IMPROVEMENT OF PORT INFORMATION SYSTEMS FOR TCDD PORTS

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Abstract

In today's world of globalization, utilization of information technology in transport and port industry is rapidly gaining importance. After Turkish government decided to privatize the operation of Turkish ports, the efficiency issues became more seriously important. When the privatization of Mersin, Izmir and Iskenderun Ports will be over, the companies to operate these terminals will intend to implement their operating systems and these systems should be integrated to Turkish State Railways (TCDD) and Turkish Customs Office. If the efficiency level of the port administration and the customs office will be far below that of the terminal operating systems, it will be a bottleneck for the ports' overall efficiency.

In this research, future port information systems development strategy and corresponding administrative precautions for Turkish government are discussed, under the light of past system development projects for the ports. First, the information systems utilized in the world's leading ports are reviewed. Then past attempts to implement information systems to TCDD ports and the current situation of the ports are reviewed and problems in front of information system improvements are stated. Finally, under the light of previous studies and actual applications in world's leading ports, some recommendations to overcome these problems using information technology are proposed.

Keywords: ports, Turkey, TCDD ports, information systems

1. Introduction:

It is for sure that ports are one of the most important elements of a country's economy. They are not only the intersection points of different modes of transport, but also focal points of economic activity. Due to various factors, such as increasing amount of international trade, increasing capacity of vessels, decreasing cost of inland transport, introduction of new technology to ports and containerization, the competition between ports has become severe and efficiency issues has become a major point of concern in the last few decades.

Recent developments in information technology have deeply affected almost every field of industry. Ports are no exception. Since ports are places where various tasks must be carried on in harmony by various bodies, utilization of information technology is inevitable to coordinate and harmonize these activities, ranging from basic tasks like cargo handling to auxiliary tasks such as communication between port-related bodies.

On the other hand, for the case of Turkish ports, utilization of information technology has been delayed for such a long time that inefficiency is severely affecting Turkish economy (Mersin Chamber of Commerce and Industry, 2003). Due to undeveloped transport infrastructure, international cargo routes between Europe and Asia is being shifted beyond the borders of Turkey (The Undersecretariat of the Prime Ministry for Foreign Trade, 2001). On the other hand, Turkey is holding negotiations with European Union, and – if the negotiations are successful- is expected to be a member of it within the next decade. This will certainly cause an increase in the amount of import and export cargo due to expected foreign investment drawn to the country, because of low land and labor costs compared to European countries. Moreover, the strategic value of Turkish ports, especially Mersin Port, will increase due to reconstruction of Iraq after the war and the port is competing with Tartus and Lazkiye ports of Syria. Therefore, low efficiency of Turkish ports will be a bottleneck for such improvements.

In this research, first of all, the current sophisticated port information systems utilized in the world's major ports are overviewed. Then the past projects to develop port information systems for Turkish ports are summarized and the present situation and problems of Turkish ports are described. Finally, based on the past experiences, applications in the world's advanced ports and the implications suggested by previous studies; some basic characteristics of the of the information system that should be implemented to solve these problems are suggested.

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2. Current Situation of World Ports According to Information Technology:

The term "port information system" is used for every kind of information technology –hardware or software– that is used in port operations, and further explanation will be given within this chapter. Such a system can be extremely diversified according to the functions of the system and the tasks that are carried out within the port.

In this section, information technology utilized in some leading ports of the world will be reviewed in order to seize the scope of information systems utilized in ports.

2.1 Port of Singapore:

Port of Singapore is a good example for one of the best usage and application of information technology in port terminal operations. Port of Singapore Authority (PSA) runs one of the most technologically advanced ports in the world and information technology is the key to become the most efficient port in the world (Lee-Partridge, Teo, & Lim, 2000:86). Since the country is in severe lack of land, the efficient utilization of existing land is crucial for the Port of Singapore, and this was achieved by the sophisticated technology used in the port. This can be a good example of overcoming physical limitations by the proper utilization of information technologies.

