Quayside Container Crane Efficiency in the United States

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요 약

본 논문은 미국내의 다른 터미널 운용구조를 고찰하고, 크레인 사용을 위해서 가장 효과적인 터미널 관리 장치유형(ACC, CUP, PTU)을 찾고자 시도하여 연구한 결과이다.

터미널 비교에 사용된 효율을 산정하기 위해서 시간당 순총 크레인 움직임을 사용했다.

가장 효과적인 장치를 찾기 위해서 총 31개 터미널을 비교하여 시도했다.

이 이론에서는 PTU시설이 가장 효과적인 운영장치임을 알게되었으며, 보기로 든 터미널이 너무 적어서 미국내 터미널에 이 결과를 직접적으로 적용하기에는 어려움이 있다.

Abstract

This paper presents the results of a study that looks into the different operating structures of terminals in the United States and attempts to find the type of terminal management scheme (All-Comers Common User Facilities, Programmed Common User Facilities, and Program-Tied User Facilities) that is most efficient with regard to crane usage. The paper uses gross and net crane moves per hour to develop an efficiency ratio that is then used to compare terminals.

A total of thirty-one terminals were compared in an attempted to find the most efficient management scheme. While the hypothesis that Program-Tied User Facilities are the most efficient operating scheme was accepted, the sample was too small to provide conclusive results pertinent to the terminals in the United States.

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1. Introduction

One of the most remarkable and widely accepted innovations in the movement of cargo has been the introduction of the containerized system of unitization. The ability to transport commodities in containers yields substantial savings in time and money, to the shipper, carrier, and terminal operator. For the shipper, savings result from the reduction in time needed to transport the goods to a purchaser. Thus, the sooner the goods are delivered, the sooner the shipper receives payment. With the advent of "Just in Time" delivery, stock, and manufacturing techniques, the timeliness and predictability of product delivery through containerization has become indispensable.

Reducing the amount of time it takes to load and discharge a container vessel can provide benefits to the terminal or port operator. Reductions in the amount of time it takes to transfer containers between the ship and terminal can increase berth availability. Increased berth availability potentially allows more ship calls at the berth, increasing berth cargo utilization rates and revenues. By increasing cargo berth utilization, the need for constructing additional berths can be reduced, and the effective berthing capacity of the terminal increased. This is particularly important in areas where the construction of new berths is not feasible due to space limitations, economic factors, or environmental considerations.

For the carrier, containerization represents a reduction in operating costs and an increase in revenues owing to the speed at which the container-carrying vessel can load and discharge cargo. The less time a vessel spends in port, the more revenue-generating voyages the vessel can accomplish on an annual basis.

This paper will examine three types of operating schemes utilized by ports and terminals in the United States, using the crane throughput of the port or terminal to determine its productivity, in order to evaluate terminal operating scheme.

1.1 Types of Terminal Operating Schemes

Presently, there are three types of terminal operating schemes. The first type of operating scheme is the All-Comers Common User Facility (ACC). This type of user facility will take any type of cargo ship that calls at its berthing space, whether the ship carries container, break-bulk, or roll-on/roll-off cargoes.

The second scheme that a terminal may operate under is the All-Comers Programmed User facility (CUP). In this scheme, the terminal will service ships that carry similar types of cargo. An example of this would be a terminal that only accepted containers, bulk cargo, or roll-on/roll-off cargo.

A third type of operating scheme is the Program-Tied User Facility (PTU). Under this type of operating scheme, the operator of the terminal also operates the vessels that call at the facility. This type of scheme also includes terminals operated by a single company that serves not only its own ships, but ships that are operated by other companies in conjunction with terminal/shipping company through Vessel Sharing Agreements (VSA) and alliances.

1.2 Scope of Research and Hypothesis

The major question posed in this paper is:

What is the best terminal operating scheme in terms of quayside productivity?

