Southwest Region University Transportation Center

The Role of Information Technology on the Implementation of Priority Systems and the State of the Practice of Information Technology on Marine Container Terminals

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Center for Transportation Research
University of Texas at Austin
3208 Red River, Suite 200
Austin, Texas 78705-2650

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16. Abstract

This report discusses the role of information systems and information technology on the implementation of priority systems, as well as the state of the practice of information technology on marine container terminals. The analysis is comprised of several parts. First, an idealized import process is described in a network representation in terms of the interactions among the agents involved i.e., shipping companies, brokers, motor carriers, container terminal operator and regulatory agencies, and the internal activities of the agents.

The network representation of the import process is then used to construct the networks of information activities for the interactions and internal activities of the terminal operator. These network representations are used as the framework to analyze the Survey on the State of the Practice of Information Technology. The aforementioned survey targeted a number of selected terminals and retrieved information on current practices.

The network of information activities for the internal activities of the container terminal operator is used to estimate the characteristics of the information flow for the current operational schemes. Then, this network is modified to make it reflect the information needs associated to priority systems. The characteristics of the resulting information flow are estimated accordingly. The role of information technology in the context of priority systems is analyzed as well. Using the characterization of the information flow, previously defined, the desirable characteristics of the information technology system are estimated for a priority systems environment. The main obstacles for these types of application are identified. Current trends in information technology applications are examined and the possible impacts on priority system are estimated.

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THE ROLE OF INFORMATION TECHNOLOGY ON THE IMPLEMENTATION OF PRIORITY SYSTEMS AND THE STATE OF THE PRACTICE OF INFORMATION TECHNOLOGY ON MARINE CONTAINER TERMINALS

by

José Holguín-Veras
and
C. Michael Walton

Research Report SWUTC/96/721928-3

Southwest Region University Transportation Center
Center for Transportation Research
The University of Texas
Austin, Texas 78712

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EXECUTIVE SUMMARY

This report is part of the research conducted at The University of Texas at Austin on the implementation of priority systems (PS), and it focuses on the definition of the role of IS/IT on the implementation of such systems. The analysis is presented in four sections. The first section characterizes the information flow associated with import and export containers. The second section presents the responses to the "Survey on the State of the Practice on Information Systems and Information Technology." The third section analyzes the information requirements in a PS environment and defines the role of IS/IT in such an implementation. "Conclusions" summarizes the major findings of this research.

The following are some of the main conclusions of this research:

a) Information and computation technology have been unevenly implemented at marine container ports.

b) The extrapolation of the data gathered in this survey, regarding resources consumed in container location, indicate that significant savings can be achieved by using more efficient container identification and container location equipment.

c) The results of the survey corroborated previous findings that indicate that motor carriers have not been successfully integrated with an information technology environment, especially EDI. The respondents classified the integration of motor carriers as "low." Furthermore, the motor carriers were reported to make a "low" to "moderate" use of information systems intended for their use, such as the container inquiry system. Since taking full advantage of the possibilities of information technology and information systems requires the active participation and integration of all parties involved, providing incentives to motor carriers should be considered as a primary policy goal.

d) The data provided by the survey indicated that, for the typical terminal, the information flows among agents (referred to as "interactions") and within terminal operators are very loosely integrated. It is our believe that significant benefits could be attained through better integration of the IS/IT into all levels of information flows.

e) Existing EDI technology is capable of absorbing the increase in information flow associated with PS and, consequently, no bottlenecks are anticipated in this area.

f) The implementation of PS will require redesigning the logic of the computer programs used to prepare the ship loading plan, the yard plan and yard equipment assignment, so that they take into consideration the priority level.

g) Efficient gate operations are required if PS are implemented. The use of Automatic Equipment Identification (AEI) devices and other technological alternatives will help to reduce waiting times at the gate.

h) Efficient container identification methods will contribute to the success of PS. The use of electronic tags, for instance, will reduce misidentification errors and will eventually be linked to Global Positioning Systems (GPS) or Differential GPS (DGPS) to determine the location of containers on the yard. [1]

[1] An interesting application linking DGPS to AEI technology is taking place at the Oakland facility of American President Companies. In this facility, the equipment location system (ELS) integrates DGPS and AEI to allow tracking of containers and yard equipment (see KELBOL95).

ABSTRACT

This report discusses the role of information systems and information technology on the implementation of priority systems, as well as the state of the practice of information technology on marine container terminals. The analysis is comprised of several parts. First, an idealized import process is described in a network representation in terms of the interactions among the agents involved i.e., shipping companies, brokers, motor carriers, container terminal operator and regulatory agencies, and the internal activities of the agents.

The network representation of the import process is then used to construct the networks of information activities for the interactions and internal activities of the terminal operator. These network representations are used as the framework to analyze the Survey on the State of the Practice of Information Technology. The aforementioned survey targeted a number of selected terminals and retrieved information on current practices.

The network of information activities for the internal activities of the container terminal operator is used to estimate the characteristics of the information flow for the current operational schemes. Then, this network is modified to make it reflect the information needs associated to priority systems. The characteristics of the resulting information flow are estimated accordingly.

The role of information technology in the context of priority systems is analyzed as well. Using the characterization of the information flow, previously defined, the desirable characteristics of the information technology system are estimated for a priority systems environment. The main obstacles for these types of application are identified. Current trends in information technology applications are examined and the possible impacts on priority systems are estimated. Specifically, the advantages and disadvantages of using Automatic Equipment Identification (AEI) devices and electronic tags are discussed.

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CHAPTER 1. BACKGROUND

The success of containerization is due to the benefits associated with reducing a potentially infinite number of shapes and sizes of cargoes into a much smaller set of standard units, containers. By unitizing containers, operators are able to take advantage of scale economies in a number of ways. First, the container is used as a consolidation unit that accommodates a batch of cargoes in one move. Second, and more importantly, since all containers can be handled in a similar manner, as boxes, operators can make efficient use of loading equipment and storage space. Without a doubt, the "container-as-boxes" approach has worked, but there are signs that indicate that this approach does not fit the needs of some segments of users. This is a fairly new situation, brought about by changes in the international economy that, among other impacts, have stressed the importance of dimensions previously considered non-relevant. The cargo value provides a good example of such a case.

Cargo value can be subdivided in two separate components: the intrinsic value of the cargo (determined by market value and replacement costs) and the logistic value of the cargo (a dynamic component that is a function of the importance of the cargo in the production system at particular times and at particular inventory levels).

In the last twenty years, developments in electronics and computer control have increasingly allowed production of goods with higher added value, smaller unit size and relatively low volume. In addition, globalization of the world economy has stressed the role of transportation and logistics as the key factors in reducing inventory costs. Concurrently, the growing popularity of Just-in-Time (JIT) production systems has increased the importance of the logistic value of cargoes. As a consequence, there is an increased need to expedite the flow of high-valued goods.

On the other hand, the advent of intermodalism has provided container carriers with the opportunity to target non-traditional markets. As part of these efforts, container carriers are trying to attract low-valued cargoes as a way to reduce the number of empty movements (e.g., cotton movements from Texas to the West Coast). If these attempts to attract low-valued cargoes succeed, container carriers and intermodal terminals may be handling, in the near future, a potentially high number of containers carrying low-valued cargoes.

The combined effect of the aforementioned trends is to increase the relative importance of both ends of the cargo value distribution. In this situation, an operational policy that does not distinguish containers according to cargo value is likely to penalize the segments of users located at both extremes of the cargo value distribution (i.e., the low-valued cargoes may be charged for a service that they do not need and the high-valued cargoes may receive a quality of service below their needs). Container carriers have responded to this new challenge by implementing simple versions of priority systems (PS). In most of the cases, these PS consist of one or two ship hatches, known as "hot hatches," defined as the hatches that will be unloaded first. So far, most of the "hot hatches" programs have been implemented for only Asia-US East Coast routes. However, it is expected that their use will be extended to other routes as soon as market conditions indicate prioritization needs.

Another issue is overall system optimality. Increasing cargo values implies increasing user costs. In this context, decisions based on operating costs will yield sub-optimal operations because the alternatives that minimize operating costs do not necessarily minimize system costs (user + operator costs).

In view of all these issues, the implementation of PS will help expedite the flow of high-valued cargoes. However, this implementation is not straightforward. There are operational and technological constraints that need to be analyzed. These constraints may be technical (e.g., equipment size and type) or physical (e.g., land availability). They are likely to be important in determining the feasibility of PS and the tradeoffs between the decision criteria (e.g., operator costs, user costs, and risk of non-compliance).

PS can be implemented at the network level (i.e., by routing high priority containers through the fastest routes or by using the fastest modes within a given transportation network) and at the port level (i.e., by using alternative operational schemes). The relative importance of each of these levels will depend on the particular conditions of the problem.

The purpose of this research is to analyze the technological and economic feasibility of the implementation of priority handling systems for containers at the port level.

The aim of such systems would be to expedite the flow of high-valued cargoes, thereby reducing user inventory costs. This "prime service" could be implemented through a combination of handling equipment, electronic data interchange technology, and innovative operational rules.

There are a number of issues that need to be studied. Among them, we must highlight the requirement of designing a system that does not penalize the efficiency of port operators in terms of operating costs, loading productivity and land requirements. Considering the impact on terminal operators is a crucial element of this research because of the importance of terminal costs.

The possible PS range from the current "hot hatch" programs, in which service differentiation only occurs at the unloading stage, to more complex systems in which service differentiation is done at all the stages (i.e., movement to storage yard, storing yard operations, gate processing in/out of the storage yard and container retrieval).

The analysis of the envisioned systems requires the examination of different aspects of the problem, including the definition and performance analysis of operational rules, pricing rules, and the corresponding information systems and information technology (IS/IT).

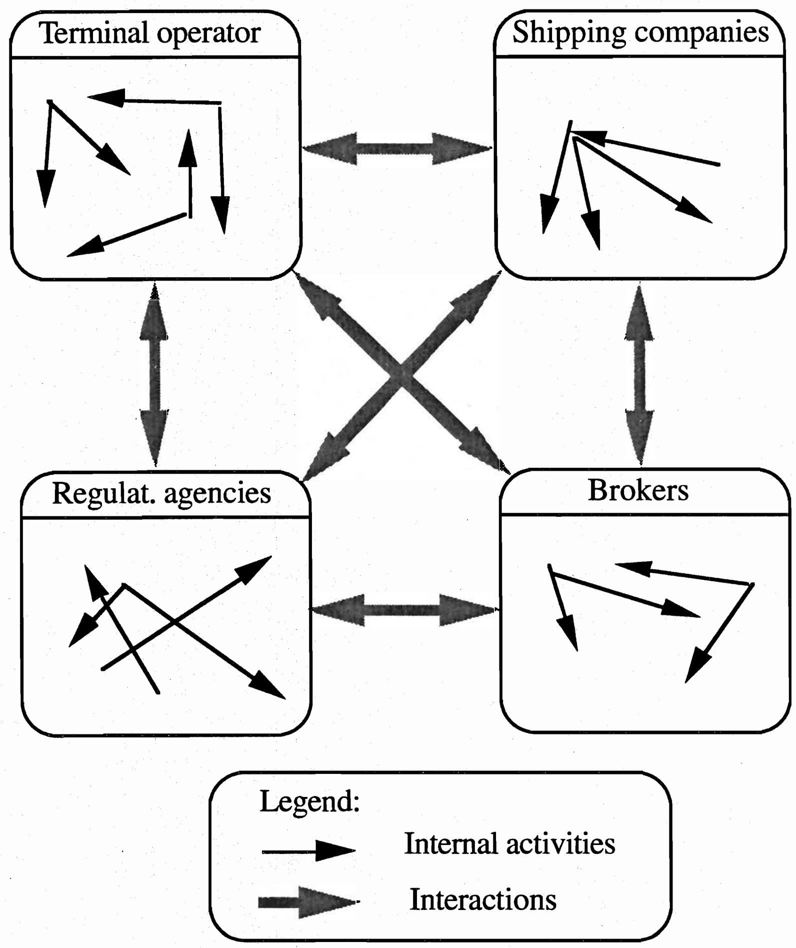
This report focuses on the definition of the role of IS/IT on the implementation of PS. The analysis is presented in four sections. The first section characterizes the information flow associated with import and export containers. The second section presents the responses to the "Survey on the State of the Practice on Information Systems and Information Technology." The third section analyzes the information requirements in a PS environment and defines the role of IS/IT in such an implementation. "Conclusions" summarizes the major findings of this research.