The information system in the Port of Singapore is separated into three levels (Applegate, Dustin, & McFarlan, 2003:325). In the first level, main operations are streamlined, synchronized and integrated by a program called Computer Integrated Terminal Operating System (CITOS). In the second level, real-time management, coordination and control of the operations are offered by PSA staff. In the third level, another proprietary software, called PORTNET, connects the port with other organizations, including shipping lines, haulers, truckers, customs, marine service providers etc.

CITOS is defined as "a comprehensive Enterprise Resource Planning (ERP) system specializing in real-time command and control of information and resources for container terminals" (http://www.portnet.com/03products/citos.htm). It supports all planning requirements, including berth allocation, yard planning, ship planning, rail planning and resource allocation. It keeps track of all activities related to terminal operations and movements in the yard, regulates gate operations, and enables real-time terminal operation through connections with control centers. It also contains modules for equipment maintenance, performance reporting, invoicing and container number recognition. On the other hand, operation of break-bulk terminals is carried out by another system, called Computer Integrated Conventional Operations System (CICOS).

PSA offers integrated services to shipping lines, haulers, freight forwarders, shippers and local government agencies operating in Singapore, through Portnet, via internet environment. The system enables online ordering of services, such as berth application, stevedoring services, yard crane booking, ordering pilot, tug or waterboat. Document submission, like electronic bay plan (EBP), vessel itenary or required information for pre-gate activities can be fulfilled through Portnet. The system also allows the customers to track and trace the location and the status of their cargo and orders. Legal or regulatory documentation, such as electronic delivery order (EDO), container store & release order, hauler's job lists and subcontract functions, and government permits applications seamlessly flow through the system. It offers an easy-access data repository to share critical coordination data, such as detailed schedules, ship planning data, reefer containers temperature and dangerous goods containers condition. The system also offers financial functions such as online charges and billing. On-line connection with custom services is supplied through Tradenet (http://www.portnet.com/03products/ portnet.htm).

Such investments in information system infrastructure returned back to the Port of Singapore as performance increase and high efficiency. For example, the world record in vessel loading and unloading (243 containers in an hour) was broken in April 25, 2000 (Applegate et al., 2003:328). And in March 2000, the port handled 1.5 million TEUs in a single month, which is still an unreachable record in anywhere else in the world (Lee-Partridge, Teo, & Lim, 2000). On the other hand, this success depends on not only the IT system but also modern management strategies of the government and the port authority. In fact, absence of such awareness can be a major obstacle in front of Turkish ports.

2.2 Port of Hamburg:

Port of Hamburg is one of the most modern ports in Europe. Its highly automated terminals, such as Container Terminal Altenwerder (CTA) operates 24 hours a day, almost totally automated. The terminal has 14 semi-automated container cranes to load the containers onto "driverless" container carriers, called Automated Guided Vehicles (AGV). On the yard, two automated gantry cranes operate in each block by one passing over the other to ensure high handling rates and avoid time losses due to system failure (Engelhardt, 2006).

The system is coordinated by software called Container Terminal Information System (CTIS). The system enables real-time data overviews, supports EDI Electronic Data Interchange. If the container data, e.g. from customers and agents, is pre-advised, it will reduce the manual input to a minimum. It also offers Windows-based Graphic User Interface to provide the user with a real-world environment, helping manage the container yard, equipment and resources more efficiently. An overview on the CTIS modules is as follows (http://www.hamburgportconsulting.de/s2_engl.html):

- Gate- und Truck Monitoring
- Vessel Call and Berth Planning
- Yard Planning

- Ship Stowage Planning
- CFS Container Packing Station
- Customs Access
- EDI (Electronic Data Interchange)
- Report Generator
- Connectable devices/systems
- Radio Data Terminals
- Internet
- Invoicing/Tariffing

On the other hand, Hamburg's Data Communications System (Dakosy) networks port operations and logistics companies within the port. It was established in 1982 and was selected as the world's top transport related EDI system by International Federation of Port Cargo Distributors.

Dakosy provides a data interchange interface that enables information flow among the companies along the whole transport chain. It offers customized software packages for specific segments in the transport chain that not only complement the existing software but also provide new solutions, such as monitoring dangerous goods or steering railway traffic.