The hypothesis for this question is that the Program-Tied User Facility is more efficient than the All-Comers Common User Facility and All-Comers Programmed User Facility operating schemes. Additionally, it is hypothesized that while the levels of efficiency at various terminals will fluctuate, the Program-Tied User Facilities will be more efficient not only on a national level, but also on a regional level.

Due to the fact that the company that operates the vessels calling at the facility operates the Program-Tied User Facilities, it is in the best interest of the company to ensure their vessels are profitable. Since the vessels do not make money while berthed, the operating company can reduce the losses incurred by the vessel by decreasing the port time. The Program-Tied User Facility can look upon the ship and facility as a total system. Terminal operating companies that have no vested interest in the ships that operate at their facilities have no financial interest in the vessels except to retain their business at the port. Thus the All-Comers Common User Facilities and All-Comers Programmed User Facilities do not look upon the vessels in the same manner as the Program-Tied User Facility.

2. Improving Efficiency

While containers represent a vast improvement in the movement of cargo through a variety of modes, efforts are still being made to improve the efficiency of the loading and discharge process of a container ship. Such innovations include automated hardware used in securing containers, increased container crane capacity, and improved methods of transporting containers to the berth.

2.1 Benefits of Efficiency

One may wonder how improved efficiency benefits the various entities involved in the shipment of containers. For the carrier, containerization represents a reduction in operating costs and an increase in revenues due to the speed at which the container-carrying vessel can load and discharge cargo. The less time a vessel spends in port, the more revenue-generating voyages the vessel can accomplish on an annual basis.

There are several costs that are time dependent when a vessel is in port. Dockage and water usage costs increase the longer a vessel must stay in port. While the vessel is in port, it must also consume water for a variety of reasons. The longer the vessel remains in port, the more water is consumed, thus increasing the cost to the ship.

When examining the costs of labor for handling containers, labor is often paid for by the hour. Thus, if a vessel must transfer four hundred containers at a rate of twenty-five moves per hour using a single crane, it would take sixteen hours. If the handling rate of the single crane is increased to thirty moves per hour, it would take approximately thirteen hours, saving three hours. While three hours may seem to be a small number, when mega-container ships that can carry in excess of six thousand TEUs (Twenty-foot Equivilant Units) or more are considered, the difference of five moves per hour can represent a substantial loss or savings in a vessel's operating expenses.

2.2 Turn Around Time

A vessel's time in port is defined by its turn around time. Turn-around time commences at the pilot station when a vessel is entering port, and it terminates when the pilot departs as the vessel is bound for sea. There are several factors that are relatively constant in turn-around time for a specific port. The time to arrive at the terminal from the pilot station and the time to reach the pilot station from the terminal is one example of a constant factor that can not be altered by a significant amount. However there are two factors that can, and should, be influenced by the carrier.

The first factor is the time a vessel is required to wait for a berth at a terminal. The second factor is the time required to load and discharge cargo. By reducing the amount of time it takes to load and discharge containers, a container vessel may be able to save money due to reduced labor and operating costs.

For the terminal, the quicker a vessel is loaded and discharged, the quicker the berth will be available for another ship to utilize the berth. This may allow a terminal to reduce the amount of time a ship has to wait for a berth. If cargo handling cannot be done efficiently, a terminal may have to look for other, more costly methods of increasing berth capacity to reduce waiting time, or just allow vessels to wait for extended periods to berth. In the fiercely competitive field of terminal and port operations and marketing, this may not be a suitable alternative.

Through efficient quayside operations, ports can gain an increased piece of a highly competitive market. With shipping companies decreasing in number and consolidating into larger operating entities, carriers are focusing their mainhaul traffic on a small range of container ports. Through the use of transshipment and feeder services, and by restricting their largest vessels to a small number of deepwater ports, carriers have been able to reduce operating costs (Lambert, 1995).

