferrals to unloading activities.
3.3.4. Interview limitations

The main limitations to the findings of the on-site visit and our interviews are the following:

- Time constraints
- Limited on-site visits
- Incomplete information gathering, missing interview of pilotage and tugboat company and inspection parties.

3.3.5. Interview Summary

After all, the CFD port highly desires a platform that can facilitate quick
communication on any delays in vessel movement schedule and real time information sharing in particular to make pilot and tug boat information more transparent. The two main parties involving in harbor dispatch operation follow different objectives. The VTS Command Center focuses on traffic safety, while terminals focus on traffic efficiency. However, both parties seem are willing to cooperate and seek better solutions to overcome existing challenges. Based on our understanding through interviews, the direction of HDMIS design should focus on developing a better way for the communication and collaboration of stakeholders.
4. Problem Analysis

4.1. Current Challenges

Based on our conducted research, the following root causes of low traffic flow efficiency have been identified, namely information flow, arriving/departing vessels, the pilotage and tugboat services, and the water channel. Unknown events have furthermore been identified as a potential risk. These areas, as well as their sub-areas are illustrated in the figure below. It is pointed out that the identified areas have a strong influence on traffic flow efficiency. They are consequently the leverage points to improving the vessel traffic flow. As the potential risk of unknown events does not pose a major threat to port security and safety at this stage, but might have to be taken into consideration in the future, this area is indicated in grey.

![Fishbone Diagram](image)

Figure 7: Problem Analysis by Fishbone Diagram

Information Flow

The exchange and sharing of information within an organization and with its external
stakeholders is a crucial element of efficient operations.\textsuperscript{32} During our on-site visit in Caofeidian, we identified several issues that currently lead to a slowed down information flow. Firstly, communication between stakeholders is mainly done via email, phone, fax or face-to-face encounters, which leads to delays in information being received/distributed. Secondly, data is partially collected and entered manually into existing information systems, which again slows down the information flow. Thirdly, as information is received and distributed by all port stakeholder parties with delay, no real-time data is available.

**Arriving/departing vessels**

Regarding vessel arrival and departure, currently the VTS Command Center integrates all dispatch plans from terminals and designs the overall harbor dispatch plan while following predefined rules. Consequently, any wrong information from terminals or misalignments between the schedule and the actual condition are expected to result in traffic problems when executing the dispatch plan. When terminals compose their dispatch plan, they lack the updated schedule of other terminals, as well as current information about port conditions. So, the dispatch plan arranged by individual terminals is likely to not match with operations at other terminals and the real situation. Therefore, the VTS Command Center takes over the task of composing overall dispatch plan based on the realistic situation. Moreover, as terminals wish to have their vessel assigned with higher priority to move, they tend to state the schedule earlier and expect the delay time can be shortened. But the inconsistency between information received in planning stage and the actual condition may lead to traffic problems and cause conflicts between terminals. Additionally, any accidents, poor weather condition and inspection activities may play a role in traffic delays, as those uncertainties might not be predicted accurately.

\textsuperscript{32} Laudon & Laudon, 2009
Here, challenges concerning the arrival and departure of vessels therefore are partly caused by inefficiencies in information flows, which interlinks this challenge with the one discussed before. 

**Pilot and tugboat services**

The timely traffic flow within the Caofeidian Port is highly dependent on the availability and scheduling of piloting and tugboat services. These activities are in control of an independent company. Based on our data collection on-site, this area has been identified as current challenge to the port management as information exchange between organizations is not fully established, causing vessel delays and operational inefficiencies (e.g. terminals wait for a vessel that might stay in the anchorage area for another day). Here, the information flow between stakeholders of the port appears to be a central element to the challenge once again.

**Water channel**

At the moment, the Caofeidian port is still a one-way channel port, where vessels can only either enter or exit at a certain time. The vessel traffic movement follows the rule that a vessel berths deep inside the channel would have a higher priority to enter but the lower priority to leave; a vessel berths near the entrance would have the lower priority to enter but higher priority to leave. As each vessel on average takes 1 hour to enter or exit the water channel, other vessels have to wait when there is any vessel moving inside the channel. Although the traffic rule and geographical constraint cannot be solved by the HDMIS, we suggest deciding the dispatch plan scientifically based on accurate information can still improve the traffic efficiency in the water channel.
Unknown events

Unknown events such as natural disasters, accidents, illegal activities and terroristic attacks are highly likely to affect port security and safety, which in return causes delays in traffic flow and damage port infrastructure. Currently, these events are not a major issue at Caofeidian port. However, the port is experiencing significant growth and is planned to become a major hub port in China. Such kind of uncertainties would become high threats affecting the harbor’s normal operation.

After all, this first problem analysis has shown that communications and information flow seems to be a key challenge to Caofeidian port stakeholders that affects various operational areas and leads to slowed vessel traffic. Therefore, a further analysis of the current information flows within the port will support the formulation of tailored recommendations.
4.2. AS-IS Information flow in the Harbor Dispatch Operation

Based on the interview findings, a simplified communication (AS-IS) model (Figure 9) has been developed.

![Figure 9: AS-IS Information Flow in Harbor Dispatch Operation](image)

The network of information streams produces vast of redundancies, which is the primary explanation of inefficiency. In the meantime, these traditional communication methods, including fax and telephone, introduce possible inaccuracy of data collected. Although email is in a digital format, it relies on human typing and checking mailbox regularly, thus timely and inaccuracy, as well as difficulty of documentation, are the major consequences. Also, the website for releasing vessel movement schedules is not well accepted and other stakeholders rarely accessed.