The container information system, called COAST (Container Authorization System) offers online information about status, location and condition of container. It transfers general communication requirements from phone or fax to user friendly internet (Keith, 2003:22-24).

2.3 Busan Port:

Busan Port is the biggest port in Korea, which is located at the southeastern end of the Korean Peninsular and serving as the gateway connecting the Pacific Ocean and the continent of Asia. Although the port facilities are managed by Busan Port Authority (BPA), container terminals are operated by different companies. BPA utilizes PORT-MIS, which is originally developed by Busan Regional Maritime Affairs and Fisheries Office, to manage and control port activities, whereas every terminal operating company has its own terminal operating system.

PORT-MIS has the following functions:

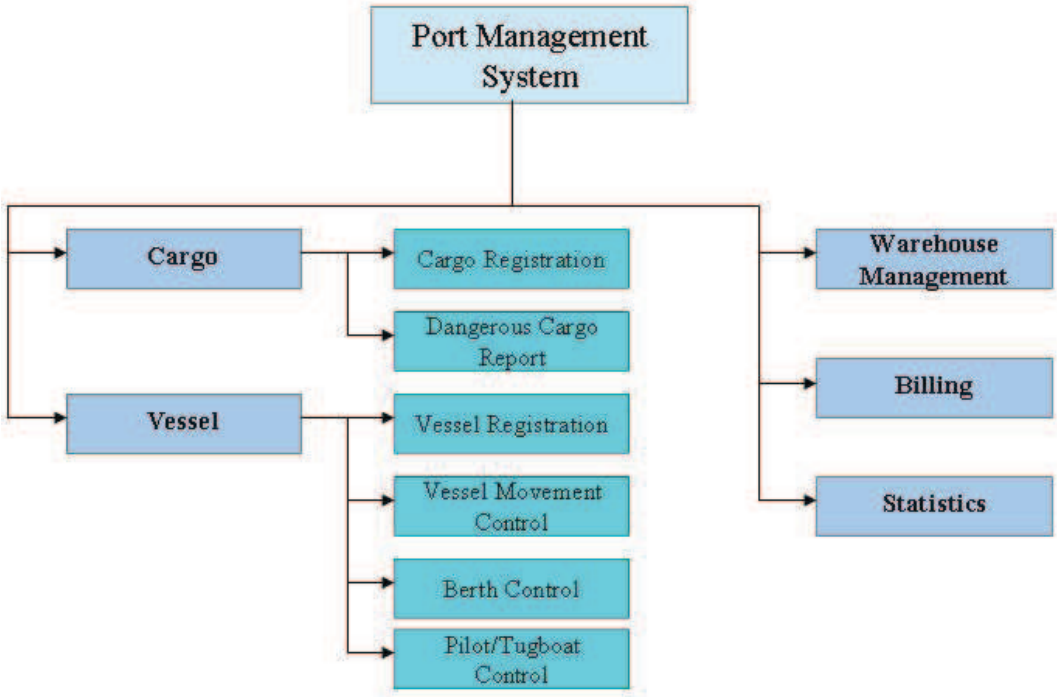

Figure 1. Main functions of PORT-MIS (http://www.klnet.co.kr/)

On the other hand, terminal operating systems differ slightly since terminals are operated by different corporations. As as example, the In-House System of Korea Hutchinson Terminal Co., Ltd. covers all terminal operations including gate, yard, vessel, sales and related statistics operations. It supports connections with CFS, EDI and customs. It also has modules for human resource management, financial system, equipment maintenance and repair, web page service and electronic mailing for team members. The system is also interfaced with a purchased ship planning system.

The communications and EDI is provided by a private network company called KL-Net. Kl-Net offers various B2G solutions through which companies can make online applications and service requests, such as booking for port

facilities, custom clearance, immigration application for ship crew, railroad transport, request for inspection (fishery products, dangerous goods etc) and a financial module that enables online payment for taxes and port services.