To determine where improvements can be made in the container handling process between the ship and terminal, several factors have to be considered. Two of the most important factors are equipment and human productivity. Equipment factors relate to the use of equipment that is not only designed to handle containers efficiently, but also equipment that is used properly in the right situation. Human factors apply to the ability of personnel to work as quickly, safely, and as accurately as possible. By examining these factors, the efficient ports for the container handling process can be ascertained. Once the efficient ports have been identified, other factors such as costs can be factored into an efficiency equation, if the data on these factors exists.

2.3 Determining Efficiency

There are several methods that can be used to calculate berth productivity or port efficiency. Many methods address container movements between the ship and wharf apron as a factor in port productivity. These methods associate port productivity with economic and cost factors as they apply to the port or to terminal operation. There are also several ways to measure the productivity of a berth. To determine efficient berth throughput, two measures are utilized: crane; and labor standards.

The units of productivity for a crane can be measured in moves per gross gang or crane hours minus down time, both of which establish net productivity. Using moves per gross gang or crane hours without the work stoppage establishes the gross productivity of a crane operation.

To measure gross labor productivity, the number of moves per man-hour is utilized. The gross labor productivity is a secondary measure to be used in conjunction with other port productivity figures.

The computation of port productivity can be determined through two classes of methodology.

The first method involves the use of the engineering, or operational, aspects of the activities being studied using ratios to determine a port's productivity. A second method involves the development of estimates of aggregate production functions through the use of aggregate economic data to produce a microeconomic analysis.

In *Port Planning and Development*, Frankel (1987) explains that a basic method of determining port productivity requires a minimum of two factors, such as labor, capital, or other limiting factors. The book associates the computation of port productivity with the economics of determining economic efficiency. Economic port production can then be used as basis for determining port tariffs and pricing strategies.

Roll and Hayuth (1993) in "Port Performance Comparison Applying Data Envelopment Analysis (DEA)," describe the use of efficiency ratings as management tools for port operators. Factors or outputs which are considered in the computation of efficiency ratings are quantity and varieties of cargoes, types of ships serviced, interchange between transportation modes, additional services such as warehousing, level of technology utilized, and nature of port ownership. This work uses DEA, a method of determining efficiency by creating an efficiency envelope in which the most efficient ports are grouped. The envelope is then used as a benchmark against which other, less efficient ports may be measured.

DEA provides an approach to determine efficiency when standards are not available. It creates an envelope in which a number of the most efficient ports, or factors of ports, are contained. All the other ports or factors are then measured against or compared to this envelope.

Another piece of literature offering a method of determining port productivity was written by Chappell (1990), "Provision of Optimal Cargo Handling Facilities at a Berth." This method utilizes the costs involved in handling cargo, handling rate, optimal handling rate, daily costs to vessels in port, number of ships in a port, and the cost of quay side facilities. The purpose of the article is to attempt to determine profit maximization for both port operators and shipowners. A secondary objective is to introduce modifications to existing formulas to allow for alternatives concerning arrival patterns and/or service mechanisms.

The literature mentioned above, *Port Planning and Development*, "Provision of Optimal Cargo Handling Facilities at a Berth", and "Port Performance Comparison Applying Data Envelopment Analysis (DEA)", present some problems when an evaluation of several ports is being conducted. The primary difficulty is the acquisition of proprietary information. While many corporate entities may be able to utilize these methods, many ports and shipping companies may be unwilling to release information concerning operating, labor, and other port costs to private individuals. Another issue associated with these methods is the fact that they are designed primarily for the use of port operators, with an emphasis on maximizing profit against berth handling rates. Additionally, these methods stress the efficiency of port operations from the perspective of the port administrations.

When emphasizing the carriers' considerations, these methods may be inadequate for the evaluation of a port or a series of ports, particularly when a carrier is trying to determine which ports to utilize for such purposes as load centers and feeder ports.