4.3. Applying Business Process Reengineering Principles

Considering the principles and tactics for business process reengineering (BPR), the information flow should be able to simplify and thus achieve higher communication efficiency, richer information content, lower human error rate and more quantitative measurement on operation. In the harbor dispatch operation, principle # 1, 2, 3, 4, 5, 6
and 8 can be applied to improve the existing situation (highlighted in red). In this section, only the principle concept is discussed. The actual redesign of the IS is included in the recommendations.

10 Principles & Tactics of BPR

<table>
<thead>
<tr>
<th>Basic</th>
<th>Principle #0 - Streamline</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Remove waste, simplify, and consolidate similar activities.</td>
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<table>
<thead>
<tr>
<th>Restructure It</th>
<th>Principle #1 - Lose Wait</th>
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<tbody>
<tr>
<td></td>
<td>Squeeze out waiting time in process links to create value.</td>
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</table>

<table>
<thead>
<tr>
<th>Restructure It</th>
<th>Principle #2 - Orchestrate</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Let the swiftest and most able enterprise execute.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Restructure It</th>
<th>Principle #3 - Mass-Customize</th>
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<tbody>
<tr>
<td></td>
<td>Flex the process for any time, any place, any way.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Restructure It</th>
<th>Principle #4 – Synchronize</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Synchronize the physical and virtual parts of the process.</td>
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</table>

<table>
<thead>
<tr>
<th>Informate It</th>
<th>Principle #5 - Digitize &amp; Propagate</th>
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<tbody>
<tr>
<td></td>
<td>Capture information digitally at the source and propagate it throughout the process.</td>
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<table>
<thead>
<tr>
<th>Informate It</th>
<th>Principle #6 – Vitrify</th>
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<tbody>
<tr>
<td></td>
<td>Provide glass-like visibility through fresher and richer information about process status.</td>
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<table>
<thead>
<tr>
<th>Informate It</th>
<th>Principle #7 – Sensitize</th>
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<tbody>
<tr>
<td></td>
<td>Fit the process with vigilant sensors and feedback loops that can prompt action.</td>
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</table>

<table>
<thead>
<tr>
<th>Mind It</th>
<th>Principle #8 - Analyze &amp; Synthesize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Augment the interactive analysis and synthesis capabilities around a process to generate value added.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Mind It</th>
<th>Principle #9 - Connect, Collect &amp; Create</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grow intelligently reusable knowledge around the process through all who touch it.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Mind It</th>
<th>Principle #10 – Personalize</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Make the process intimate with the preferences and habits of participants.</td>
</tr>
</tbody>
</table>

33 Sawy, 2001
**Principle #1 – Lose wait**

Based on the existing information flow, dispatch plan updates cannot be conducted too frequently because any adjustment would affect the whole dispatch schedule and then the VTS CC has to inform all the related parties in case of any update. The information flow is thus in a stop-start batch way. The principle#1 suggested designing continuous process flow to replace stop-start batches. The downstream bottleneck is expected to be relieved.

**Principle #2 – Orchestrate**

The harbor dispatch operation involves multiple parties as explained before. Information may be partly overlapping and the coordination of multiple parties is complex. By using information technology, the orchestration of all the organizations can be quickly and easily coordinated. If each party can use a single portal to provide or receive information, the operation would become simpler and less prone to communication inconsistent and error.

**Principle #3 – Mass Customization**

Different to services relying on manual process like the case in CFD, online service can be considered to provide customized “24/7” service to users with different needs. Thus, users can access the information anytime without limited to the specific business hour and human resource at their convenience.

**Principle #4 – Synchronize**

By using IT, a common platform synchronizing the physical process and virtual process can be developed. With the support of the VTS system, real-time vessel tracking is actually possible and increases the controllability of current vessel movements.

**Principle #5 – Digitize and Propagate**

In the existing harbor dispatch operation, we can see the information flow formats include telephone, fax and file sharing by email and websites. Principle#5 suggests that information is captured at the source and then distributed by using IT. In the CFD case,
information could be captured in digital format from the shipping company at the beginning of the process. As long as the information is stored in the database, the data can be updated and shared among users in an effective, efficient and accurate way.

**Principle #6 – Vitrify**

Up to date and richer information sharing about the process status can help involved parties to optimize their own operation based on the status of the partners. The harbor condition is always changing. With the support of IT, the information visibility can probably be improved so that different stakeholders can retrieve the useful information for their operation need. Standardized partner interfaces can also be designed to enable a seamless exchange of information.

**Principle #8 – Analyze and Synthesize**

This principle suggests that knowledge management could be used to create additional value. This means, data analysis based on information from the database and external sources can derive valuable information that provides decision support for operation processes and also to managerial planning.
5. Recommendations

In order to formulate recommendations, we applied the principles and tactics of BPR (Business Process Reengineering). Based on the BPR application we make several recommendations, that consider three main levels, namely the strategic, management and operational level. First, on the strategic level the HDMIS should align with the future port development trend, which includes the ability to integrate with external parties on the supply chain and the ports nearby to form a regional ports service group. Second on the management level, the HDMIS should be able to serve as an Executive Support System (ESS), providing indicators of the operation problems, performance and scientific decision support to CFD government to plan for future port development. Third, on the operational level, the HDMIS should serve as a centralized communication platform to improve the efficiency of the harbor dispatch operation, and increase the monitor and control level of the harbor traffic. System integration would be the main challenge for the HDMIS development. However, only a high level review and recommendation would be provided by this report. The actual system integration should be further studied because it involves detailed investigation on the existing system used by multiple parties.