KL-Net's Port Logistics' Integrated System for Maritime Business (PLISM) connects carriers, hauliers, terminal operators, checking companies and forwarders to support colloborative business. The system covers generation of precise logistics information, automated handling of compared data, maximization of information pooling, access to "job-site" information, standardization of requests and orders to minimize information dublication. The system runs on internet-base client/server system. KL-Net also provides various B2B solutions to support shippers, transporters, terminal operators. port logistics and electronic tax invoicing. (http://www.klnet.co.kr/)

2.4 Port of Hong Kong:

Terminal operating system utilized in Hong Kong International Terminals (HIT), uses BETA TUXEDO middleware that ties the elements of the system. HIT's award winning terminal management system, so called Plus Productivity Programmme (3P), is a fully- integrated solution to handle HIT's business requirements ans enhance and support yard operations. It includes capital, civil works and a large amount of process re-engineering, in order to achieve improved stacking capacity, improved handling capacity and improved yard operations (3P Brochure, http://www.hit.com.hk/facilities/3p.pdf).

All necessary information is transferred to the terminal for pre-planning process that ship planning and yard planning systems decide the method of deploying containers. For the yard operations, all necessary information about container movements and inventory control is exchanged between the system and the terminal mounted in the crane cabinet via radio frequency or fiber-optic network. After loading onto the truck, the crane operator sends a message to the system that regulates the entrance and the exit of the truck through the driver's identification card. Every component of the system works fully integrated to share information (Forward, 2003:43).

Based on 3P, the system called PIONEER allows terminal operators to automate their operations and achieve higher levels of efficiency and customer satisfaction (PIONEER Brochure, http://www.hph.com.hk/downloads/pdf/Pioneer.pdf). PIONEER System offers IT solutions not only for terminal operations, but also depot management, freight management and barge management. The functions of the terminal operation system includes vessel operations (container registrations, bay-plan and confirmations, vessel planning), gate operations, yard operations (yard crane and movement monitoring, automatic assignment for ground location), inventory management, operation management and billing.

Not only the terminal operations, HIT also invested in port community systems. In 1998, it launched Customer Plus Programme that enables exchange of electronic messages between HIT and shipping lines. Also, in 2003, it a new joint venture called OnePort Limited. The main purpose of OnePort is to improve business processes at the Port of Hong Kong by providing port community with value-added services and electronic information exchange between all port users. The system provides services such as on-line custom declaration, paperless container exchange services, paperless container collection and delivery for truckers and services for shipping documentation. HIT also offers EDI for invoicing and container related information through cellular phones.

2.5 Port of Rotterdam:

Rotterdam is one of the most modern ports in Europe. Europe Container Terminals (ECT) utilizes unmanned AGV's to transfer containers from berth to yard, and unmanned yard cranes operate in the yard to minimize waiting times. ECT plans to launch a new terminal system, called Total System Solution, in order to integrate the information systems in its Delta Terminals (http://www.ect.nl/).

All available information concerning the port is accessible via one central access point, PortofRotterdam.com. The port authority intended to provide a secure platform for engaging all manners of financial transactions, through a port-wide application of e-business. The site also provides an index of available e-commerce companies. The system is supported by various applications. For example Virtual Port: Rotterdam program provides a fast secure and reliable portal platform which enables easy access to electronic message exchange. This enables small companies within the port community to utilize EDI. Gigaport at Rotterdam program provides services including electronic verification of financial transactions, paperless transfer of commercial documents and web application for customs clearance. And WebJonas program, launched by Roterdam Municipal Port Management allows ship brokers to announce electronically the arrival of cargo and ships and settle their port dues (Forward, 2003:24-30).

2.6 Summary:

Utilization of advanced technology is common in almost every application of a port. Since the ports consist of various activities with different characteristics, a well-designed port management information system should supply information, goals, timing and frequencies to enable decision making for efficient port management. The system can differ depending on the characteristics of the task done.

On the basis of the above examples, information systems can be divided into three broad categories. *Terminal operating systems (TOS)* are "computer systems available for organizing the container terminal itself" (Jeffrey, 1999:39).