2.4 Container Terminal Production

With the advent of containerization, the output of a terminal facility has improved. However, figures that measure output and throughput of a terminal are not always consistent, and may not always display a true picture of container handling productivity. When the task is undertaken to investigate port performance, the job is complicated by several factors. Some of these factors include the volume of defining parameters involved, the lack of reliable numbers, the lack of common definitions, and the predominance of local factors (DeMonie, 1987).

To determine the performance of a port or range of ports, measures pertaining to the duration of a ship's stay in port, the quality of cargo handling, and the quality of service to inland transportation are needed. A strong inter-relationship between these three factors, as well as the performance measures within each of the factors, makes it difficult to study each of the factors as separate entities. However, due to the heavy influence of the length of stay in port and quality of cargo handling upon the users of the port and terminal facilities, these two factors are combined into a ratio that is used to measure the productivity of a series of terminals.

3. Methodology

The determination of port productivity is defined by the various factors in berth throughput. Berth throughput refers to the amount of cargo that is transferred between the port facility and vessels carrying cargo, and to the movement of the cargo within the terminal facility. For the purposes of this paper, berth throughput is limited to the transfer of containers between ships and the marginal wharf.

An engineering approach to determining port productivity will be used for determining the capacity of a crane through the use of actual and intrinsic performance factors. The difference between the actual and intrinsic performance of the crane results from slack or lost time. The slack results from disruptions during cargo handling operations such as equipment failure, labor stoppages, and other interruptions to the handling process.

A crane's output is measured in container moves per hour. The actual performance of the crane can be regarded as the gross productivity of the crane. The intrinsic performance of the crane, where slack is taken into account, is directly related to the net productivity.

In order to eliminate some of the factors that may be influenced by the size of vessel and crane limitations, a productivity or efficiency ratio is created by taking the actual, or gross, productivity of the crane in moves per hour and dividing this number by the net crane productivity in moves per hour. This ratio allows ports to be ranked by how efficiently the cranes are utilized.

This ratio is expressed as follows:

$$R = GP/NP$$

Where: R = Productivity Ratio
GP = Gross Productivity
NP = Net Productivity

A productivity ratio of 1.00 would indicate that no lost or slack time is present. These ratios will be compared between the various types of terminals using the three operating schemes.

In order to determine the validity of the sub-hypothesis, the United States is divided into four regional elements, the Northeast, the Southeast, the West, and the Pacific Northwest/ Hawaii/Alaska. A total of sixteen ports and thirty-one terminals are compared. The Northeast contains eight terminals, the Southeast contains seven terminals, the West contains eight terminals, and the Northwest/Hawaii/Alaska region contains eight terminals.

To determine the validity of the primary hypothesis, the findings of the secondary hypothesis are examined, and a determination of the production efficiency of the private terminals in relation to the multi-user terminals is made.

3.1 Data Collection

In order to test the validity of the hypothesis, and to gather information pertaining to the factors which establish berth productivity, various players were asked to provide information on average gross moves per hour, average net moves per hour, and average slack times. These players primarily included stevedores, longshoremen, port authorities, terminal operators, and carriers.

As previously noted, lost time occurs when the movement of containers stops due to any of a variety of reasons. Some of the factors that are considered when computing lost time include truck lost time, weather lost time, stevedore lost time, ship lost time, stowage lost time, and crane lost time.

3.2 Data Collection

Unfortunately, once the process of data collection was instituted, several companies were unwilling or unable to provide precise numbers for their container crane movements. Several companies also refused to provide information on their container crane movements stating that the information was proprietary. Indeed, when the U.S. Maritime Administration attempted to collect data on crane movements, the information was unavailable. This is partially due to the fact that once information is given to the U.S. government, it becomes public domain, regardless of whether the information is considered proprietary or not.

The most reliable, as well as accurate, information appears to have come from three terminals operated by American Presidents Line (APL), and two terminals operated by SeaLand. The reason for the accuracy is varied. For the three APL terminals, the data was requested through a manager at the APL headquarters. The manager then requested three APL terminals to provide the necessary information.