CHAPTER 2. CHARACTERIZATION OF THE IMPORT AND EXPORT PROCESSES IN PORTS

In this section, the import and export processes are characterized. These characterizations will serve two different purposes. First, though idealizations of actual processes, these characterizations will provide a comprehensive framework for analyzing the responses to the survey on the state of the practice of information systems and information technology. Second, since the most appropriate information system/information technology (IS/IT) implementation is determined by the characteristics of the information flow that takes place, the characterizations will help define what should be the role of IS/IT in the implementation of priority systems.

The import and export of containers involves a fairly high number of different agents (i.e., shipping companies, container terminal operators, motor carriers, brokers, shippers, forwarders and regulatory agencies) that perform a wide variety of activities related to importing and exporting containers. These activities can be depicted as an activity network that captures the fundamental structure of the process. In doing this, a distinction will be made between interactions (i.e., activities linking two agents) and internal activities (i.e., activities performed within each agent). Since the detailed examination of all the interactions and internal activities is beyond the possibilities of this research, the paper will focus on the most relevant interactions and the internal activities of the container terminal operator. The conceptual representation of internal activities and interactions, as defined in this research, is depicted in Figure 2.1.

Figure 2.1 : Conceptual representation of interactions and internal activities



Furthermore, the activities are classified according to their characteristics. Three categories were used: (a) physical activities, those in which its main component requires intense physical work and equipment (e.g., reorganizing the container yard); (b) information activities, those that are related to transfer and request of information; and (c) administrative-technical activities (e.g., verifying documentation, producing the yard plan). Figures 2.2 and 2.3 show the activity networks for idealized import and export processes. Tables 2.1 and 2.2 show brief definitions of the corresponding activities.

Seven different agents are shown in Figures 2.2 and 2.3:

(1) shipping companies, that are in charge of the maritime portion of the trip;

(2) container terminal operator, who is in charge of planning and operating the terminal;

(3) motor carriers, that are in charge of the land portion of the trip;

(4) brokers, that act as representatives of customers by expediting customs clearances and other related paperwork;

(5) shippers;

(6) forwarders, that handle the export traffic for the shippers that hire them, and

(7) regulatory agencies, that supervise and perform law enforcement duties related to import activities, like the U.S. Department of Agriculture (USDA), Drug Enforcement Agency (DEA), U.S. Customs (USC), Environmental Protection Agency (EPA) and the Federal Food and Drug Administration (FFDA).

Table 2.1: Description of activities related to the import process[1,2]

Shipping company:
(1-2) Notifies consignees two days prior to ship arrival
(1-8) Provides freight release to terminal operator

Broker:
(2-3) Obtains USC release, freight release, USDA clearances, etc., before contacting motor carrier
(2-4) Checks Bill of Lading (BOL) for completeness: checks number of packages, description of the cargo, marks and numbers, inland destination, gross weight of each commodity shipped, consignee identification
(4-5) Checks Delivery Order (DO) for completeness: checks forwarder's name, shipper's name, ultimate consignee's name, motor carrier making pick-up, vessel arrival date, voyage number, ocean bill of lading, pier number and location, marks and numbers, number of packages, description of goods, gross weights, legible signatures
(5-12) Forwards to motor carrier an original of the domestic BOL and an original DO, which authorizes pickup of import cargo
(5-21) Guarantees with terminal operator loading charges and demurrage

Regulatory agencies: USC, USDA, FFDA
(3-6) Verify documentation and schedule physical inspections, if needed

Container terminal operator:
(7-8) Updates location of containers at container yard
(8-9) Produces yard plan using the information about incoming/outgoing containers
(9-10) Assigns handling equipment and berths according to ship priority and expected arrivals
(10-11) Loads/unloads containers
(11-12) Container yard is reorganized

[1] After MULLER95.
[2] The numbers in parentheses refer to the node numbers in Figure 2.2

Motor carrier:

(12-13) Secures interchange agreement with steamship company of containers
(14-11) Ascertains expiration of free time and availability of container before dispatching driver
(12-15) Checks BOL and DO for completeness, as above
(15-16) Provides driver with original and copy of DO before departure to pier
(16-17) Contacts terminal operator to make appointment, if required, before pickup
(18-17) Dispatches driver to the pier

Container terminal operator:

(17-27) Clears container
(17-19) Verifies driver's identity and issues pass at the gate
(19-20) Checks DO for completeness and legibility, as above
(20-21) Verifies motor carrier's credit rating for loading charges
(21-22) Makes arrangements for payment of demurrage, if any has accrued
(22-23) Directs driver to pier USC office

Regulatory agencies:

(23-24) Verify driver's papers against prelodged USC permit
(24-25) Stamp DO on tally sheet
(25-26) Perform all necessary functions prior to the release of the cargo
(26-27) Approve clearance
(26-30) Approve clearance

Container terminal operator:

(28-29) Assigns checker and loading point
(29-31) Loads cargo onto vehicle with pier personnel. Checker notes exceptions and shortages
(33-32) Retains original DO

Driver:

(30-29) Assists in and/or supervises loading of vehicle
(31-33) Signs tally and loading ticket. Exceptions and shortages noted
(33-34) Reports back to delivery office, if required
(33-36) Retains copy of DO
(36-37) Surrenders gate pass at gatehouse

Motor carrier:

(34-35) Advises broker of completion of cargo pickup

Table 2.2: Description of the activities related to the export process[3,4]

Shipper:

(1-3) Prepares DBL for movement of cargo to pier, and sends copy to his forwarder at the port of loading, along with packing list. Checks Bill of Lading (BOL) for completeness: checks number of packages, description of the cargo, marks and numbers, foreign destination, gross weights of each package shipped, local party to be notified

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[3] After MULLER95.

[4] The numbers in parentheses refer to the node numbers in Figure 2.3

(1-2) Marks cargo plainly to show: gross and net weights, cubic measurement, foreign destination, identification marks, country of origin
(3-4) Sends BOL to forwarder

Motor carrier:
(6-7) Secures interchange agreement with steamship company of containers.
(4-6) Accepts cargo for transit to the port of loading
(16-18) Advises freight forwarder or shipper's local representative of cargo's arrival in the port
(4-5) Obtains the following information from forwarder or representative: name of vessel, sailing date, pier number and location, location of any special permits needed to clear hazardous or oversize cargo for acceptance by ocean terminal
(6-8) Contacts terminal operator to make appointment for special handling or equipment, if required, at least 24 hours before delivery
(6-9) Assigns driver
(9-10) Driver is dispatched

Forwarder:
(4-5) Checks dock receipt for completeness: checks shipper's name, name of vessel, ports of loading and discharge, number and type of packages, description of cargoes, gross weight, dimensions and cubic measurement of each package, marks and numbers, shipper's export declaration, if needed. Provides dock receipt and special permits, if any, to delivering motor carrier

Driver:
(9-10) Moves his truck in line upon arrival to the pier

Container terminal operator:
(10-11) Verifies driver's identity and issues pass at the gate
(11-12) Checks driver's papers: checks dock receipt, permits, weights
(12-13) Calls driver for unloading
(13-14) Assigns checker and unloading point

Driver:
(15-19) Obtains signed copy of dock receipt, and receipt for extra labor, if used

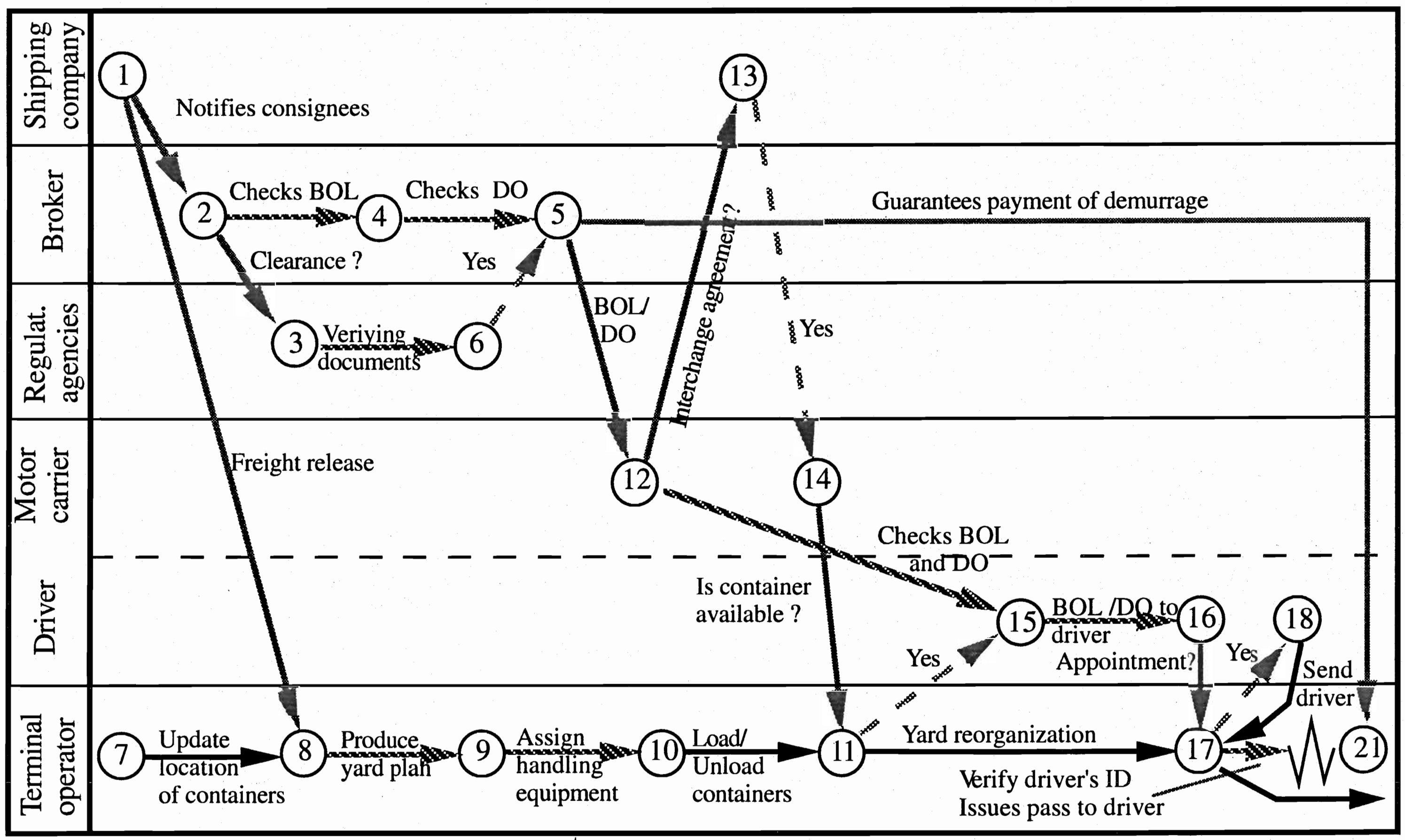
Container terminal operator:
(15-20) Retains original dock receipt
(15-19) Unloads the vehicle
(20-23) Arranges containers for loading at container yard
(23-25) Loads ship