Terminal operating systems:

- Manage the flow of containers through the terminal by relocating the containers in the right places in the most efficient manner;

- Plan loading/unloading schedule and yard transfer operation by receiving information from shipping companies, describing position of containers on vessel coming into the port and which ones need to be taken off at the terminal;
- Process the containers transported into the terminal by rail or road, receiving notification from shipping companies and trucking companies about them; and
- Notify shipping companies and trucking companies about the locations of containers. (Choi, Kim, Park, Park, & Lee, 2003)

On the other hand port authorities may need systems to monitor and control the overall port activities and to accept official requests for vessel arrivals or using port facilities, called *Port Management Information Systems* [1]. Such systems can be distinct in the ports that don't operate its own terminals (such as PORT-MIS of Busan Port Authority) or such functions can be embedded in an integrated system (such as PORTNET of Port of Singapore Authority).

Moreover, *Port Community Systems* are "computer networks which link up the port with all the companies that use it, including hauliers, rail companies, shipping lines, feeder ports, shippers and customs officers" (Forward, 2003:14).

Although the configuration of the information system can differ depending on the port, an ideal port information system encloses all these functions under the umbrella of a totally integrated system.

3. Information Systems in TCDD Ports:

3.1 Information System Development Process for Turkish Ports:

TCDD ports started to build container terminals in 1985 to catch up the rapid changes of container transport in the world. Among these, Mersin, Haydarpasa and Izmir Ports were the ones with busiest container traffic.Increased traffic in these ports caused congession due to Turkish custom regime that is not flexible enough to develop regulations to easy such transport and the lack of sufficent control of the port operations with computerized systems.

In order to supply compter support to container terminals of Mersin, Haydarpasa and Izmir Ports, Ports Branch and Data Procesing Branch of TCDD prepared "TCDD Port Services Telecommunication Project", abbreviated as DELIMTEL. The analysis tasks were started in August of 1990. This had a wide range of purposes, including analysing container terminal activities and needs, developing a management information system for a selected pilot port and implementing the system to other ports.The project was estimated to be finished by the second half of 1992.

Meanwhile European Union (EU) carried out a project called MEDITEL, in order to develop a computer application program to ease the services the ports that face Mediterranean Sea and to form an information network that enables information transfer about ship and cargo traffic between these ports. The software package called ESCALE that was developed by Port of Marseille Authority was to be used in this project. TCDD declared to be involved in this project in 1991. Haydarpasa Port was chosen as the pilot port. According to the agreements, EU would finance the cost for software, and $70,000 of the hardware cost would be compensated by PMA.

The port officials examined both the software and the hardware to be used in the project and it was agreed that Haydarpasa Port is suitable for the project. On the other hand the modifications to be made on ESCALE package in order to fit the differences in management technique and infrastructure couldn't be finished on time by the French officials. Instead, the second ESCALE package was offered because of being better for problem handling. But even the second package couldn't fit the existing system. Negotiations with French officials and EU did not end in any result, and the project was clogged. So, in August of 1995, the technical committee declared to EU officials that developing a new application program for this port would be more suitable.

After four years, TCDD project group added "fare services", which was missing in the original project, to the application program of DELIMTEL and MEDITEL Projects and finished the new program called "Computerized Tracking of Port Operations Project" in the beginning of 1999. For the time being, this program is in service except for "services offered to the ship" (i.e. pilotage, fuel supply and so on) interface.

In 1995, another project was developed by using C programming language under UNIX operating system, in Izmir Port. This program was activated in Izmir Port after testing phase. But because of the problems about real-time operation of this application program with manually offered services, usage of this program was cancelled in 1999.

In order to ensure effective terminal and port management for TCDD ports through the application of "fully automated terminal operations", a technical committee was formed within TCDD and this committee started to compose required technical specifications in the beginning of 2000's. On the other hand, in the beginning of 2005, High Council of Privatization Administration decided that all services except transfer of ownership in all TCDD ports except Haydarpasa Port, would be privatized. This decision resulted in the cancellation of the project.

Meanwhile, server and computer parks provided to Mersin and Izmir Ports in 2004 and the application program developed by Haydarpasa Port's IS staff is still in use as an out-of-project application[2].