The most accurate SeaLand data were obtained from personal interviews with two port managers. These managers provided the data from their own records. These records not only contained the gross and net moves per hour, but also lost time. The main office of SeaLand provided data, but stated that they were rough numbers, due to the fact that they do not want to have accurate proprietary data made available to the public.

While a total of forty-five companies and operating entities were contacted, only thirty-one entities were able to provide information. This resulted in a sixty-nine percent (69%) response rate from those willing to participate. Included in the fourteen entities which could not provide information are those entities who could only make broad guesses at their net and gross movement rates. Five entities would not provide any information for use in a study, stating proprietary reasons. Three of the five entities were located on the East Coast. All five of the entities were non-US owned shipping companies that operate their own program-tied facilities.

4. Data Analysis

In <Table 1>(Terminal Operators, Crane Moves, and Efficiency Ratios), a list of terminals, and the statistics for these terminals are listed. The information contained in this table includes the region, operating scheme, gross and net cranes moves per hour, and the terminal's efficiency ratio. It is evident by looking at Table 1 that the gross and net moves per hour vary by a large degree not only by port, but also by terminal. By creating an efficiency ratio, factors such as slow crane rates are eliminated, allowing the productivity of various terminals to be compared more equitably. Regional Analysis

Of the total of thirty-one terminals that provided information for this paper, ten terminals were All-Comers Common User Facilities, six terminals were All-Comers Programmed User Facilities, and fifteen terminals were Program User Facilities. The Northeast Region has the

〈Table 1〉 Terminal Operators, Crane Moves Per Hour, and Efficiency Ratios

Port	Region	Operating Scheme	Gross MPH	Net MPH	Ratio
BOSTON1	NE	ACC	24.50	26.60	0.92
BOSTON2	NE	CUP	23.00	26.00	0.88
NYNJ1	NE	ACC	20.00	24.60	0.81
NYNJ2	NE	PTU	31.60	33.00	0.96
BALTIMORE1	NE	ACC	23.00	27.00	0.85
BALTIMORE2	NE	CUP	35.00	48.00	0.73
BALTIMORE3	NE	CUP	35.00	40.00	0.88
BALTIMORE4	NE	PTU	37.00	39.00	0.95
HAMPTONROADS1	SE	ACC	25.00	27.50	0.91
HAMPTONROADS2	SE	PTU	32.10	33.70	0.95
CHARLESTON1	SE	ACC	32.50	36.00	0.90
CHARLESTON2	SE	PTU	38.00	40.00	0.95
JACKSONVILLE	SE	PTU	35.50	37.20	0.95
NEW ORLEANS1	SE	CUP	28.00	34.00	0.82
NEW ORLEANS2	SE	PTU	38.50	40.00	0.96
LONG BEACH1	WC	ACC	23.00	26.00	0.88
LONG BEACH2	WC	CUP	23.00	25.00	0.92
LONG BEACH3	WC	PTU	32.50	33.80	0.96
SAN PEDRO	WC	PTU	24.30	25.40	0.96
OAKLAND1	WC	ACC	28.00	31.00	0.90
OAKLAND2	WC	PTU	31.50	33.10	0.95
OAKLAND3	WC	PTU	20.38	24.25	0.84
SAN FRANCISCO	WC	ACC	21.00	23.50	0.89
SEATTLE1	NW	ACC	24.00	26.50	0.91
SEATTLE2	NW	ACC	24.00	26.50	0.91
SEATTLE3	NW	PTU	18.73	20.84	0.90
PORTLAND	NW	CUP	28.00	30.50	0.92
TACOMA	NW	PTU	27.50	29.00	0.95
DUTCH HARBOR	NW	PTU	18.00	21.00	0.86
HONOLULU1	NW	PTU	23.00	25.00	0.92
HONOLULU2	NW	PTU	29.00	31.50	0.92

CUP = All-Comers Programmed User Facility
PTU = Programmed-Tied User Facility
MPH = Moves per Hour
ACC = All-Comers Common User Facility

fewest number of Program-Tied User Facilities with a total of two, while the Northwest Region has the largest amount of Programmed-Tied User Facilities. In contrast, the Northeast Region has the largest number of All-Comers Common User Facilities, along with the West Coast Region.