Driver:
(19-24) Surrenders gate pass at gatehouse

Container terminal operator:
(20-21) Forwards dock receipt to steamship company

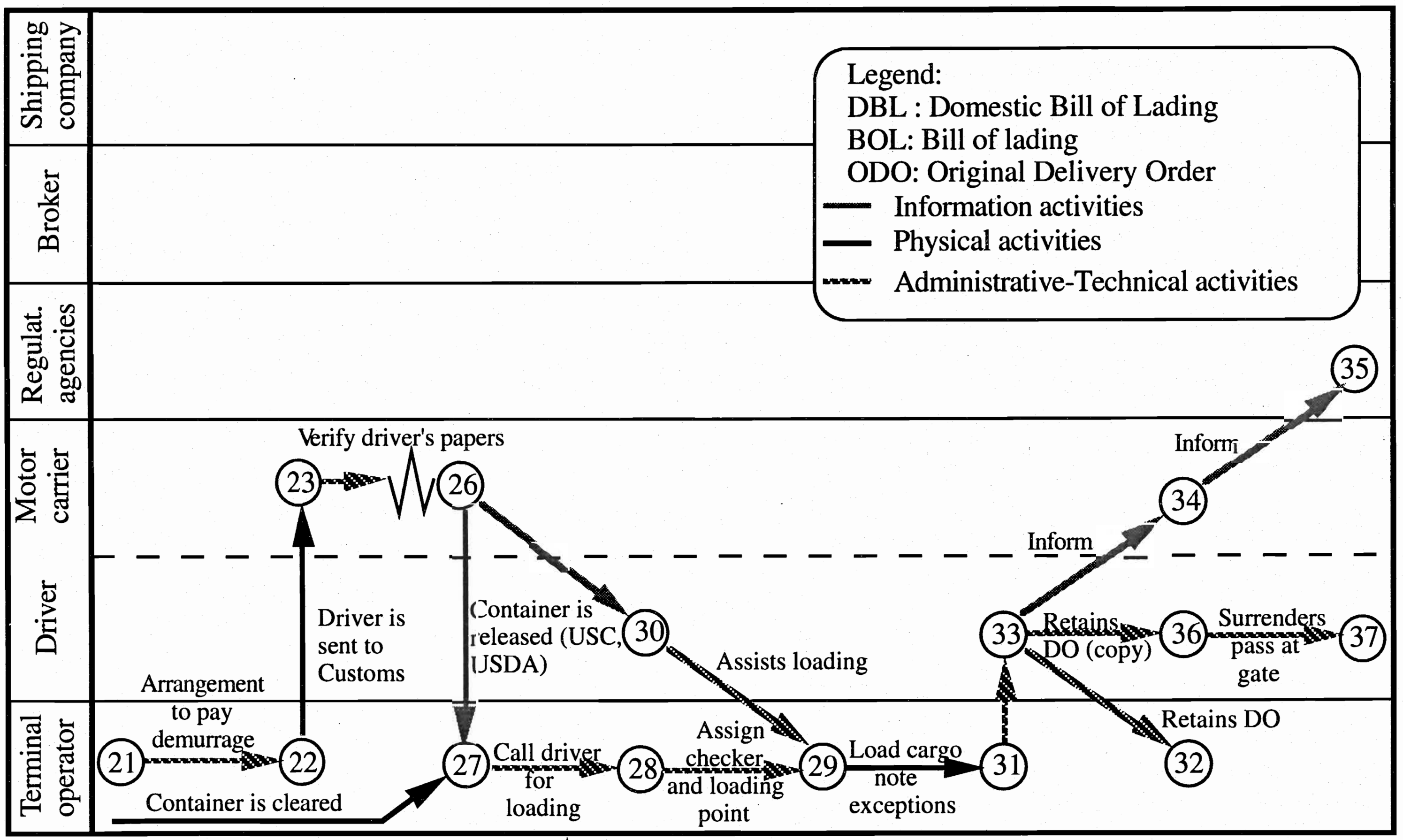
Shipping company:
(17-21) Produces loading plan
(21-23) Forwards ship loading plan to container terminal operator
(21-24) Issues ocean bill of lading to shipper or his agent

Figure 2.2: Activity network for an idealized import process



Note: The symbol ⋀⋁ indicates an activity not depicted in the figure

Figure 2.2: - cont. -



Note: The symbol ⋀⋁ indicates an activity not depicted in the figure

Figure 2.3: Activity network for an idealized export process

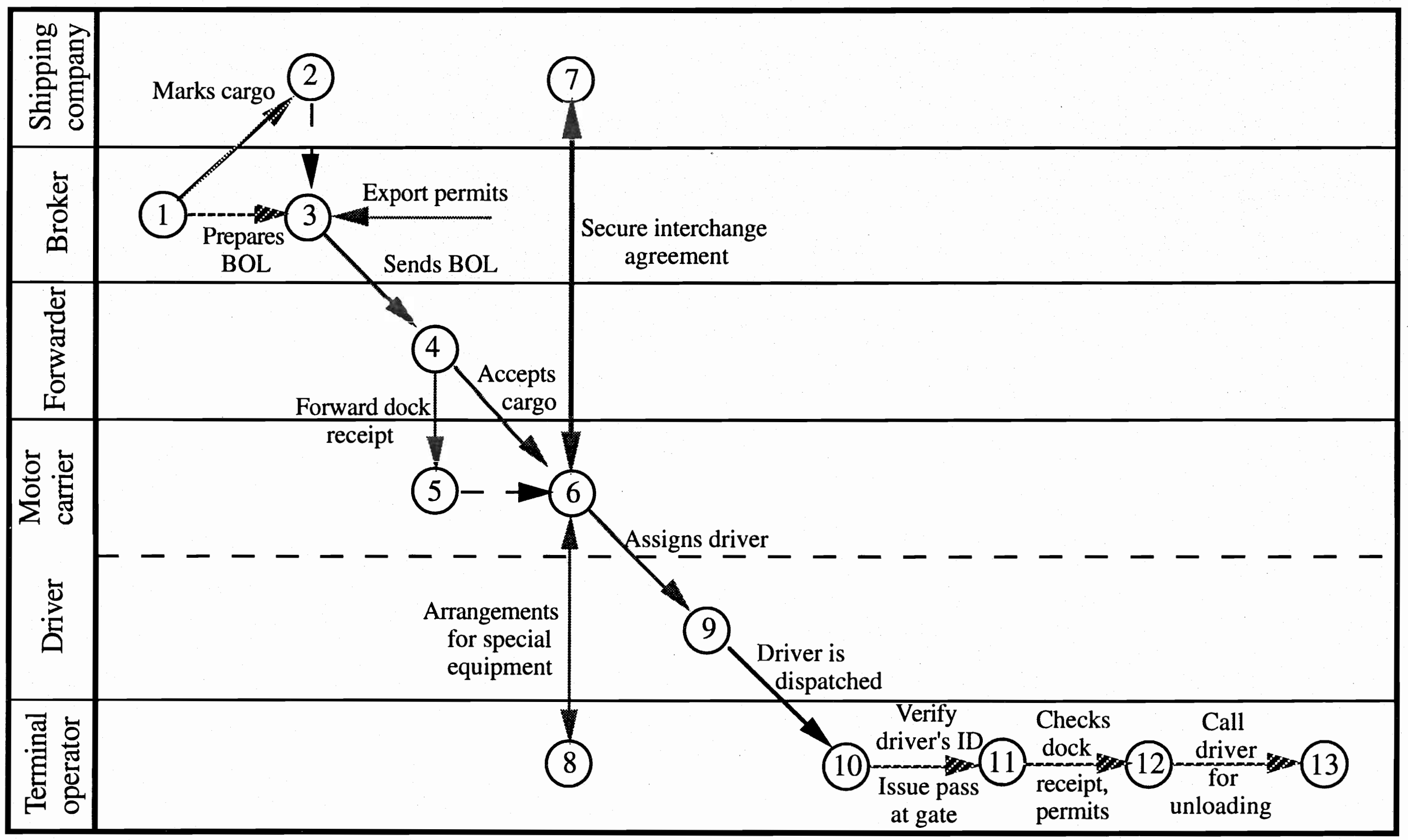
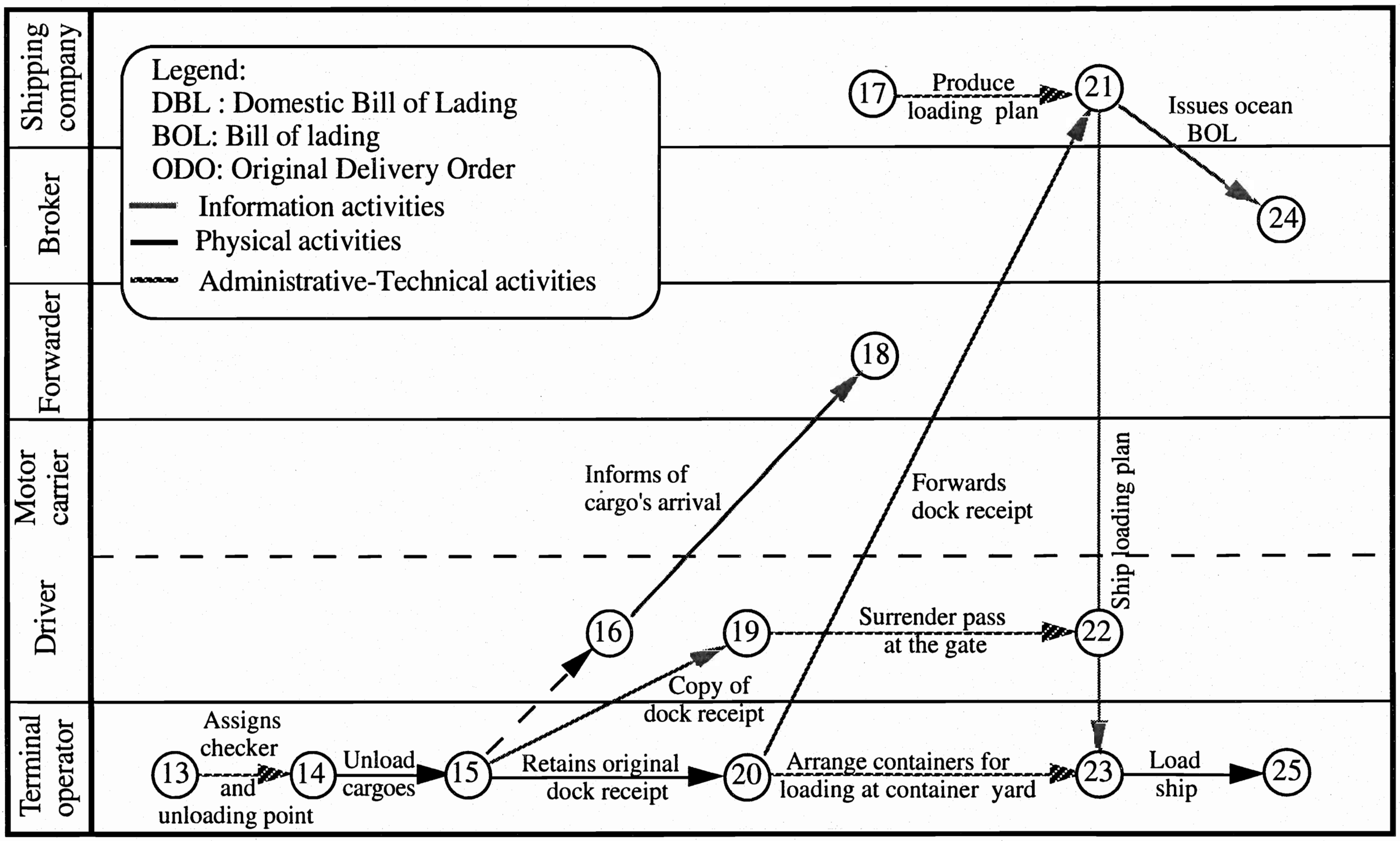


Figure 2.3: - cont. -



The interactions and the internal activities of the container terminal operator are related to two distinct levels of information flow, each of which have different requirements from information systems and information technology. Hence, these requirements will be analyzed separately.

The first level of information flow is shown in Figure 2.4, which depicts the interactions among the agents corresponding to the import process. The information flow was obtained by rearranging the information activities, described in Table 2.1, around the agents involved. As can be seen, at least twelve information activities (some activities are performed more than once) are required per container.