[1] These systems are also referred as "Port Administration Support Systems" in Park, Choi, Lee, Kang, & Yang, 2005.

[2] Obtained directly form TCDD Headquarters, according to the Freedom of Information Act Law.

3.2 Current Situation in Turkish Ports:

Today, most of the basic operations are still carried out on paper. All applications for port services are taken by fax for the terminal operation tasks and even berth planning is done on paper. The situation is not so different in the case of port management tasks and custom declarations.

To make the present situation clearer, an interview survey was carried out in Mersin Port about the present condition of the port information systems[1]. Based on this survey, the problems of information systems of Turkish ports can be summarized as follows:

- Since the previous projects to implement information technology did not end in a success output, there is still no information system utilized in TCDD ports.
- Almost every operation is carried out by paper-based methods; computers are just used for in-office purposes.
- Electronic data interchange (EDI) technology is not utilized at all.
- There isn't a portal site for the ports that inform the users about up-to-date information about the ports.
- There isn't enough academic research on port information systems.

Based on literature survey, basic administrational and structural problems seen on TCDD ports are stated briefly as follows:

3.2.1 Administrational Problems:

Port management couldn't be converted to an autonomous port authority system, so it suffers severe bureaucratic and regulative inefficiency. Port management must be flexible enough to deal with severe competition in the region, to meet the market demands and to be able to manage the port activities with low cost and high service standards. But such requirements are not likely to be realized by the current public administration (Lokmanoglu, 2003). Free Trade Zone in Mersin Region is a good example that same workers in the same port area are working more efficiently, due to the autonomous management

Since these ports are operated by government organs, port revenues are used for supporting other public services such as railroad expenses (Yucel, 1997), thus capital needed for port infrastructure investments is distributed over those services. As a result of this, required projects for infrastructure cannot be finished as predicted.

Port services are expensive. Turkish ports are indicated as the most expensive ports among the North Europe and Mediterranean ports and this situation is affecting international competitiveness of the ports (Undersecretariat, 2006).

Since most of the tasks are carried out by paper-based manual methods, speed of port and custom services fall behind the commercial activities. Information flow and coordination between port-related parties are inefficient.

The public ports suffer from insufficient human resources. The managers lack modern business management knowledge and trained operational staff, such as crane operators, is scarce.

Other administrational problems cover issues related to insufficient advertising and marketing of the ports, unregistered port land, and insurance policy that does not cover damages given to ships and cargo.

3.2.2 Structural Problems:

Structural problems of the TCDD ports are about insufficient physical resources of the ports such as quays and wharves, lengths and drafts, equipments and vehicles that serve the hinterland, stacking and storage places and vehicle parking lots.

Provided that private ports in Turkey do not have railway connection, 95% of the cargo handled in the ports is transferred by trucks, indicating that connection of railway and ports couldn't be realized for inter-modal combined transport. Other structural problems about railway transport –such as lack of easy access cargo tracking system and container land terminals, etc- are affecting Turkey's international competitiveness and the cargo route between Europe and Asia is being shifted beyond the borders of Turkey.

Old equipments frequently break down. Maintenance and repair of the equipment cannot be handled in an efficient way because of bureaucratic problems. On the other hand, cranes also break down due to overloading (Gulenc, 2004).

Traffic within the ports is not well-regulated and frequently congests. This is due to insufficient sign tables, lack of control, and uncontrolled and irregular usage of yard area (Gulenc, 2004).

General administrational and structural problems of TCDD ports are summarized in Table 1.

4. Contribution of Information Systems to the Problems of TCDD Ports:

In this section, contributions of information systems to solution of the problems stated above are discussed. Most of these problems can be solved, or at least reduced by effective utilization of information technology.

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[1] The main reason for selection of Mersin Port is that in the study of Yucel (1997)it is stated that TCDD operates all the ports in the same way. So the results of Mersin Port are assumed to be applicable to other ports that are operated by TCDD.

Table 1. General administrational and structural problems of TCDD ports.