5.1. TO-BE Information flow in the Harbor Dispatch Operation

To achieve the business requirements, the HDMIS should be the centralized platform to enable the communication between multiple parties to achieve richer information sharing and higher efficiency in information flow. In the TO-BE model, each party should be able to provide the data and receive the information through a single customized portal depending on their own role. The overview of the TO-BE model is illustrated below.
5.2. User and Permission Control

User accounts can be setup and assigned into user groups by the HDMIS owner. User accounts and user groups are used to control the access right of users on certain system functions. On the other hand, the system design should include permission control functions to manage the access rights of users to system modules.

5.3. Architecture

The system architecture can be separated into three layers: the interface layer, application layer and the data storage layer. The interface layer includes the graphical user interface that allows the users to interact with the system and the system interface that allows system interaction. The application layer contains the system logical processes, which retrieve data from the interface and multiple data storage sources, process according to the regular practice and procedure, then return the result to the interface layer and store through the storage layer if necessary. The storage layer stores data in database and file format.
5.4. System functionalities on business perspective

The HDMIS functionalities described in this section mainly focus on solving the daily business problems in the CFD port. In addition to the function description, the user of the function would also be stated in this section to indicate the interaction between different parties through different system functions. “User” refers to the party who submits the request through the system. “Administrator” refers to the party who receives and manages all the requests from users.

A. Berth requests and scheduling

<table>
<thead>
<tr>
<th>User: Shipping company/Shipping agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>The shipping company sends a request for a berth in a particular terminal through the HDMIS. To make a berth request, the shipping company usually has the preferred berth, expected arrival time and berthing duration. After logging in the HDMIS, the shipping company can search the future available berth based on the berth schedule stored in the database. The HDMIS should only provide the available berths and timeslots for the user to select based on the dispatch plan maintained by each terminal and the estimated availability of travelling channel in the port. All the requests submitted by the users would be received and managed by the terminals (described in “Terminal Dispatch Plan Management” function). The shipping company finally should receive confirmation of the request from the terminal.</td>
</tr>
<tr>
<td>Benefit:</td>
</tr>
<tr>
<td>The back and forth communication on booking the berth and the manual checking work on berth availability can be replaced by the automated system. Human error due to communication and manual process is expected to be reduced.</td>
</tr>
</tbody>
</table>
### B. Pilotage and tugboat service requests and scheduling

<table>
<thead>
<tr>
<th>User: Shipping company/Shipping agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Having the berth booked, some of the vessels (especially foreign vessels) may need the pilotage and tugboat service because they need guidance to travel in the CFD port area. The HDMIS should provide an optional function for shipping companies to request the pilotage and tugboat service in additional to booking the berth after the shipping company had appointed the berth.</td>
</tr>
<tr>
<td>Benefit:</td>
</tr>
<tr>
<td>It would be more convenient to the shipping companies as the HDMIS can provide a one-stop service for them to request the berth and all the required service in the port. The pilotage and tugboat service request can also be passed to the service providers so that they can prepare the resource in advance.</td>
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### C. Terminal Dispatch Plan Management

<table>
<thead>
<tr>
<th>User: Terminals</th>
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<tbody>
<tr>
<td>Description:</td>
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<tr>
<td>Each terminal can maintain their dispatch schedule through the HDMIS after receiving the request from shipping companies (described in “Berth requests” function). In general, the request by the shipping companies should have been validated because the shipping company user can only select the available timeslot of the berth. However, the terminal may still need to reschedule the dispatch plan due to special condition. So, HDMIS should provide functionality for terminal users to arrange and manage the dispatch plan manual in order to maintain flexibility. Constraints and error checking should be added to the system design in order to</td>
</tr>
</tbody>
</table>
minimize the human input error, which may result in the dramatic reschedule of the dispatch plan affecting many parties. E.g. There should be a minimum berthing time, as the loading/unloading operation is time consuming. The vessel also takes time to arrive or leave the berth, which mean certain time interval should be reserved between the consecutive appointments of the same berth. But the dispatch plan arrangement constraint may be different between berths due to the difference on the operation and goods natures. Those constraints should be developed based on the statistic figures measured by the system (described in “Statistic measurement” function). Finally, if the berth request is not to be changed, the terminal can confirm the request with the shipping company. If the request has to be changed, then the terminal would need to communicate with the shipping company to compromise the change.

Benefit:
As the dispatch plan arrangements of all the terminals are done through the HDMIS under the predefined constraints, the dispatch plan prepared by each terminal should become more up to date, reliable and standardized. The berth request information filled in by the shipping company is stored in a digital format. Thus, paper works, typing jobs and manual spreadsheet processing can be reduced. In the current situation, terminals arrange the own dispatch plan and send to VTS Command Center in spreadsheet file format. Because the process is mainly relying on the personal experience and preference of the terminal staff, the planning process may not be scientific and up to date. The rework on the dispatch plan may affect all the terminals and vessels, which does not only bring inconvenience but also dispute between different parties. So, by developing a more accurate dispatch plan scientifically, the additional problem fixing work should be reduced.
### D. Overall Dispatch Plan Management