4.1.1 Northeast

By examining Table 1, the Northeast Region's most efficient terminal is NYNJ2, a Program-Tied User Facility, with an efficiency ratio 0.96. The only other Program-Tied User Facility in the Northeast, BALTIMORE4, achieved an efficiency ratio of 0.95.

The All-Comers Programmed User Facilities in the Northeast have various levels of efficiency, from a low efficiency level of 0.73, at BALTIMORE2 to a high of 0.88 at BOSTON2. It is interesting to note that while BALTIMORE2 has a low efficiency ratio, it attained the highest net moves per hour at 48 moves per hour. This results in a difference of 13 moves from the facility's gross moves per hour.

For the All-Comers Common Users Facilities in the Northeast Region, the BOSTON1 terminal in Boston achieved the highest efficiency ratio of 0.92. The other All-Comers Common User Facility in the Northeast region, BALTIMORE1, while located in the same port as the BALTIMORE2, has a higher efficiency ratio, yet handles fewer containers per hour.

4.1.2 Southeast

In the Southeast Region, the Programmed-Tied User Facilities have all achieved an efficiency ratio equal to or greater than 0.95, with NEW ORLEANS2 achieving 0.96. NEW ORLEANS2, as well as CHARLESTON1, also achieved high net moves per hour at 40.00.

The single All-Comers Programmed User Facility in New Orleans, NEW ORLEANS1, had the lowest efficiency ratio in the Southeast region with 0.82.

NEW ORLEANS1 also has the second slowest movement rates of containers, with HAMPTON ROADS2, an All-Comers Common User Facility, having the slowest movement rates.

The All-Comers Common User Facilities in the Southeast performed at relatively high levels of efficiency. HAMPTON ROADS1 achieved a 0.91 ratio and CHARLESTON1 achieved a 0.90 ratio.

4.1.3 West Coast

In the West Coast Region, as well as the Northwest Region, more than one Program-Tied User Facility operator was present, adding greater validity to the results obtained from these regions. With the introduction of the additional PTU data, the performance of the Program-Tied User Facilities becomes more representative of this type of terminal.

With the exception of OAKLAND3, the Program-Tied User Facilities achieved an efficiency ratio of 0.95 or greater. The LONG BEACH3 and SAN PEDRO terminals each obtained a 0.96 level of efficiency.

The single All-Comers Programmed User Facility in this region, LONG BEACH2, attained a 0.92 efficiency ratio, a ratio that is second to the Program-Tied User Facilities. The All-Comers Common User Facilities did the poorest, as a group, in this region. The All-Comers Common User Facilities efficiencies ranged from 0.88 to 0.90.

4.1.4 Northwest

In the Northwest Region, the overall efficiency ratios were relatively high with the exception of DUTCH HARBOR (0.86). Possible explanations for the low efficiency DUTCH HARBOR are the weather conditions and a small berth with only one container crane and one general-purpose crane. The efficiency ratios between the three types of facility types are relatively high with only the aforementioned DUTCH HARBOR dropping below 0.90.

The highest level of efficiency in this region was achieved by a Programmed-Tied User Facility, TACOMA. The HONOLULU1 and HONOLULU2 terminals both attained a 0.92 ratio, as did PORTLAND, an All-Comers Programmed User Facility. SEATTLE1 and SEATTLE2, both All-Comers Common Users Facilities, achieved a ratio of 0.91.