	Problems	Source
Administrational problems	Port management couldn't be converted to an autonomous port authority system, so port management suffers severe bureaucratic and regulative inefficiency.	Yucel (1997), Undersecretariat (2001), Gulenc (2004)
	Speed of port and custom services fall behind the commercial activities.	Yucel (1997), Cubukcu (1998)
	Port services are expansive and are not based on cost-analysis.	Yucel (1997), Undersecretariat (2001), Gulenc (2004)
	Long-term planning cannot be made and investments cannot be realized as predicted.	Yucel (1997), Cubukcu (1998)
	Information flow and coordination between port-related parties are inefficient.	Yucel (1997)
	Human resources are insufficient and managers lack modern business management knowledge.	Yucel (1997), Gulenc (2004)
	Trained operational personnel (i.e. crane operators, etc.) are scarce.	Gulenc (2004)
	Tasks are carried out by paper-based manual methods.	Yucel (1997), Cubukcu (1998)
	Advertising and marketing of the ports are insufficient.	Yucel (1997)
	Port revenues are used for supporting other public services.	Yucel (1997)
	Damage given to ships and cargo are not compensated by insurance.	Yucel (1997)
	Maintenance and repair of the equipment cannot be done properly due to regulation problems and heavy bureaucracy.	Gulenc (2004)
Structural problems	Land is insufficient; there isn't enough land for containers and truck parking.	Yucel (1997), Undersecretariat (2001), Gulenc (2004)
	Handling technology is old and equipment is out-of-date.	Yucel (1997), Undersecretariat (2001) Gulenc (2004)
	Berth lengths and depths are insufficient to accommodate large container vessels.	Yucel (1997), Undersecretariat (2001)
	Special facilities for dangerous cargo are either insufficient or do not exist.	Yucel (1997)
	Equipment and facilities to prevent pollution are insufficient	Yucel (1997)
	Traffic and physical distribution within the port is frequently congested.	Yucel (1997), Gulenc (2004)
	Combined transport between maritime and rail transport cannot be realized, therefore 95 percent of the cargo is carried from the port by trucks.	Undersecretariat (2001)
	Gantry cranes broke down frequently due to overload.	Gulenc (2004)

4.1 Contribution of Information Systems to Administrational Problems:

In order to solve the regulative and bureaucratic problems privatization was a necessary (UNCTAD, 1982) but late move. The most important contribution of information systems to flexible port management is that it is generally accompanied by its peculiar management method, referred as business process re-engineering (Hammer, 1990). When information systems are designed, corresponding business processes are to be transformed in order to ensure flexible management and maximized efficiency of the system utilization. If the business processes do not accompany information system deployment, the gaps and contradictions between the system and the on-going processes may cause failure of the system, just as in the case of previous system development efforts in TCDD ports.

Real-time information exchange between the port administration and other port related parties is one of the most important features of the port information systems and it provides coordination and efficient control of the operations. Through electronic data interchange (EDI) technology, all traditional paper documents can be converted to electronic documents and exchanged between related parties thus the service speed is increased and error rates are decreased.

Another problem stated above is the port service fees. Although determination of port fees is a complex procedure, information systems can help the costs to go down by the efficient utilization of existing resources. Moreover, information systems decrease the need for human resources, thus decrease labor costs.

The contribution of information systems to human resources problem is that it makes the operations and tasks more human-independent. In most of the advanced ports, even container handling is done by unmanned, automated cranes and transfer vehicles, thus the need for trained and experienced operators is reduced. Even office work can be done by less number of staff, due to reduced paperwork. On the other hand, when a new system is introduced, the staff must be educated about the new system, and it must be considered separately.

As the information systems increase the operational efficiency, they certainly contribute to the competitive power of the port, contributing its marketing and commercial activity within the port.

4.2 Contribution of Information Systems to Structural Problems:

For most of the time, deployment of new infrastructure and equipment, or expansion of the yard area would be very expensive, or sometimes impossible for certain restrictions. Instead, port administrations should maximize the utilization of available resources. From this point of view information systems play a crucial role. All the tasks performed in the terminal area can be planned, organized and coordinated by corresponding modules. Moreover, information systems can coordinate the operations of different parties, resulting in more efficient operational performance and less wastes of time and resources. For example, due to its terminal operating system, CITOS, the Port of Singapore can stack containers up to nine high in order make a good use of its very limited land (Applegate, 2003:315).