<table>
<thead>
<tr>
<th>User: VTS Command Center</th>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
</tr>
<tr>
<td>Although each terminal can maintain their own dispatch plan according to the requests from shipping companies, the VTS Command Center still holds the final control to resolve any conflict and adjust the overall dispatch plan. Because the port has the natural constraint that several vessels cannot travel in the one-way channel, the VTS Command Center may need to amend the dispatch plan and notify relevant parties through the HDMIS. In addition, when the dispatch plan is executed, the VTS Command Center probably needs to make adjustments on the schedule according to the actual port situation. E.g. if the harbor visibility is too low, all the vessels have to stop moving. Then, all the vessels are delayed accordingly. Another example is that if a vessel does not enter the CFD port according to the dispatch plan, the VTS Command Center has to decide and rearrange the priority of the vessel traffic. So, the HDMIS should provide functions for VTS Command Center to update the overall dispatch plan on rescheduling the vessels and determine the ETA/ETD. The latest overall dispatch schedule can then be with other parties (<em>described in Real-time Vessel Schedule Broadcast function</em>).</td>
</tr>
<tr>
<td><strong>Benefit:</strong></td>
</tr>
<tr>
<td>Basically, human error, paper work and process time are likely to be reduced. With higher information flow efficiency, the overall dispatch plan update can also be done more frequently. In the current situation, the overall dispatch plan would be announced once every 4 hours, which is not satisfactory according to our interview with terminal operators. If the terminals can receive the latest vessel information, they can reduce the phone call enquiry to the VTS Command Center and also arrange the</td>
</tr>
</tbody>
</table>
resource more efficiently.

E. Real-time Dispatch Plan Broadcast

| User: Terminals, Shipping companies, Inspection parties and others |
| Description: |
| After vessels have entered CFD waters, the VTS Command Center is the only party who can control the harbor traffic and maintain the most updated status. Any change in traffic arrangements or unexpected incidents would affect the operation downstream in the supply chain (terminal). Other parties such as shipping companies and inspection parties would also need to know the real time status of a specific vessel, which may negatively affect their business process. The overall dispatch plan maintained by the VTS Command Center in HDMIS (described in “Overall Dispatch Plan Management function”) can be shared with other parties through the network. However, further study on what kind of information should be shared should be conducted, as other operation parties may only need a subset of information maintained by the VTS Command Center. Additionally, sharing the information in the VTS system containing graphic and real time data would require high network bandwidth, so at the current stage, it is recommended to provide a searching function for users to address the vessel status and list the information in text format. |
| Benefit: |
| Currently, the VTS Command Center updates the dispatch plan and shares it via email and their website every 4 hours. If there is any ad-hoc request or incident within the intervals, the terminal has to communicate with the VTS CC via phone. Although instant communication like phone call can enable quick communication between two |

34 www.cfdmsa.gov.cn
parties, such kind of one-on-one communication would demand high resources from both parties especially when the harbor traffic becomes busier in future. By streamlining the harbor dispatch planning process from a stop-batch process mode to a continuous process mode, the real time dispatch plan sharing then becomes possible. A higher level of information transparency can then be achieved, which is expected to benefit the whole supply chain. It also can bring CFD harbor service level closer to other ports in the world. For example, in Hong Kong, the vessel schedule would be updated automatically on the website every 30 minutes\textsuperscript{35}. In Hualien harbor, the real time information of vessels is also available online\textsuperscript{36}. In Shanghai port, online service is provided for tracking the vessels’ status\textsuperscript{37}.

F. Pilotage and tugboat management

<table>
<thead>
<tr>
<th>User: Pilotage and tugboat service provider</th>
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<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Regarding vessels’ requests for pilotage and tugboat services (described in “Pilotage and tugboat service request and scheduling function”), the HDMIS should also provide the administration function for pilotage and tugboat service provider to manage the service request and responses to clients. First, the service provider can register pilots and tugboats in the system. Then, after they have received the client request, they can then assign particular pilots and tugboats to that request, so that the clients can confirm with the service status.</td>
</tr>
<tr>
<td>Benefit:</td>
</tr>
</tbody>
</table>

\textsuperscript{35} www.mardep.gov.hk
\textsuperscript{36} http://210.69.161.216/9000/ (Hualien Port Berths Status)
\textsuperscript{37} www.shmsa.gov.cn
In fact, this is an optional function as this is not the critical process causing the traffic delay according to our interview results. However, if pilots and tugboats are registered through the HDMIS, it would be easier to keep track of the service capacity and the updated status of pilots and tugboats. Shipping companies or agencies may also find it more convenient to submit the request as the website can provide a one-stop shop service to complete all necessary requests and information.

G. Statistic Measurement

<table>
<thead>
<tr>
<th>User: Port Management, CFD Government</th>
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<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>As long as data is stored in the HDMIS database, measurements of efficiency, cost and error become possible by retrieving and analyzing the operation data. For example, the difference in expected arrival and actual arrival time could be analyzed to evaluate the dispatch planning accuracy. The historical figure can be used to provide decision support scientifically and to refine the harbor dispatch planning process (<em>described in “Terminal Dispatch Plan Management function”</em>). The data warehouse function should also be included in the HDMIS so that on the management level data can be analyzed to support the future strategic planning.</td>
</tr>
<tr>
<td>Benefit:</td>
</tr>
<tr>
<td>The quantitative statistic can provide an objective measurement on the port operation efficiency, cost and return. Data can be analyzed in different dimensions and is expected to strongly support decision-making processes. On the operation level, the dispatch plan scheduling can be refined based on the historical figures such as the difference between estimated and actual time, the vessel travelling time and minimum berthing time, etc. On the management level, the operation bottleneck and resource</td>
</tr>
</tbody>
</table>
allocation problem may also be addressed through data analysis. The result of the data analysis can give the direction for the future port development.