Similarly, Figure 2.5 shows the information flow corresponding to the export process. As seen, at least eleven information activities are required. For a combined import and export volume of 65,000 containers a month, typical for a large terminal, the number of transactions related to import and export containers amount to approximately 1.5 million transactions /month. It is evident that the intensity of this information flow justifies advanced IS/IT implementations.

The second level of analysis focuses on the internal activities of the container terminal operator. Since this research focuses on the analysis of operational issues (e.g., how to use information systems and information technology to enhance port productivity), the description will focus on the activities related to container handling. Therefore, the information flow related to accounting, financial analysis and the like will not be described.

Figure 2.6 shows the internal activities performed by the container terminal operator. These activities have been classified according to three different categories: (a) "Interface with marine transportation modes" that embodies the operational activities on the marine side of the terminal; (b) "Container terminal" that includes the operational activities that do not have an interface with either the maritime or the land transportation modes and (c) "Interface with land transportation modes" that is comprised of activities on the land side of the system.

The next section will present the results obtained from the "Survey on the State of the Practice on Information Systems and Information Technology."

Figure 2.4: Information flow among agents
(import process)

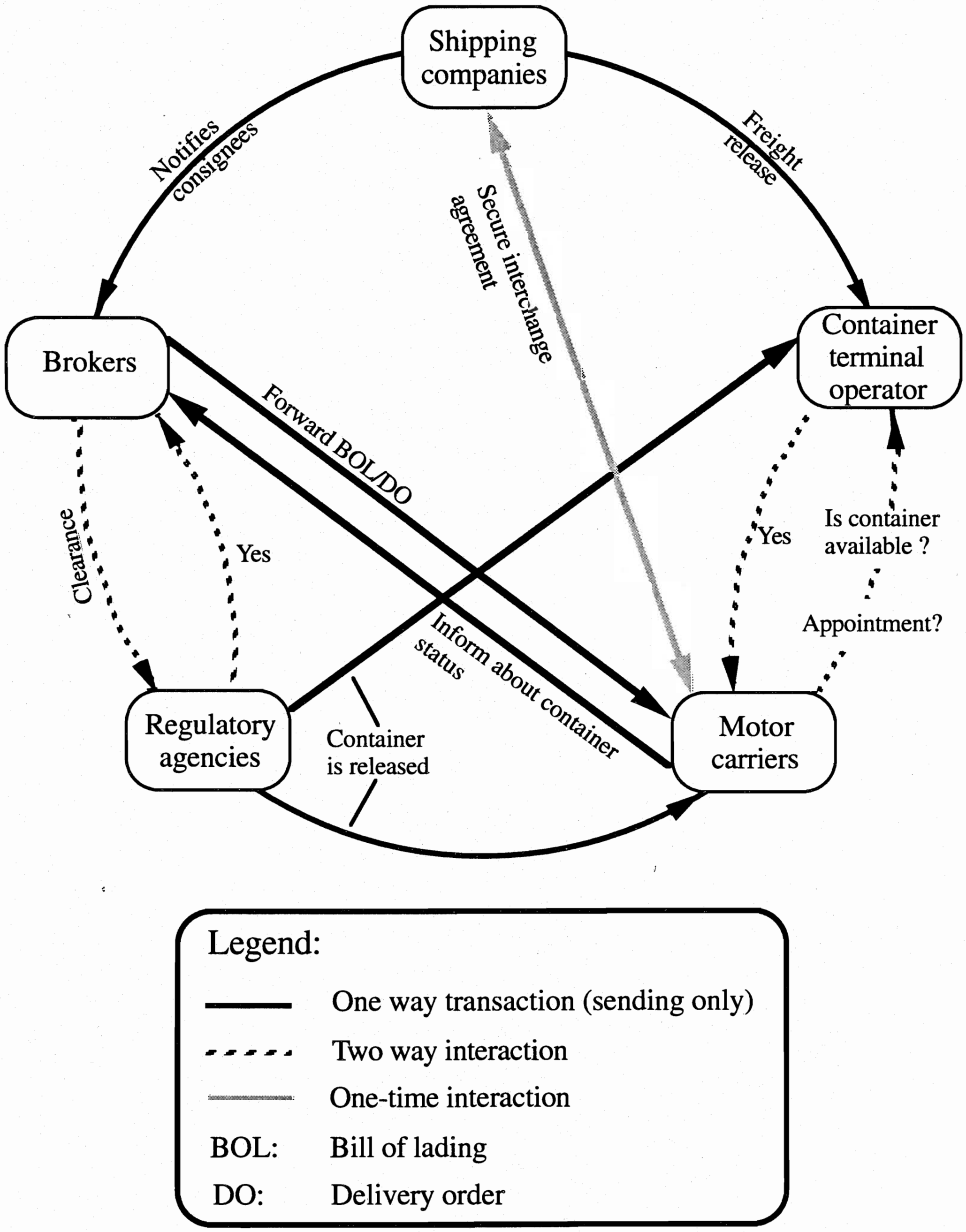


Figure 2.5: Information flow among agents
(export process)

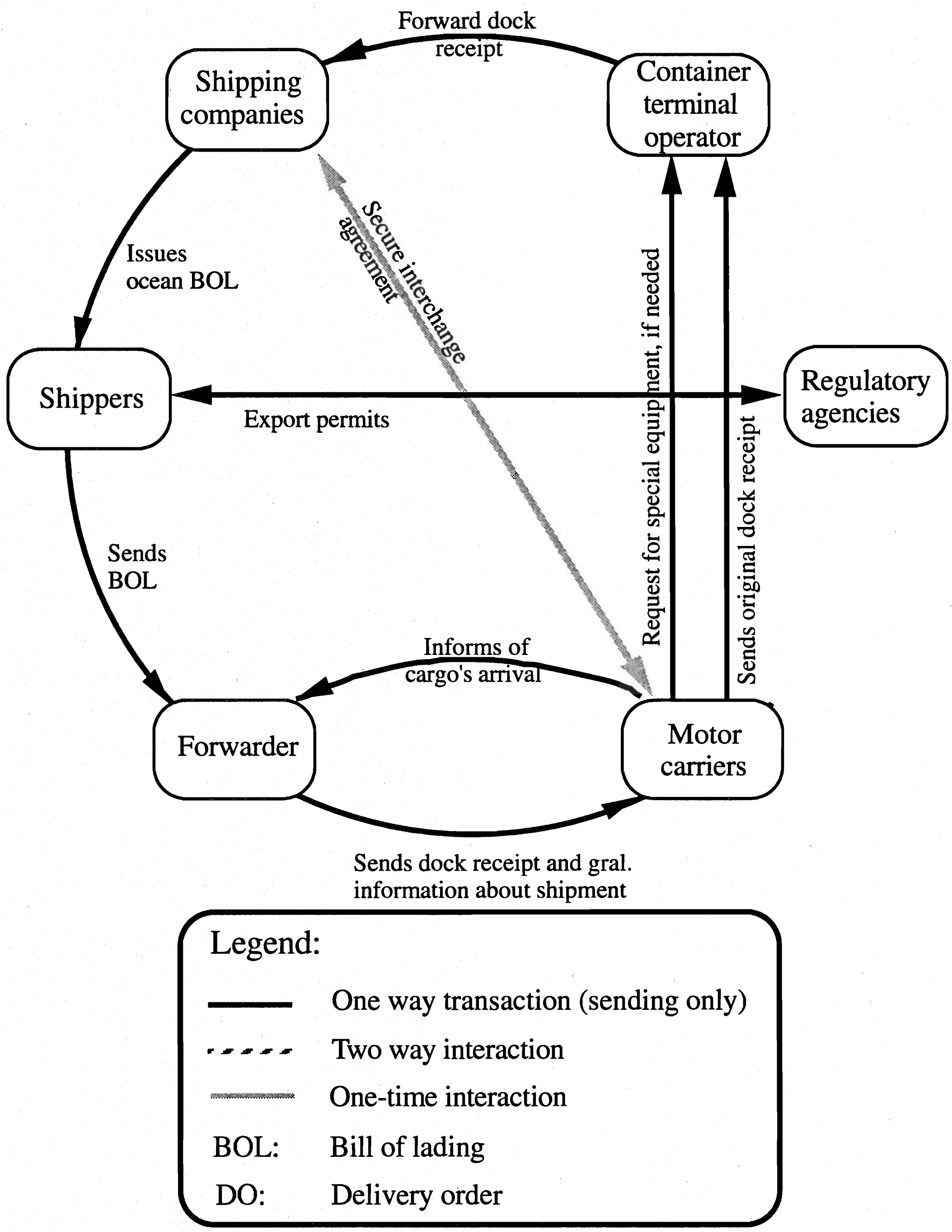


Figure 2.6: Internal activities of container terminal operator

Interface with marine transportation modes	Container terminal	Interface with land transportation modes
	Update container's location	
	Produce yard plan	
	Assign handling equipment to ship and container yard	
Receive ship loading plan		
Arrange containers for loading		
Load/Unload ship		
	Yard reorganization	
		Verify driver's ID Issue pass to driver
		Container is cleared
		Check DO
		Verify motor carrier's credit
		Arrange to pay demurrage
		Call driver for loading
		Assign checker, loading point
		Load cargo, note exceptions
		Retain DO
	Retains original dock receipt from driver	
Forward dock receipt		

CHAPTER 3. ANALYSIS OF THE RESPONSES TO THE SURVEY ON THE STATE OF THE PRACTICE OF INFORMATION SYSTEMS AND INFORMATION TECHNOLOGY

The "Survey on the State of the Practice on Information Systems and Information Technology" provided a glimpse into current practices on marine container terminals. The survey was conducted with the enthusiastic cooperation of the Information Technology Committee of the American Association of Port Authorities (AAPA). Representatives of twelve marine container terminals and three landlord ports responded to the questionnaire. Table 3.1 contains the summary of the responses corresponding to container terminals, as well as the set of questions.

As can be seen in Table 3.1, the questionnaire targeted four different areas. The first section, "General Information," provided information about the general characteristics of the terminal. The second section, "Internal Activities of the Container Terminal," retrieved information about the way in which the most important internal activities are performed. The third section, "Interactions Among the Parties Involved," focused on the interactions that take place among the different agents associated with either importing or exporting containers. The fourth section, "About the Future," gathered the respondents perceptions about the future of information technology.

The terminals included in the sample were assigned an identification code (from T1 to T12). The identification codes and the numbers of twenty foot equivalent units (TEUs) handled/month are presented in Table 3.2.

A wide variety of conditions are represented by the surveyed terminals. Six of the terminals are located on the East Coast, three on the Gulf Coast and three on the West Coast of the United States. The size of operations varies between 700 TEUs/month and 67,000 TEUs/month (see Table 3.1). As shown in Table 3.2, the terminals have a wide range of size of operations.