It is a fact that the equipments used in the ports are old and need to be renewed. Despite, maintenance and repair of the equipment can be controlled efficiently by the help of information systems. An ideal terminal operating system should contain an equipment management module (Choi, Kim, Park, Park, & Lee, 2003).

On the other hand, cranes do break down due to overloading (Gulenc, 2004). Again, information systems can help equipment management by controlling time schedules for each crane and vehicle, regulate task dispatching for each equipment and allocate operator to cranes and transfer vehicles. By doing so, the system not only ensures the efficient utilization of port resources, such as equipment as well as human operators, but also avoids overloading.

To reduce congestions within the terminal area, information systems can allocate each container in the yard in the most efficient manner, and send instructions to trucks and trailers for container movement. The order of tasks can be coordinated by the system in order to minimize equipment moves and time wastes and thus the traffic not only within the yard but also during entry/exit through gates is regulated efficiently.

The effect of information systems will be enhanced if they are connected to other systems. Integrated information systems, enabling cargo tracking and information exchange between various related parties, should accompany other infrastructural investments for port and rail developments in the future. Such developments will certainly help Turkey to regain its strategic position for cargo flow between Europe, Asia and the Middle East.

These contributions are summarized in Table 2.

Table 2. Summary of the results.

Problems		Contribution of IS
Administrational	1. Expensive fees	1. decrease cost by efficient use of resources 2. decrease labor cost
	2. Severe bureaucratic and regulative inefficiency.	1. accompany changes in business processes
	3. Manual, paper-based management, inefficient information flow and coordination.	1. enable real-time information exchange 2. paperless work environment with EDI
	4. Insufficient human resources.	1. tasks become more human-independent 2. less labor needed for same amount of work
	5. Insufficient advertising and marketing.	1. increase competitiveness
Strucural	1. Insufficient land, equipment and facilities.	1. more efficient utilization of existing resources
	2. Old equipments, frequent breakdowns, inefficient equipment maintenance and repair.	1. optimize work instructions to avoid overloads 2. online control of equipment M&R
	3. Frequent traffic congestions within the ports.	1. optimize work instructions and yard allocation
	4. Inefficient connection between the marine and railway infrastructure.	1. information exchange between parties 2. on-line cargo tracking

5. Conclusion

In the preceding chapter, on the basis of world's advanced ports and previous academic studies, how information technology can contribute to solve the general structural and administrational problems of the public ports in Turkey was discussed. If they are added up, the basic level of information system that needs to be built in Turkish ports should include the following properties.

Terminal Operating System (TOS) :

- planning
- yard allocation for containers
- job dispatching for equipment and operators
- work load optimization
- equipment M&R

Port Management Information System (PMIS) :

- paperless work environment
- real-time monitoring and control of operations
- better marketing through increased competitiveness

Port Community System (PCS) :

- real-time information exchange
- coordination between transport modes

On the other hand, a well-designed information system may not always guarantee successful results. The system must be supported with other precautions to ensure efficiency. These are the problems that cannot be solved by information systems directly, and have significant effect on the success of the system. These factors can be summarized as follows:

- Legal regulations should be amended to ensure a flexible business environment within the port.
- Information planning must be well-established before the implementation project to avoid future operational failures and user dissatisfactions
- Out-of-date business processes within the ports should be improved to be in consistence with information systems
- Old equipment should be replaced by high-performance equipment that can operate in harmony with the new system.
- Both operational personnel and managerial staff should be trained about the new system, since they are the ones who are supposed use the system

It must be noted that logistics activities are like links of a chain, strength of which depends on the strength of the weakest link. Each and every of the factors above can be a bottleneck for the development of the new system. The failure of the projects in the past can be seen as evidence, so the success of the future projects, especially after privatization, depends on these precautions.

6. Acknowledgements

This work was supported by the Korea Research Foundation Grant funded by the Korean Government (MOEHRD) (Ref. KRF-2006-042-B0006)

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