5.5. Other non-functional requirements

Additionally to the functions focusing on the business problem, the system design also includes the following non-functional requirements:

Providing system interfaces to other IS

Besides the user-interface, it is desirable to have system interfaces to communicate with third party ISs such as the VTS system and the terminal’s MIS. Due to the different units in the port, parties may have their own IS supporting their unique business needs. Hence, it is recommended that the input and output data of the HDMIS should be seamlessly integrated with other ISs. Also, the designed HDMIS should take into consideration existing technological structures to benefit from those rather than starting from scratch. Additionally, in the long-term consideration, API (Application Programming Interface) can be provided for other IS to integrate with HDMIS.

Expandability

As more terminals and berths in the CFD port are planned to be built (or are currently built), the port’s throughput is expected to increase in the future. In order to meet future demand, the HDMIS should be scalable to meet the increasing workload in the future. By following the SOA (Service Oriented Architecture), the system development can break down the system functions into services in order to achieve higher reusability. In terms of system capacity, Load-Balancing Cluster can be setup to maintain the scalability of the system capacity. Thus, additional servers can be added into the cluster to cope with the increasing system demand in future.

Supported by network connection

38 Hashimi, 2003
Network support is an essential component in connecting third party IS to the HDMIS. The data exchange between HDMIS and other IS can be done through SOAP (Simple Object Access Protocol) or EDI (Electronic Data Interchange). In the case of CFD, they now have wired network in the harbor. If the wireless network has been setup covering the whole harbor, then the HDMIS can even supply access to the mobile users through mobile devices.

**Access control and tracking users**

In order to keep the system simple for the user and prevent any unauthorized user accessing the system, specific functions should be granted to particular parties for access restrictions. Moreover, the user activities should be tracked so that if there is any system error or dispute the system log can provide data for further investigation.

**Data integrity**

The data in the system should be stored, transferred and accessed consistently and accurately. Thus, accurate database design should be followed to maintain the key constraints and referential integrity.

**System security**

The system should be protected physically from theft, natural disasters and digital attack. Sensitive information should also been encrypted to prevent unauthorized third parties to access the information. PKI (Public Key Infrastructure) can be applied to encrypt the information package to be transmitted through network.

**System reliability**

The system should be reliable, as any down time would result in a traffic halt in the port, as all parties have to rely on the HDMIS. Backup and recovery mechanism must be set up to undertake any contingency.

**User-friendly design**

The graphical user interface of the HDMIS should be designed to guide the user to
complete the task by common sense.

**Multiple language support**

Users may be foreigners who do not understand Chinese. As CFD is near Korea and Japan, the system should be designed with multi-language support including English, Korean and Japanese. Even though providing Chinese interface can cater the current need, the capability of adding new language support should be considered in the system design.

### 5.6. Additional Suggestions

#### 5.6.1. Enhancement of the existing VTS system

According to our client, improving harbor safety is one of the goals for the HDMIS. Although the VTS Command Center monitors the port situation through the VTS system, a higher the monitoring level could lower the chance of any unexpected event. Currently, the VTS system includes the Automatic Identification System (AIS) to receive vessel information automatically, CCTV is used to monitor the harbor condition and the weather sensors detect the wind speed, temperature, visibility, etc. However, there are some constraints regarding the current VTS system. One of them is the limited number of locations of sensors, which may not cover the whole port area. Another constraint is the limited video resolution of the CCTV affecting the visibility and accuracy in detecting any activity related to the port. Based on this current status, additional patrol is needed to keep track of the condition in CFD port. Therefore, in order to achieve a higher safety level, we suggest the following enhancement on the existing VTS system managed by the VTS Command Center:

**Implementation of an oil spill detection system**

Oil spill detection is important because it can cause serious pollution problems and may lead to further subsequence affecting human beings and the environment. Immediate
detection or even prevention of such incidents is expected to avoid high costs related to such incidents. Therefore, while such incidents should be prevented in the first place, we suggest the installation of oil spill detection sensors\(^{39}\) in specific areas in case of oil spill accidents.

**Install infrared camera system**

Besides using CCTV, an infrared camera system can also be an option to monitor the port condition. There are several advantages of using an infrared camera over CCTV. For instance, infrared sensors can work not only during daytime but also during nighttime. Although foggy conditions would affect the visibility of both cameras, the visibility of infrared cameras is still better than with a CCTV camera. With the aid of an infrared camera system, the CFD Port would have an additional dimension to monitor the harbor and detect any abnormal condition. Important to mention is also that illegal activities in the area could be detected more easily\(^{40}\).

**Install water temperature sensors**

Located in northeast China, the CFD Port is prone to be frozen during winter. In 2009, the Bohai area suffered the most serious snow disaster of the last 30 years\(^{41}\). Although the water channel in CFD port is less likely to be heavily frozen, the area around the terminals may still be affected by the cold weather. Thus, the weather and climate data is also an essential input data for the VTS system in order to closely monitor the situation and take any action in case of incidents that can affect the port’s activities.