Table 3.1: Responses to the Survey					
	TERMINAL ID CODE				
A) GENERAL INFORMATION	**T1**	**T2**	**T3**	**T4**	**T5**
1) Number of TEUs/month					
Dry containers	450	5,000	5,000	9,500	20,000
Refrigerated containers	250	30	250	500	200
Roll On/Roll Off	0	0	0	0	10
Total	700	5,030	5,250	10,000	20,210
4) Number of companies serving the terminal					
Shipping companies	8	14	5	1	24
Railroads	1	6	1	2	3
Motor carriers		150	35	55	150
Brokers		20	12	15	200
B) INTERNAL ACTIVITIES OF CONTAINER TERMINAL					
8) Difficulty level in locating containers	Small	Small	Moderate	Small	Small
9) Do you update container location ?	Yes	Yes	Yes	Yes	Yes
10) If yes, How frequently?	Daily	(2a)	Daily	(4a)	Daily
How many man-hours/month does it take?	40	72		(4b)	
How do you identify containers?	Clerks	Clerks	Clerks	Clerks	Clerks
How the information is sent to storage?	Manual	Radio freq	Manual (3a)	(4c)	(5a)
How is the information stored?	Computer	Computer	(3b)	Computer	Various
Purposes of this information?	(1a)	Yard plan	(3c)	Yard plan	(5b)
16) How drivers' identity is verified?	BA	BA	BA	BA	Not
17) How is the truck identified?	BA	n/a	(3d)	BA	BA
C) INTERACTIONS AMONG THE PARTIES INVOLVED					
18) Has this terminal EDI capabilities?	Yes	Yes	Yes	Yes	Yes
19) If yes, How is the use by ship. co's?	Moderate	Intense	Intense	Intense	Intense
Railroads	Low		Low	Low	
Motor carriers	Low		Low	Low	
Brokers	Moderate		Low	Low	
Government agencies	Moderate		Intense	Intense	
24) Container status inquiry systems?	No	In project	Yes	Yes	Yes
25) If yes, describe the system			(3e)	(4d)	(5c)
Level of use by motor carriers?			Low	Low	Moderate
27) How do the shipping companies send freight release to the terminal?	Paper	EDI	EDI	EDI	EDI
28) How motor carriers' credit is verified?	Manual	n/a	Electronic	(4e)	(5d)
29) How is demurrage paid for?	In person	n/a	(3f)	Not	(5e)
30) To your knowledge, how do.. Brokers forward BOL to motor carriers?	EDI	(2b)	(3g)	Don't know	(5f)
Brokers request/receive clearances from government agencies?	EDI	EDI	(3h)	EDI	(5g)
D) ABOUT THE FUTURE					
32)Would help to update cont's location..					
Radio frequency tags	No	Yes (2c)		Yes	
Manual input to hand held computers	Yes	Yes (2d)		Yes	
34)Benefits from standardization?	No	(2e)		Yes	
35)Needs for field encodability?	No	No (2f)		Yes	
36)Needs for temporary storage of info?	No	No (2g)		Yes	

Table 3.1: -cont.-					
	TERMINAL ID CODE				
A) GENERAL INFORMATION	**T6**	**T7**	**T8**	**T9**	**T10**
1) Number of TEUs/month					
Dry containers	44,000	60,000	13,500	14,400	20,000
Refrigerated containers	1,500	5,000		140	8,000
Roll On/Roll Off	0	2,000	n/a	0	
Total	45,500	67,000	13,500	14,540	28,000
4) Number of companies serving the terminal					
Shipping companies	50	60	10	11	5
Railroads	2	1	n/a	1	2
Motor carriers	100	200	+ 1000	500	3,000
Brokers	25	20	n/a	315	n/a
B) INTERNAL ACTIVITIES OF CONTAINER TERMINAL					
8) Difficulty level in locating containers	Small	Small	Small	Moderate	Small
9) Do you update container location ?	Yes	Yes	Yes	Yes	Yes
10) If yes, How frequently?	Daily	Real time	Daily	Daily	2 hours
How many man-hours/month does it take?	n/a	n/a	232	232	28 (10a)
How do you identify containers?	Clerks	Clerks	Clerks	Clerks	Clerks
How the information is sent to storage?	(6a)	Radio freq	(8a)	Radio freq	Radio freq
How is the information stored?	Computer	Computer	(8b)	Computer	Computer
Purposes of this information?	(6b)	(7a)	Yard plan	(9a)	(10b)
16) How drivers' identity is verified?	BA	BA	(8c)	(9b)	Bar codes
17) How is the truck identified?	BA	BA	BA	BA	CCTV
C) INTERACTIONS AMONG THE PARTIES INVOLVED					
18) Has this terminal EDI capabilities?	Yes	Yes	Yes	Yes	Yes
19) If yes, How is the use by ship. co's?	Intense	Intense	Intense	Intense	Intense
Railroads	Intense	Moderate	n/a	Moderate	Intense
Motor carriers				Low	Moderate
Brokers				Low	Low
Government agencies	Intense	Intense	Intense	Moderate	Low
24) Container status inquiry systems?	Yes	Yes	Yes	Yes	Yes
25) If yes, describe the system	(6c)	(7b)	(8d)	(9c)	(10c)
Level of use by motor carriers?		Low	n/a	Intense	Intense
27) How do the shipping companies send freight release to the terminal?	Via CRT	Paper+EDI	EDI	(9d)	EDI
28) How motor carriers' credit is verified?	Manually	Manually	Computer	Computer	EDI
29) How is demurrage paid for?	(6d)	Personally	(8e)	(9e)	Personally
30) To your knowledge, how do.. Brokers forward BOL to motor carriers?	(6e)	n/a	Fax	Fax	Fax
Brokers request/receive clearances from government agencies?	EDI	EDI	EDI	EDI	Fax
D) ABOUT THE FUTURE					
32)Would help to update cont's location..					
Radio frequency tags	Yes	Yes	(8f)	Yes	Yes
Manual input to hand held computers	No	Yes	Yes (8g)	(9f)	Yes (10d)
34)Benefits from standardization?	Yes	Yes	Conditional	Yes	Yes
35)Needs for field encodability?	Yes	Yes	Conditional	Yes	No
36)Needs for temporary storage of info?	Yes	Yes	Yes	No	Yes

Table 3.1: -cont.-		
	TERMINAL ID CODE	
A) GENERAL INFORMATION	**T11**	**T12**
1) Number of TEUs/month		
Dry containers		20,000
Refrigerated containers		1,000
Roll On/Roll Off		16,500 (12a)
Total	+/- 50,000	37,500
4) Number of companies serving the terminal		
Shipping companies	31	25
Railroads	2	3
Motor carriers	4,000	250
Brokers	500	15
B) INTERNAL ACTIVITIES OF CONTAINER TERMINAL		
8) Difficulty level in locating containers	Small	Small
9) Do you update container location ?	Yes	Yes
10) If yes, How frequently?	On line	Real time
How many man-hours/month does it take?	n/a	n/a
How do you identify containers?	(11a)	Clerks
How the information is sent to storage?	(11b)	(12b)
How is the information stored?	Computers	Computers
Purposes of this information?	(11c)	(12c)
16) How drivers' identity is verified?	BA (11d)	BA
17) How is the truck identified?	BA (11e)	BA
C) INTERACTIONS AMONG THE PARTIES INVOLVED		
18) Has this terminal EDI capabilities?	Yes	Yes
19) If yes, How is the use by ship. co's?	Intense	Intense
Railroads	Intense	Low
Motor carriers	Moderate	Low
Brokers	Moderate	Low
Government agencies	Intense	Moderate
24) Container status inquiry systems?	Yes	Yes
25) If yes, describe the system	(11f)	(12d)
Level of use by motor carriers?	Moderate	Low
27) How do the shipping companies send freight release to the terminal?	EDI	EDI
28) How motor carriers' credit is verified?	EDI	(12e)
29) How is demurrage paid for?	(11g)	(12f)
30) To your knowledge, how do.. Brokers forward BOL to motor carriers?		Fax
Brokers request/receive clearances from government agencies?		EDI
D) ABOUT THE FUTURE		
32)Would help to update cont's location..		
Radio frequency tags	Conditional	(12g)
Manual input to hand held computers	Yes	Yes (12h)
34)Benefits from standardization?	No	Yes
35)Needs for field encodability?	Conditional	Not sure
36)Needs for temporary storage of info?	Yes	Not sure

NOTES:
Blanks in the matrix indicate blanks in the questionnaire.

BA: Booth attendant
BOL: Bill of lading

1a: Statistical purposes + Bookkeeping

2a: Before each ship
2b: Telephone + Fax
2c: It would help monitor turn times, productivity and other things
2d: We have been using this for many years
2e: On Ship: Yes. At the Yard: No.
2f: We maintain this on our computers
2g: Transponders-- No.

3a: Manually. In the future, using radio frequency devices
3b: Paper + Computers
3c: Statistical purposes + To produce yard plan + Bookkeeping + Financial
3d: Booth attendant + Closed circuit cameras at the gate
3e: Online access + Dial-up modem from 7:00 am to 5:00 pm daily
3f: Personally + Electronically + EDI/online guarantees
3g: Fax + Courier services
3h: Electronic Data Interchange (EDI) + Manually

4a : Whenever the container is moved
4b: Not measurable
4c: The system tells the longshoremen where to put the container. Thus, the info is already stored.
4d: Touch tone phone access 24 hours/7 days a week
4e: Not concerned with this issue because the steamship lines maintain an authorized list of motor carriers

5a: Radio to clerk, enter via CRT and via list
5b: Statistical purposes +To produce yard plan + Financial
5c: 24 hours/7 days a week. Both touch tone phone access + dial in to on-line system
5d: Not verified. Bills typically go to carrier, agent, broker or forwarder
5e: Demurrage is not charged. May charge storage to carrier.
5f: Telephone + Fax
5g: EDI + Manually

6a: Keyed CRT. In the future, using radio frequency devices
6b: Statistical purposes + To produce yard plan + Bookkeeping
6c: 6:00/11:00 pm access by CRT. Updated hourly
6d: Check by US mail
6e: Telephone (some); fax (some); EDI (some)

7a: Statistical purposes +To produce yard plan + Financial
7b: Touch tone phone access 24 hours/7 days a week

8a: Radio frequency devices + Manually
8b: Paper + Computers
8c: Booth attendants + Magnetic strip cards
8d: Access is 24 hours, 7 days a week. Access is controlled by specific job function and user ID.
8e: Credit on a customer by customer basis.
8f: Too expensive.
8g: Currently active.

9a: Statistical purposes + To produce yard plan + Financial.
9b: Bar coded cards identify the driver.
9c: he terminal has a container availability telephone system in place which allows truckers and brokers to inquire on the status of a container or booking at any time - 24 hours a day- via touch tone phone. The system provides, among other information, customs and freight release and demurrage due.
9d: Some smaller lines still have paper systems.
9e: Electronically. However, we will accept personal payment by trucker.
9f: Yes. Currently in use.

10a: When the container arrives to the terminal a magnetic strip is attached to it. The magnetic strip identifies the container as loaded or empty. A vehicle equipped with radio frequency devices drives through the terminal locating the containers, the clerk reads the container numbers and input the container numbers into the computer. (The estimate of man-hours does not include the time spent attaching the magnetic strips. Assuming one minute per container, the additional man-hours amount to approximately 500 man-hours/month).
10b: Statistical purposes + To produce yard plan
10c: Touch tone telephone + ASCII dial via PC's. 23 hours, 7 days a week
10d: Yes. Already in use

11a: Clerks + Electronic tags
11b: Manually + Radio frequency
11c: Statistical purposes + To produce yard plan + Financial + Operational decision making
11d: Booth attendants + Bar coded cards
11e: Booth attendants + Transponders on the trucks
11f: Touch tone telephone
11g: Personally + Guarantees

12a: Mostly autos.
12b: Manually + radio frequency devices
12c: Statistical purposes + to produce yard plan + bookkeeping + financial.
12d: Full terminal management system with real time query. CRTs distributed throughout terminal. PCs using terminal emulation are widely used in local shipping companies. 24 hours, 7 days a week.
12e: Local steamship lines maintain credit and authorization of motor carrier. They can inmediately block carrier via computer if they choose to do so.
12f: This is strictly between motor carrier, shipper and shipping lines. We carry last free day on screen for information purposes only.
12g: Conditional. It may help to quickly spot containers.
12h: We are currently using radio frequency handheld computers.