4.2 Regional Comparison

Using Fig. 1, Regional Terminal Efficiency, as a reference, the three types of terminal management schemes can be compared both within their regional subset, and on a national level. With the exception of the Northwest Region, the Program-Tied User Facilities were more efficient than any other type of terminal type as a group. If the Dutch Harbor terminal is disregarded, the Northwest Program-Tied User Facilities would have attained an average 0.92 efficiency ratio, putting this group of facilities on a par with the Northwest All-Comers Programmed User Facilities grouping.

It is interesting to note, referring to Table 1, that the All-Comers Common User Facilities, with the exception of the Northeast Region, have lower efficiencies than the other two types of operating schemes.

Referring to Fig. 1, a trend can be seen that where the two East Coast Regions have high efficiency ratios at the Program-Tied User Facilities, the All-Comers Common User Facilities and All-Comers Programmed User Facilities have relatively low efficiency ratios, when examined as a group. In comparison, the

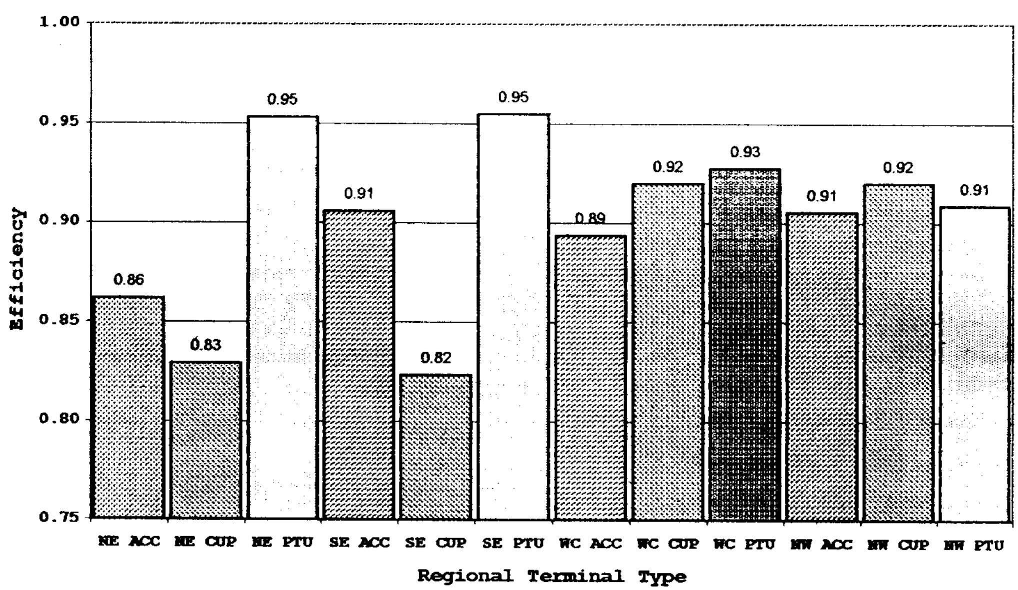

Fig. 1 Regional Terminal Efficiency

West Coast and Northwest Regions facilities have similar operating efficiencies among the three types of operating schemes.

In Fig. 2, Averaged Regional Moves per Hour, it is seen that the Northeast and Southeast Regions have a higher rate of container moves per hour, with the Southeast having a marginal higher movement rate. But when the overall efficiency of the regions are reviewed (Fig. 3 Average Regional Efficiency), the West Coast and Northwest Regions have efficiencies that are superior to the other two Regions.

4.3 Summary

Overall, the Program-Tied User Facilities and the All-Comers Programmed User Facilities performed more efficiently than the All-Comers Common User Facilities. This indicates that terminals that are designed to handle a specific type of cargo are more efficient than terminals that will accept any type of cargo. This is particularly true in the Northwest and West Coast Regions of the United States. Additionally, terminals that are operated by the carrier are more efficient than terminals that are operated by an operator that has little interest in the operation and profitability of a carrier's vessel.