As the VTS system aims to maintain the port safety, we suggest enhancing the system with additional features. However, some of the hazard alerts may also be useful for shipping companies and terminals, which is why this information could also be shared

\(^{39}\) www.interoceansystems.com

\(^{40}\) www.prosecurityzone.com

\(^{41}\) www.caofeidian.gov.cn

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through the HDMIS

5.6.2. Organization adaption (Leavitt Diamond)

Based on the Leavitt Diamond diagram (Figure 11), which is an intuitive conceptual framework that indicates that any change in each of the four business elements (business processes, technology, organization structure and people) would have an impact on all the other elements\(^\text{42}\). Therefore, as we have already recommended the change in technology and business process, the adjustment in the “Organization structure” and “People” would be suggested in this section:

![Leavitt Diamond diagram](image)

**Figure 11: Leavitt Diamond (Harold J. Leavitt)**

**Organization structure**

Since the HDMIS is a suggested centralized communication platform in the harbor dispatch operation, the owner of the HDMIS should also be established as a central role. Currently, the harbor dispatch operations include two main parties; the terminals and the

\(^{42}\) Sawy, 2001
VTS Command Center. Due to the fact that the terminals are owned by different companies having their own interests and needs, the HDMIS is suggested not to be owned by those organizations as they might give their own interest higher priority. On the other hand, the VTS Command Center, which reports to the Central Government, is recommended to focus on port traffic safety rather than the overall port performance. Thus, we suggest to the CFD local government the establishment of an authority that becomes the HDMIS’s owner in order to share the same goal and vision as the HDMIS.

People

IT specialists would be needed to deploy, maintain and enhance the HDMIS or any further development in the IS integration with the HDMIS. In addition, training should also be provided in order to educate users not only on how to use the system but more importantly to achieve support and acceptance of the system to fully exploit its benefits.

5.6.3. Standardization of IS and Process

Standardization on the system design and electronic data exchange format can facilitate the system integration between different IS. To have a boarder vision in the long-term development, both International standard and national standard should be considered. The standardization should not only refer to the technical perspective but also on the operation process and procedures. If all the ports in China can follow the same operation standard and use the same system, port regionalization\(^{43}\) (suggested in literature review section) then would become possible to achieve higher efficiency and better utilization of shared resources.

\[^{43}\] Xu, 2004
5.7. Summary of Expected Benefits

Through the implementation of the proposed HDMIS, the CFD port has several benefits to gain.

Firstly, the overall information flow is optimized and ensures that more accurate and timely data is available to all stakeholders of the port. Also, the proposed system enhances data control and correctness through improved data flow visibility and partially automated information flows.

Secondly, with the help of the HDMIS, information sharing between all parties could be improved, which is expected to lead to a closer cooperation of port organizations. In particular, this fact could minimize the current uncertainty concerning piloting and tugboat services as activities within the port become more transparent. As a result, unavoidable delays could be efficiently managed and operations adapted accordingly.

Thirdly, the occurrence of procedural errors could be reduced due to the fact that the HDMIS simplifies and better communicates port procedures. As digital formats are used and information is more easily accessible for external parties, it can be expected that arriving and departing vessels are better informed and needed information is available in a timely manner. Furthermore, based on an established HDMIS client database, new clients of the CFD port could be identified and given access to certain HDMIS shared information to avoid any information flow delays.

Fourthly, the proposed HDMIS offers a clear benefit to management. As desired output, the IS provides comprehensive and customized business reports that support the decision-making process, the monitoring of KPIs and ensures immediate detection of potential internal inefficiencies.

Lastly, technological and operational solutions can provide maximum navigation safety in the port area. The here proposed HDMIS offers the option of including features of a Crisis Management System that as a safety system would be capable of responding to
existing and potential threat. As such, it supports damage estimation, planning of response actions and general control of crisis operations, and could be used in situations such as fire, oil spills, floods, accidents on potentially dangerous objects, search and rescue operations in sea and acts of terrorism.

6. Implementation

6.1. Implementation Action Plan

As this report made clear, the benefits of the implementation of the proposed HDMIS are significant. However as first step, the CFD government needs to conduct a cost analysis to determine the budget for the project, as well as the amount of funding sought. If the project is feasible the implementation of the project can begin. The CFD port could consider establishing a collaboration with neighboring ports to develop a system together in order to share costs and information, thus, scope economies could be realized.

Our proposed implementation plan for the HDMIS project is a phase-by-phase plan, which is illustrated in the figure below.
**Stage 1: Consulting Process**

In this first phase, the CFD government is recommended to choose a software provider that offers tailor-made IS solutions. It is suggested that CFD develops system requirements by taking into consideration the here presented functional and non-functional requirements, in order to be able to compare providers and make the right choice. The software provider should be picked based on its service offerings, the costs involved, the capacity it can manage and its degree of customization. This phase is expected to take three months and the CFD government has the full responsibility for the project.

**Stage 2: System Design and Testing**

After having chosen a software provider, the second stage begins, which is expected to last for 12 months in total. Firstly, the software provider starts the system design process (6 months). In this process, CFD is recommended to provide as much information to the

---

**Figure 12: Implementation Action Plan**

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<th>Stage</th>
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<td></td>
<td>• Execution of Change Plan</td>
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<td></td>
<td>• Extensive on-the-job training for users</td>
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<td>Stage 4</td>
<td>Provider assistance:</td>
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<td>• Co-monitoring of system performance (KPIs)</td>
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system designer as possible to ensure that the final system fully meets the needs and requirements of the CFD port. In the following testing phase (4 months), both parties should continue to work closely together as this stage will give a first insight of whether or not the designed system actually meets the expectations. The here presented system design should be used as guideline. Meanwhile, it is recommended that the CFD government develops a change plan to guarantee a smooth launch of the HDMIS. At this stage, changes to the organizational structure are recommended to establish a clear owner of the HDMIS, to define which and how entities and stakeholders are involved, and to clarify responsibilities.