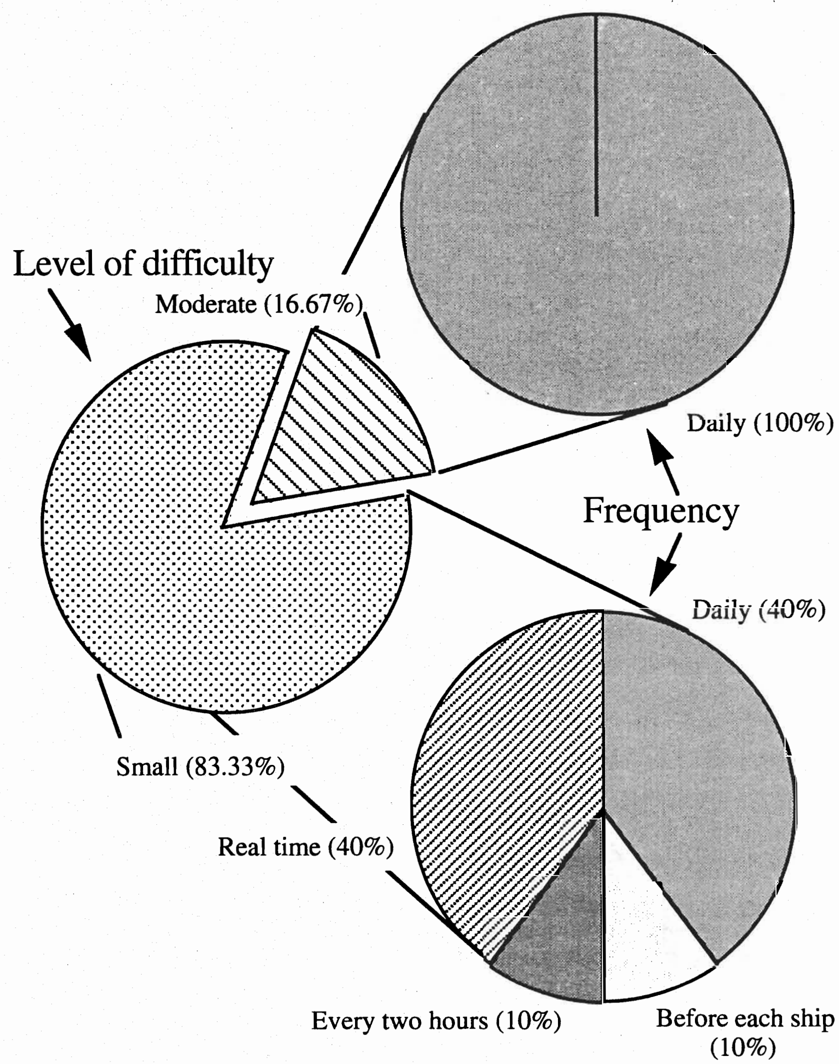
Table 3.2: Distribution of terminals by size of operations	
Terminal :	**TEUs/month**
T1	700
T2	5,030
T3	5,250
T4	10,000
T5	20,210
T6	45,500
T7	67,000
T8	13,500
T9	14,540
T10	28,000
T11	50,000
T12	37,500

The following sections present the main results and conclusions extracted from the survey. The order of the analysis follows the order of the questions in the survey. The number of responses are indicated in parentheses.

Information about container location systems:

All the respondents classify the level of difficulty of locating containers in the yard from small (ten responses) to moderate (two responses). Six of the terminals, T1, T3, T5, T6, T8 and T9, update container locations daily. T2 updates location before each ship's arrival. One terminal, T10, updates location every two hours. The two largest terminals, T7 and T11, the fourth largest, T12, and the fourth smallest, T4, have real-time updating systems. Figure 3.1 shows the level of difficulty and frequency of updating container location for the surveyed terminals.

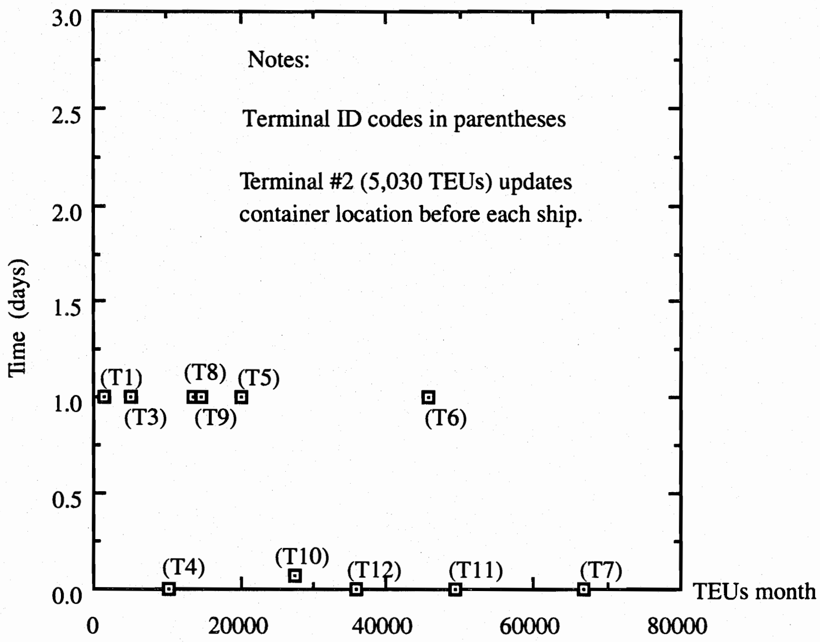
Figure 3.1 Level of difficulty of locating containers and frequency of updating location



As can be seen in Figure 3.1, 40% of the terminals that reported small level of difficulty in locating containers are using real-time, or quasi real-time location systems. On the other hand, 100% of the terminals that reported moderate level of difficulty in locating containers only update location daily.

Figure 3.2 shows the time interval between consecutive container location updates and size of the terminal. As can be seen, there is no correlation between these two variables (see Figure 3.2).

Figure 3.2: Time interval between container location updates



While all terminals reported the use of clerks to identify containers, only six of them provided estimates of the number of man-hours needed to update container location (see Figure 3.3).[5] According to these estimates, an average of 15.13 man-hours/month are required per 1,000 TEUs/month. Assuming that this average is valid for the upper range of size of operations, a rough estimate of man-hours needed to update container location can be calculated. For the size of operations represented by terminals T4 through T7, the corresponding values are shown in Table 3.3. These values can be interpreted as an upper bound on the labor requirements for such a task, and they can be used to estimate the potential savings attributable to the implementation of more efficient information systems.

[5] Two out of these six terminals are using magnetic strip cards and radio frequency tags in conjunction with clerks. Since the objective of this analysis is to quantify the man-hours required by the "traditional" approach of using clerks, the estimates provided by these two terminals were left out of the analysis.

Figure 3.3: Man-hours/month spent in updating container location

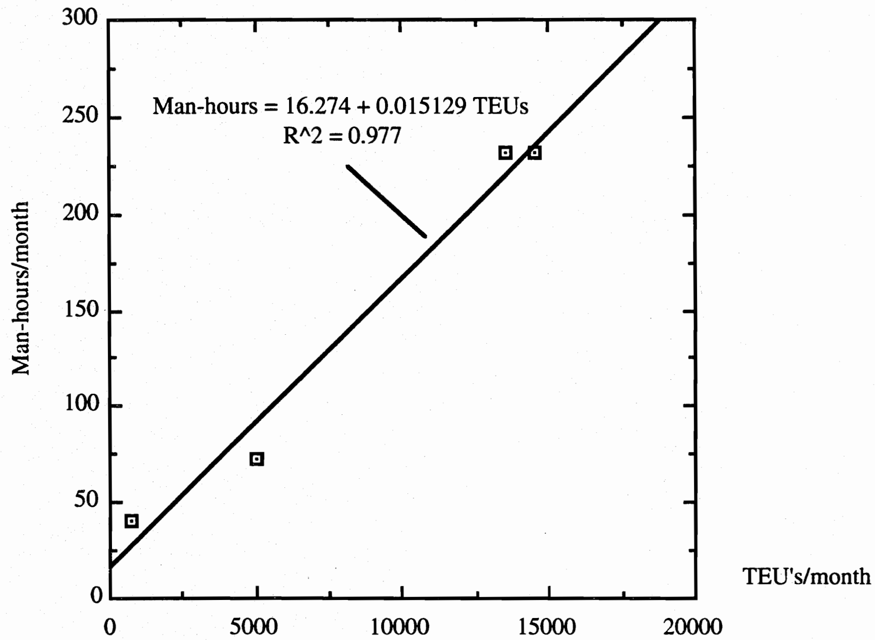


Table 3.3: Man*hours needed to update container location (estimated)	
TEUs/month	**Man-hours/month**
5,000	92
10,000	168
20,000	319
30,000	470
40,000	621
50,000	773
60,000	924
70,000	1075

As can be seen in Figure 3.4 the vast majority of terminals, 58.33%, are using radio frequency devices to transmit container location data to storage, while an additional 16.66% are planning to implement such systems. On-line systems are the second most used system (16.67%). In only one case, T1, the information about container location is sent to storage manually only. In all terminals, the information about container location is stored in computers.

The most common uses of this information are: "to produce the yard plan" (eleven responses) and "statistical purposes" (nine responses), followed by: "financial" (five responses) and "bookkeeping" (four responses).

Figure 3.4 Technology used to send container location data to storage

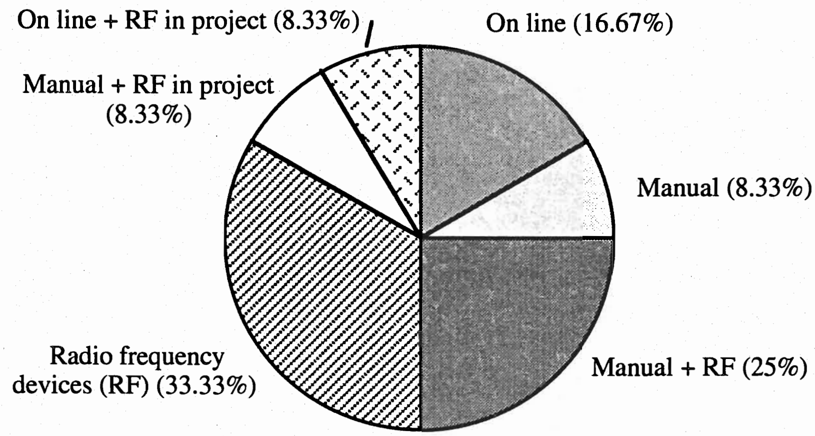
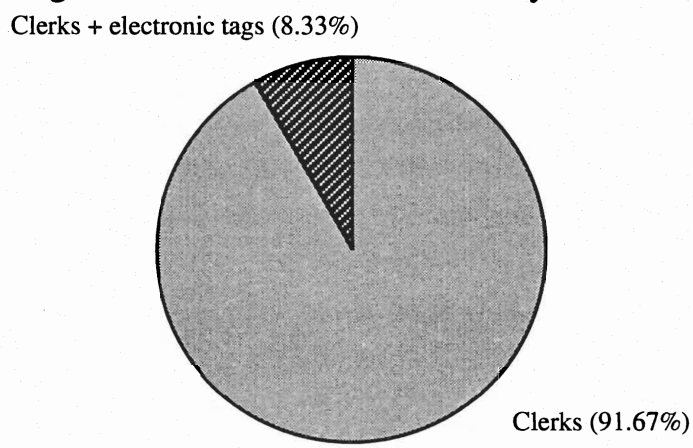


Figure 3.5:Methods used to identify containers



As can be seen in Figure 3.5, the most widely used method to identify containers, as expected, is by using clerks. This situation may change in the future if electronic tags for containers increase their acceptance.

Information about gate processes:

In seven terminals, booth attendants identify drivers; while in four cases the identification is done by using special cards (magnetic strip cards in T8 and bar coded cards in T9, T10 and

T11). In one case, T5, the driver's identity is not verified. Figure 3.6 shows the methods used to identify drivers.