When comparing regional efficiency, the West Coast and Northwest has a higher level of efficiency as a whole that indicates that factors such a labor or equipment may be better west of the Mississippi River.

5. Conclusion

Through the use of telephone and personal interviews, data was collected in order to test a major hypothesis and a supporting minor hypothesis. While the information was not easy

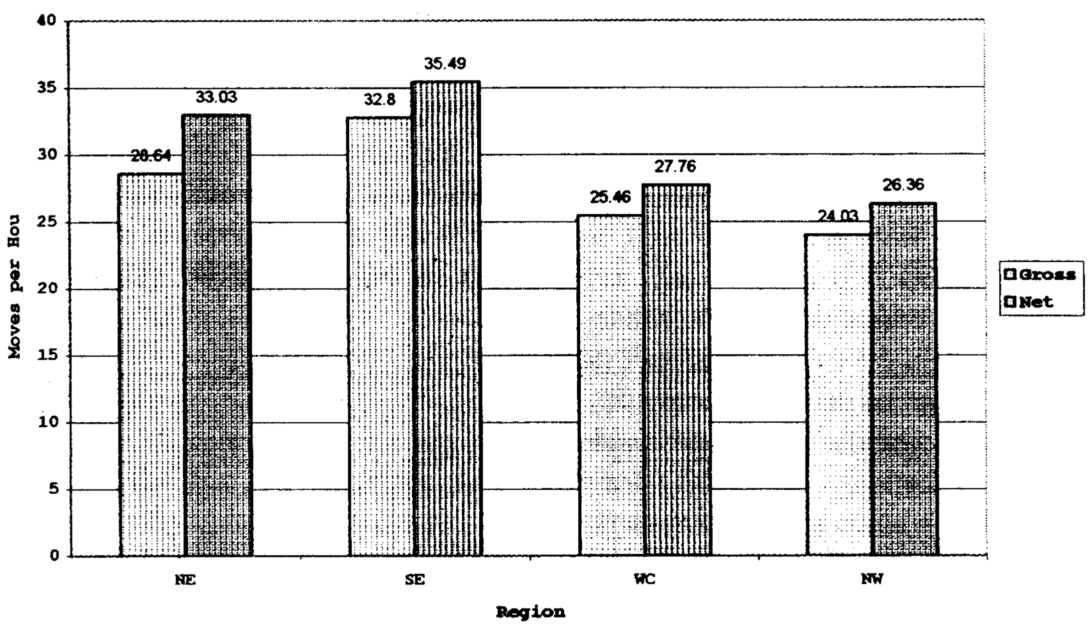

Fig. 2 Averaged Regional Moves per Hour

to collect, due to varying views on the proprietary nature of the information, and because the data are in no case to be considered complete and absolute, several basic conclusions can be reached.

Testing of the secondary hypotheses was supported at two levels, within a region and nationally, the efficiency ratios follow similar trends in that the Programmed-Tied User Facilities are more efficient than the All-Comers Common User Facilities or the All-Comers Programmed User Facilities.

The Program-Tied User Facilities provide better productivity and container movements, with a few exceptions. This occurs not only at the national level, but also at the regional level. This supports the primary hypothesis that a Program-Tied User Terminal is more efficient than either the All-Comers Common User Facilities or the All-Comers Programmed User Facilities.

However, it must be noted that the measurement of the efficiencies across the United States is limited. Several companies did not or could not respond to the survey. While all companies that did respond did so hesitantly, no company would provide cost figures, for labor or other costs.

In order to provide a more complete picture of port efficiencies within the United States, it is essential that all terminals must respond with data which not only represent moves per hour, but also the cost to move the containers. As the major carriers increase their vessels' capacity and shift to a load-center concept, the ability to decrease the vessel's turn around time will become more important. Not only will the ability of a terminal to expedite the loading and discharge of containers become more important, but the ability of a terminal to do so cost effectively will aid in the port selection process.

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