**Stage 3: Trial Period**

If the testing phase is successful it is followed by the trial period. In this 6 months long stage of the implementation process, the HDMIS is tested by the CFD government in its actual setting, the port. Furthermore, at this stage the developed change plan should be executed and extensive on-the-job training provided to all system users. It is recommended that the needs of the port are closely observed to allow features to be adjusted accordingly. At this stage, the CFD government (or the nominated responsible department/ entity/ organisation) and the software provider should continue to cooperate closely. The responsibility of the HDMIS is now moving towards CFD, while the software provider still has to ensure that the system fulfills the requirements.

**Stage 4: Provider Assistance**

In this last phase, software providers generally offer their exclusive assistance for a certain period of time (approximately 6 months), where the new system has been fully implemented but the provider however continues to co-monitor the system performance. It is recommended that the CFD government ensures that during this period all issues or complications with the new system are identified and addressed to the software provider.
6.2. Limitations and Challenges

The implementation of the proposed HDMIS has several limitations and challenges that the CFD government needs to be aware of to guarantee a successful implementation of the system. Firstly, central and local governmental policies and regulations need to be considered during the development process. In particular, any political changes might pose a challenge to the project. Secondly, changes in the economic conditions are regarded as challenge to the implementation as a negative development could lead to lack of funding and additional pressure on the port performance. Thirdly, possible changes in the industry and competitive conditions might force the CFD port to develop new skills of adapting quickly to new situations and build a sustainable competitive advantage. The implemented HDMIS would then need to support this agile approach. Fourthly, the actual technology poses a challenge itself, as it needs to be continuously updated. This means that all stakeholders find themselves in an ongoing learning and change process. Lastly, any problems concerning maintenance of the HDMIS or system outages can be regarded as challenge to the owner of the system and therefore need to be addressed and planned for.

After all, the HDMIS implementation can only be successful if it is fully supported by management and all involved parties and organizations. Collaboration and communication between parties as well as overcoming resistance to change can be regarded as crucial issues during the development, implementation and long-term usage of the HDMIS.

7. Conclusion

In summary, after having undertaken in-depth analysis of the internal and external factors that have an impact on the CFD port operations, the root cause for current issues
regarding vessel traffic flow inefficiencies has been identified as being inefficient information flows between parties within the port. Our analysis led to the conclusion that the implementation of a HDMIS could facilitate collaboration and communication, and hence, increase operational efficiency and lower operational costs. Additionally, the suggested HDMIS would maximize harbor safety through various features that allow close monitoring and surveillance.

Furthermore, by following the here presented implementation action plan, the CFD port will be enabled to close the gap to leading ports worldwide, as the report highlighted that those ports all already benefit from the significant advantages of a centralized MIS. By doing so, the HDMIS would support the port to realize its vision of becoming a central port hub in China. Most importantly, it is supposed to grow with the port and is able to support complex supply chains in the future.

As a conclusion, although this report presented only high-level recommendations to the CFD Government, this is a first step towards a high level of standardization and a high level of standards in China. If the HDMIS is considered as a feasible project, further research on the operation process is recommended to design the system in detail.
References


Appendix

A. Interview summary

A. 1. Interview with management of Admin of CFD Government

Interviewee: Dr. Wang

Position: Vice director

Time: 2010.6.6

Location: Video Conference

Interview summary:

Dr. Wang narrowed the scope of this project by stating that information system construction at this stage is for integrating information flows at all levels to facilitate management and control by the local government. The inefficient operation under the bottom-up establishing style in Caofeidian port has not apparently caused damage though; there is a severe concern that the potential risks will threaten both the structure of development and interests of all stakeholders.

The request of developing this information system is aroused by the following concerns: first, an approach of assembling information flows brings ease to the management over the port; second, unified data exchanging platform enables different parties acquire desired information to arrange their own working flows and human resources accordingly in order to reach the goal of efficiency; third, scheduled plan and real-time communication can maximally coordinate and monitor the harbor traffic order, guaranty traffic security and response to any unexpected events.
A. 2. Interview with management of Admin of CFD Government

Interviewee: Dr. Wang
Position: Vice director
Time: 2010.6.28
Location: Office building of CFD new zone

Interview summary:

Dr. Wang further suggested that there are currently five companies operating all terminals in CFD port. The Port Corporation Limited, which is one of the five companies, is one-hundred percent owned by CFD Government. Although these corporations are directed by disparate managing styles, physical operations in port are similar to each other. Thus, not only is the Port Co. Ltd. partial client of this project, but also an appropriate standing point to verify inefficiency of port operation.