Figure 3.6 Driver identification methods

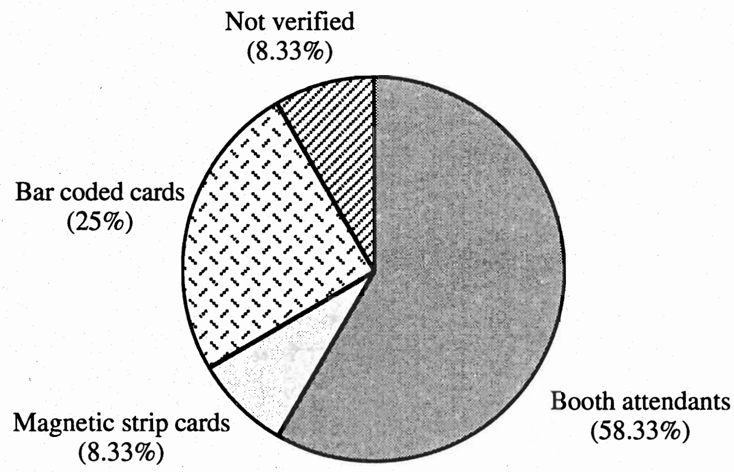
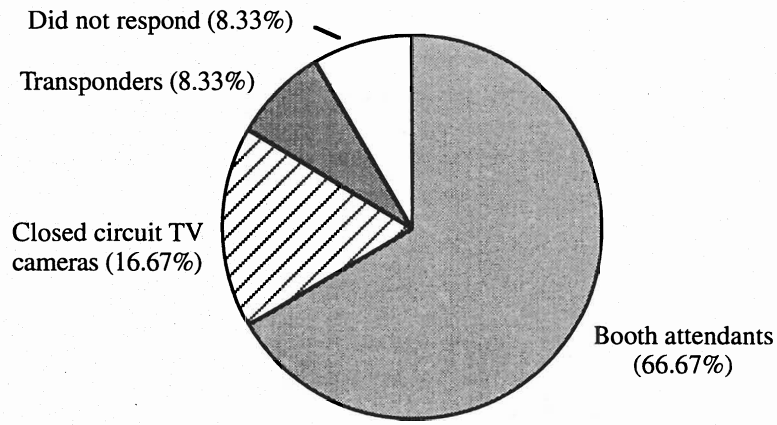


Figure 3.7 Truck identification methods



As can be seen in Figure 3.7, the majority of the terminals do not use advanced information technology to identify trucks. In most of the cases trucks' identities are verified by booth attendants. Only in two terminals special equipment is used, transponders (electronic tags) in T11 and closed circuit television cameras (CCTV) in T10.

Information about the use of electronic data interchange (EDI):

All terminals reported as having EDI capabilities. The representatives of the container terminals were asked to classify the level of EDI use by the different parties involved. The responses were:

a) Shipping companies: intense (eleven responses), moderate (one response)

b) Railroads: low (four responses), moderate (two responses) and intense (three responses)

c) Motor carriers: low (five responses), moderate (two responses)

d) Brokers: low (five responses) and moderate (two responses)

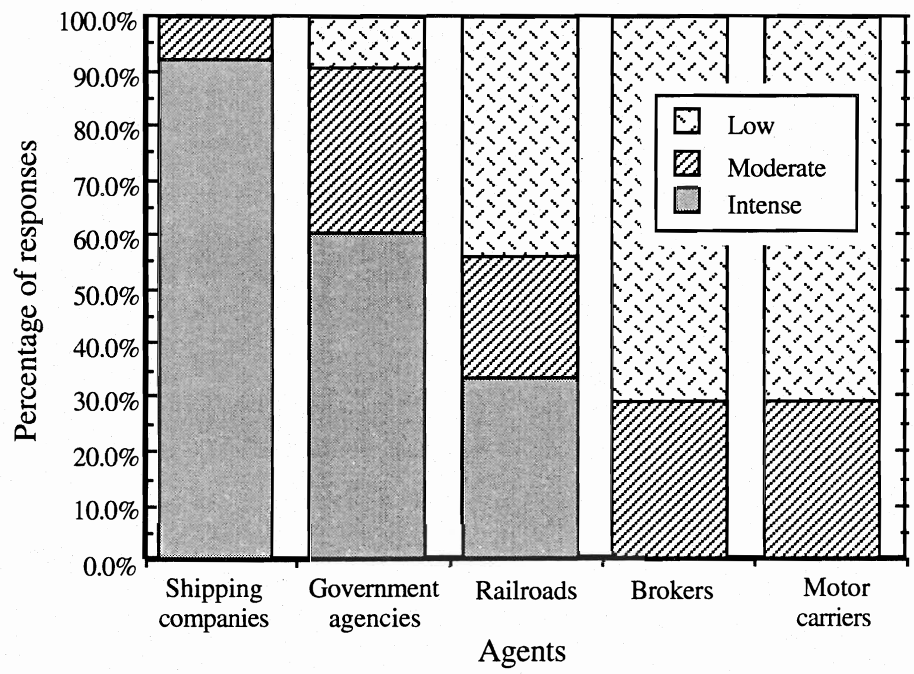
e) Government agencies: intense (six responses), moderate (three responses) and low (one response)

As can be seen in Figure 3.8, the respondents have a fairly homogenous opinion about the level of EDI use by shipping companies and government agencies, which they qualify as "intense." This result is not surprising given the fact that both groups have been very active in promoting EDI applications.

On the other end of the spectrum, motor carriers were classified under "low" EDI use, which is also consistent with the findings of previous studies that indicate lack of integration of motor carriers to EDI systems.

The classification of railroads and brokers under "low" use of EDI was not expected. It may be a reflection of local conditions that need further analysis before drawing definite conclusions.

Figure 3.8: Intensity of use of EDI by agent



Information about container status inquiry system:

Ten out of the twelve terminals have a container status inquiry system. The two smallest terminals, T1 and T2, did not have one, though T2 is currently planning such a system. The touch tone telephone access systems appears to be the most popular; seven out the twelve terminals have implemented this type of system. Five of the terminals, T3, T5, T6, T10 and T12, offer the possibility of on-line access to their systems. The access hours vary: 7:00 am to 5:00 pm (T3); 6:00 am to 11:00 pm (T6); 23 hours, 7 days a week (T10) and 24 hours, 7 days a week (T4, T5, T7, T8, T9, T11 and T12).

Figures 3.9 and 3.10 show an interesting situation. The vast majority of terminals, 83.33%, have implemented a container status inquiry system or have the system in project, 8.33%. However, the end users, motor carriers, do not seem to use the system as the developers anticipated. Half of the respondents classify the level of use by motor carriers as low and another quarter as moderate.

There may be a number of different explanations about this disparity. The first one may be that container terminals and motor carriers have different perceptions about the potential benefits attributable to container status inquiry systems. Another possible explanation may be that tradition and inertia are the trademarks of motor carriers. Whatever the explanation may be, the lack of integration of motor carriers with modern information technology seems to be a consistent theme in intermodal transportation that needs to be addressed with an aggressive policy.

Figure 3.9: Container status inquiry system

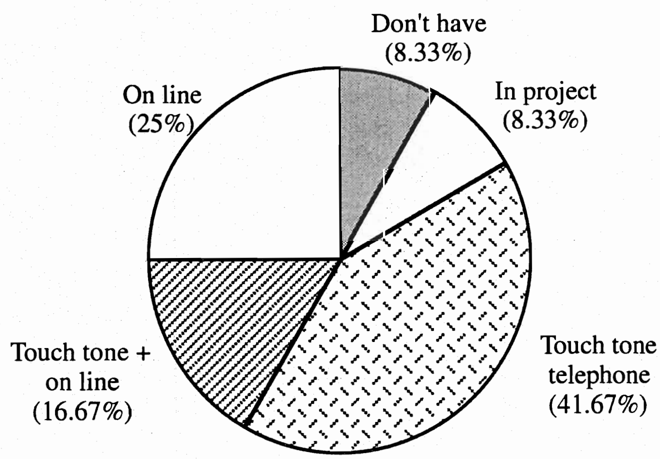
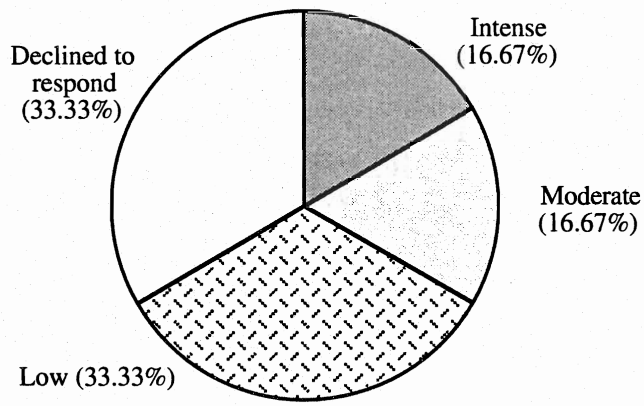


Figure 3.10: Level of use of container status inquiry systems by motor carriers



Information about other interactions:

EDI is most widely used in links connecting shipping companies to container terminals and brokers to government agencies. In the former case, eleven out of twelve terminals reported the use of EDI to send the freight release. In one case the release is sent manually. Figure 3.11 shows the technologies used to send the freight release. Ten respondents reported that brokers receive and request clearances from government agencies predominantly by EDI (see Figure 3.12).

Figure 3.11: Technologies used by shipping companies to send freight release to container terminal

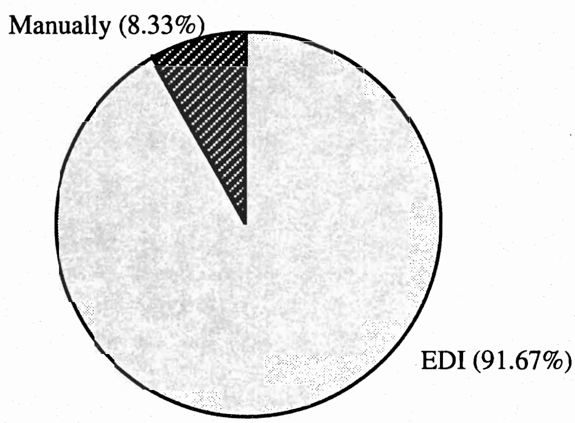
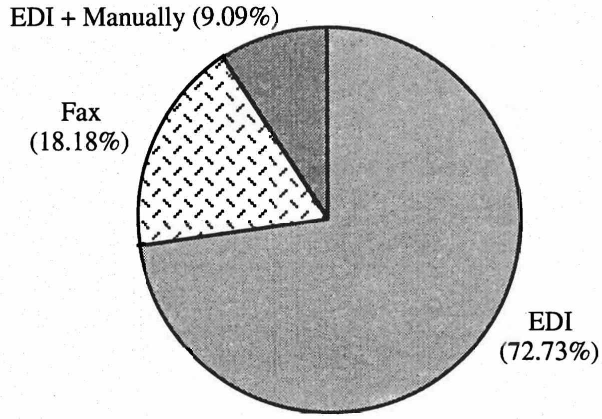
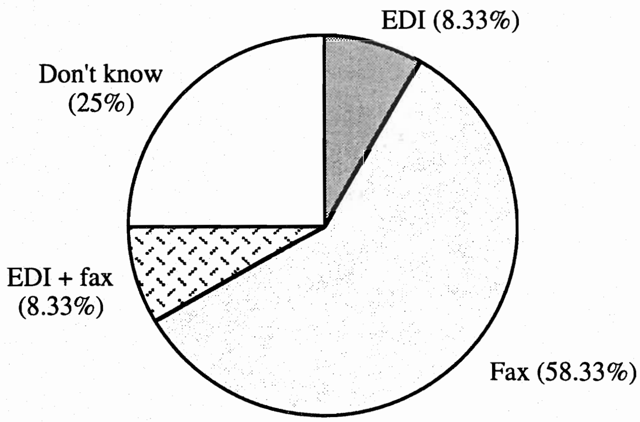


Figure 3.12: Technologies used by brokers to request/receive clearances from government agencies



In contrast, the transactions linking brokers to motor carriers are done by means other than EDI. According to the survey, brokers send bills of lading to motor carriers predominantly by fax. Three of the respondents did not respond to this question (see Figure 3.13).

Figure 3.13: Technologies used by brokers to send bill of lading to motor carriers



Other uses for information technology are interactions of a financial nature. The survey indicated that in this area there is room for information technology applications. Two activities of this type were considered in the survey: a) credit verification of motor carriers and b) the payment of demurrage charges. In the first case, credit is verified manually in three terminals (T1, T6 and T7). In six cases (T3, T8, T9, T10, T11 and T12) it is verified electronically. Three terminals, T2, T4 and T5, do not verify credit for different reasons (see Figure 3.14).

Figure 3.14: Credit verification of motor carriers

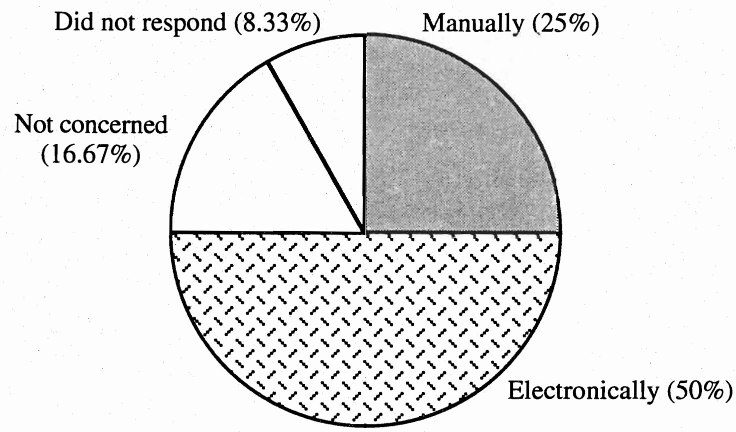
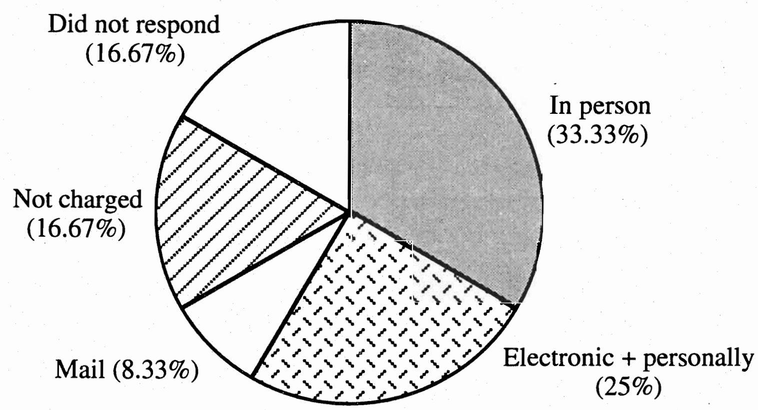


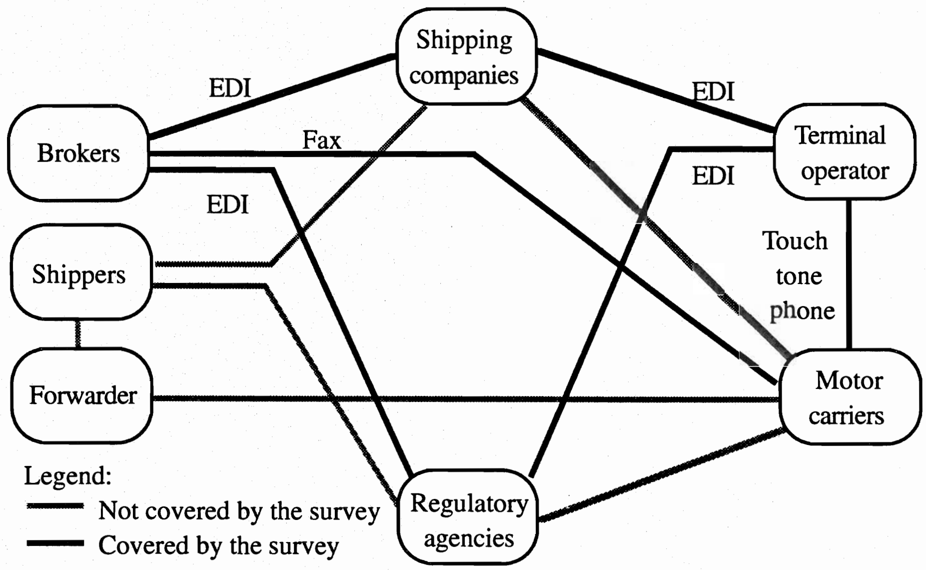
Figure 3.15: Means used to pay demurrage



As can be seen in Figure 3.15, the predominant method to pay demurrage is in person, followed by electronic transactions plus in person and mail. In two cases, demurrage is not charged at all.

Using the responses discussed in the previous paragraphs, the predominant means of communication among the different agents were determined (see Figure 3.16). As shown in Figure 3.16, motor carriers are linked to the other agents predominantly by telephone communication, while the other agents have significant interaction by EDI.

Figure 3.16 Predominant modes of communication



<u>About the future:</u>

The last section of the survey gathered information on the respondent's perception about the future of information technology. The questions asked followed, to a certain extent, the questionnaire used by Kromberg (KROMBE88) in the survey conducted by the American Association of Railroads (AAR) and the Massachussetts Institute of Technology (MIT). It was expected that by using the same set of questions some comparisons could be made about how the perception about the future of information technology has evolved over time. However, since Kromberg's survey targeted rail intermodal terminals, the comparison is limited because the working environments are vastly different. The questions common to both surveys, as well as the responses, are shown in Tables 3.4 and 3.5.

Table 3.4: Responses about the future. AAR-MIT survey (1987)

- Would help to update inventory..	Yes	Conditional	No
Radio frequency tags	1	4	9
Manual input to hand held computers	4	3	7
- Benefits from standardization?	9		5
- Needs for field encodability?	7	1	3
- Needs for temporary storage of info?	5	3	3

Table 3.5: Responses about the future. AAPA-UT survey (1995)			
- Would help to update cont's location..	Yes	Conditional	No
Radio frequency tags	6	2	2
Manual input to hand held computers	9 (1)		1
- Benefits from standardization?	8 (2)		3 (2)
- Needs for field encodability?	4	2	4 (3)
- Needs for temporary storage of info?	6		4 (3)

Notes:

(1) Five out nine terminals are currently using hand held computers.

(2) One of the respondents answered that standardization would be beneficial to locate containers on ship and that it would not be beneficial to locate containers in the yard.

(3) One respondent answered "Not sure."

As can be seen in Tables 3.4 and 3.5 there has been a significant change in the perception of the potential benefits of radio frequency tags. In 1987, the majority of the respondents doubted that electronic tags could be of any help. Eight years later, 98% of intermodal equipment is equipped with radio frequency tags.[6] On the other hand, the majority of the representatives of the marine container terminals agreed in considering radio frequency tags as beneficial.

Manual input to hand-held computers also experienced a change in perception. In 1987, only 40% of the respondents considered it to be of any help. In 1995, the vast majority of the respondents consider manual input to hand-held computers as beneficial to their operations. Five terminals reported to be using such a system. As can be seen, predicting the future of information technology is a highly difficult task because of the magnitude and character of the forces involved.

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[6] AAR ruled that all Class I railroads must tag their intermodal equipment by January 1, 1995.

CHAPTER 4. THE ROLE OF INFORMATION TECHNOLOGY ON THE IMPLEMENTATION OF PRIORITY SYSTEMS

This section focuses on defining the general characteristics IS/IT should have to support the implementation of PS.

As seen in previous sections, handling containers at marine container terminals involves intensive information exchange among agents as well as within the container terminal operator. Since PS add another dimension (i.e., priority level) to the information flow, the impact of this added demand upon the information system needs to be analyzed.

This research is concerned with the analysis of the implementation of PS at marine container terminals and, consequently, the scope of the section's analysis will focus on the information activities within the container terminal and its main interactions. The analysis will be done by estimating the impact of PS upon the basic information functions: creation, updating, storage, processing and transmission of information, identified by the letters C, U, S, P and T (see BIRAN84). Table 4.1 shows qualitative estimates of the impacts that PS may have upon the information functions associated with the internal activities of the container terminal operator.

As can be seen in Table 4.1, the activities on the marine side interface are likely to experience a slight increase in the amount of information flow. Transmitting ship loading plan, for instance, would have to include container priority as well. Since the extra amount of information is not significant, it can be accommodated easily by existing EDI links.

Table 4.1 : Expected impacts

	Information functions:				
Activity:	**C**	**U**	**S**	**P**	**T**
A) Marine side interface					
Receive ship loading plan	+	+	+	+	++
Arrange containers for loading	++	++		+++	
B) Container terminal					
Update container's location	*	*	*	*	*
Produce yard plan				+++	
Assign handling equipment				+++	
C) Land side interface					
Verify truck and drivers's ID	*	*	*	*	*
Verify documentation				++	

Legend:
+ : Slight impact on information flow
+ +: Moderate impact on information flow
+ + +: Significant impact on information flow
*: Greater reliability and efficiency are required

Processing the information associated with "arrange containers for loading" is likely to require redesigning the logic of the computer programs used to determine the stowage plan. This may be needed so that they are able to take into consideration the container priority and the impact of a particular stowage plan upon the productivity of the next port.

The internal activities of container terminal operators are likely to be significantly changed by the implementation of PS. The nature of this change is not only operational, it is informational as well.

Faster and more reliable container identification methods are needed for two different purposes. First, since the priority level would determine the kind of treatment the container receives, identification errors may be costly (e.g., sending a high priority container through a low priority channel may imply significant opportunity costs). Second, having fast and reliable container identification methods would increase the efficiency and reliability of container location technology.

In addition, implementing PS will require changes in the way the yard plan is produced and the yard equipment is assigned. In the former case, the yard plan should be aimed at expediting the flow of high priority containers, while keeping operating costs at a reasonable level. Regarding the latter, yard crane allocation rules -usually based on queue lengths- should be redesigned to consider that containers belonging to different priorities have different opportunity costs.

On the land side interface, it is of primary importance to implement efficient gate operations. High priority containers are usually retrieved within a short period of time after ship arrival and, if the number of incoming trucks is high, the waiting costs (determined by waiting times and opportunity costs) may be unacceptable for this segment of users.

As seen above, the implementation of priority systems is expected to add new demands on the information systems at marine ports. It is found that the expected increment in the information flow can be handled by the existing information technology if modifications are made. However, the "Survey on the State of the Practice on Information Systems and Information Technology" indicated an uneven use of information technology across the different agents involved. Since, in order to take full advantage of the possibilities offered by IS/IT, it is required the active participation of all parties, the success of information technology will depend on the ability to integrate the agents that have been reluctant to embrace modern technology. The next section discusses this aspect as well as the conclusions of this research.

CONCLUSIONS

Although limited by the small sample size, the following conclusions are drawn:

a) Information and computation technology are very pervasive. Even the smallest terminal reported the use of modern computation technology that would allow the terminal to implement more sophisticated information technology systems when the need arises.

b) The extrapolation of the data gathered in this survey, regarding resources consumed in container location, indicate that significant savings can be achieved by using more efficient container identification and container location equipment.

c) The results of the survey corroborated previous findings that indicate that motor carriers have not been successfully integrated with an information technology environment, especially EDI. The respondents classified the integration of motor carriers as "low." Furthermore, the motor carriers were reported to make a "low" to "moderate" use of information systems intended for their use, such as the container inquiry system. Since taking full advantage of the possibilities of information technology and information systems requires the active participation and integration of all parties involved, providing incentives to motor carriers should be considered as a primary policy goal.

d) The data provided by the survey indicated that, for the typical terminal, the information flows among agents (referred to as "interactions") and within terminal operators are very loosely integrated. It is our believe that significant benefits could be attained through better integration of the IS/IT into all levels of information flows.

e) Existing EDI technology is capable of absorbing the increase in information flow associated with PS and, consequently, no botttlenecks are anticipated in this area.

f) The implementation of PS will require redesigning the logic of the computer programs used to prepare the ship loading plan, the yard plan and yard equipment assignment, so that they take into consideration the priority level.

g) Efficient gate operations are required if PS are implemented. The use of Automatic Equipment Idenfication (AEI) devices and other technological alternatives will help to reduce waiting times at the gate.

h) Efficient container identification methods will contribute to the success of PS. The use of electronic tags, for instance, will reduce misidentification errors and will eventually be linked to Global Positioning Systems (GPS) or Differential GPS (DGPS) to determine the location of containers on the yard. [7]

[7] An interesting application linking DGPS to AEI technology is taking place at the Oakland facility of American President Companies. In this facility, the equipment location system (ELS) integrates DGPS and AEI to allow tracking of containers and yard equipment (see KELBOL95).

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