As there are rare communication between these entities, the management over CFD port expose to the lack of existence of a system to centrally assemble available information. In other words, an essential level in the whole hierarchical structure has not yet been built. Therefore, a HDMIS, which facilitates information sharing among various stakeholders and has features of increasing operating efficiency, reducing costs and ensuring security, will help to optimize the initial phase of construction as well as the capacity of developing future potential.
A.3. Interview with IT manager in Port Company

Interviewee: Mr. Song

Position: IT Manager

Time: 2010.6.28

Location: Office building of CFD new zone

Interview summary:

Firstly, Port Company has two primary functions: one is assembling and distributing system management; the other one is loading and unloading cargo. Assembling goods refers to gathering cargo from certain places designated by consignors and place them in storage yard, while distributing goods means discharging cargo from vessels, place them in storage yard and transport them via various methods to consignees’ designated places. Loading and unloading activities, which accompany with cargo transportation and storage as a logistic operation function, are most frequent and reoccurring activities among all activities. Thus, loading and unloading cargo is a crucial factor of affecting the port operating efficiency.

Secondly, Mr. Song introduced that the main stakeholders in CFD, who portray as vital nodes in all information flows, consist of Vessel Traffic Service Command Center (VTS CC), which belongs to Marine Bureau; five companies that take control of different terminals in CFD port; pilotage and tug boat service; and inspection bodies.

Thirdly, as an example, the detailed operating procedures of one complete distributing cycle are as following:

1. Port Company transacts with shipping companies and freight forwarders. Certain documentation and formalities must be processed before vessels leave anchorage to berths.

2. Dispatcher in Port Company hand over their dispatch plan to VTS CC every four hours according to contracts and communication with shipping companies or vessels. VTC CC thus
makes the integrated vessels movement schedule to all relevant parties ever four hours and gives commands to vessels when they are allowed to cross water channel.

3. Pilotage and tug boat services are applied by vessels themselves or shipping companies in two situations: one is when coming vessels are new to CFD Port and unfamiliar with water channel; the other one is set by law that foreign vessels must be piloted when crossing water channel. Port Company will be informed once pilot has been assigned to vessels.

4. The Port Company will notify inspection bodies, such as customs, frontier inspection and commercial inspection etc., when vessels reach their berths. Discharging activities will start only after approved by these parties; otherwise vessels must leave berths immediately.

5. Consignees arrange trucks to transport cargos placed in storage yard to their own warehouses.

   Similarly, a completed assembling working cycle is inversed to distributing cycle, without the inspecting procedures.

   Fourthly, Mr. Song talked about the internal information-exchanging platform being designed by China Communications Water Transportation Planning and Design Institute Co., Ltd. The system desires for improving communicating environment and integrating information by converting most of paper works, telephone communications, faxing files and other traditional methods of data exchanging into digital format and storing them into an easily adding, deleting, retrieving and updating database. Efficiency increased by such a platform can in a large extent mitigate the effects leaded by delays in loading and unloading of ships while goods pile up waiting for transshipment.

   At last, he mentioned that they are at the beginning of planning to propose to construct an Associated Dispatch Command Center in the future to relevant higher management. In this association, external information, such as vessels movement schedule and pilotage & tugboat schedule, can be shared in a platform or even made by a central server. Thus, not only can the internal arrangements of human resources and equipments be optimized by accessing more
transparent information, but also the potential development of the whole CFD Port in future can be facilitated by system integration.
A. 4. Interview & observation with VTS operators

Interviewee: Mr. Zhao Junjun
Position: VTS Duty Officer
Time: 2010.6.29
Location: VTS Command Center (VTS CC) in Marine Bureau

Interview summary:

VTS CC, which is one department of Marine Bureau and directly subordinates to the Ministry of Communications, Central Government, is responsible for managing and monitoring traffic within maritime precinct, providing relevant information services and guarantying security of arriving and departing vessels.

In daily operation, VTS CC receives dispatch plans from five corporations of CFD Port every four hours based on which the implementing vessel movement schedule are made. In every four hours, vessel movement schedule is announced by fax or internet to all information users. Simultaneously, vessels crossed the reporting line are recognized by Automatically Identification System (AIS) and communicate with operators in VTS CC by using VHF for further guidance. Operators need to manually compare the vessel information registered in database with files faxed by the five corporations. During this period, information of weather forecasting and reminder of danger will be transmitted, too.

The current information system that CFD VTS CC now employs is Atlas 9760 VTS from Germany. Major technologies in use include AIS, VHF, radar, CCTV for fulfilling the traffic management objectives. Although the real-time information can captured by AIS and radar, the constraint of one-way water channel and traditional communication methods of fax, telephone and email produce most of the inefficiency between VTS CC and relative departments.
A.5. Interview with directors of dispatch office in Port Company

Interviewee: Mr. Li Wei and Mr. Liang Xueping

Position: Mr. Li: the Control Center Director

        Mr. Liang: the Deputy Control Center Director

Time: 2010.6.29

Location: Control Center of CFD Port Co., Ltd.

Interview summary:

Mr. Li and Mr. Liang emphasized the main problems they are encountering in daily operations regarding to the aspect of information flow. First, the VTS CC just releases the vessel movement schedule every four hours. There is no other notification of reason why all traffic flow stops or movement schedule keeps on deferral. All arranged staff and equipment have to be on call, which causes great inconvenience and inefficiencies in operation. Thus, in order to maximally reduce the waiting time, there is a motivation for them to report the dispatch plan earlier than the real time. Second, the same issue happens to pilotage and tug boat service companies, or the information released is even more inaccessible. They have to call to know what is happening. As the number of incoming vessels has been increasing for all the time, it indicates that further deferrals are at great possibility to occur from days to months.
## B. Harbour Throughput Forecast

运量预测

TangShan Harbour Throughput Forecast

Unit: 万吨、10K ton

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## CFD Harbor 2010 年集疏运量预测

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