Southwest Region University Transportation Center

Evaluating Intermodal Freight Terminals: A Framework for Government Participation

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16. Abstract

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The rail segment and sea segment of intermodal freight are the more cost effective modes while truck segments allow service to anywhere served by the highway network. Primary intermodal freight bottlenecks are related to the transfer between modes. Improving terminal efficiency and accessibility will reduce total travel time and ultimately will increase intermodal volume. Government funding for terminal access improvements will benefit the public by helping to achieve the stated goals.

This report presents an overview of the intermodal freight transportation industry. Then government intermodal freight planning and participation including examples of government sponsored intermodal projects are presented. An intermodal freight planning procedure is then proposed. A terminal capacity analysis is performed as required for a terminal prioritization process. Finally, three prioritization strategies are proposed and illustrated using data collected from Texas. The system is designed to rank priority by facility for a given network, utilizing facility operational and physical attributes.

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EVALUATING INTERMODAL FREIGHT TERMINALS: A FRAMEWORK FOR GOVERNMENT PARTICIPATION

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Research Report SWUTC/98/467505-1

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DISCLAIMER

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ABSTRACT

A method for rating the intermodal freight terminals as candidates for government funded access improvements is proposed in this report.

Government agencies desire to meet certain transportation objectives including the reduction of highway congestion, reduction of emissions, reduction highway deterioration, and the improvement of fuel efficiency. Since greater utilization of all modes is a means of achieving these goals, government agencies clearly have a vested interest in promoting intermodalism.

The rail segment and sea segment of intermodal freight are the more cost effective modes while truck segments allow service to anywhere served by the highway network. Primary intermodal freight bottlenecks are related to the transfer between modes. Improving terminal efficiency and accessibility will reduce total travel time and ultimately will increase intermodal volume. Government funding for terminal access improvements will benefit the public by helping to achieve the stated goals.

This report presents an overview of the intermodal freight transportation industry. Then government intermodal freight planning and participation including examples of government sponsored intermodal projects are presented. An intermodal freight planning procedure is then proposed. A terminal capacity analysis is performed as required for a terminal prioritization process. Finally, three prioritization strategies are proposed and illustrated using data collected from Texas. The system is designed to rank priority by facility for a given network, utilizing facility operational and physical attributes which should be relatively easily obtained.

EXECUTIVE SUMMARY

Many intermodal yards and container ports operate near or are rapidly approaching capacity. Increasing volumes will strain existing infrastructure. Poor access to the highway network, in the form of circuiticious routes, traffic congestion, and poor geometric design reduce the desirability of intermodalism. As these problems worsen, the reduction in the benefits will shift away from intermodalism.

Government agencies desire to meet certain transportation objectives including the reduction of highway congestion, reduction of emissions, reduction highway deterioration, and the improvement of fuel efficiency. Since greater utilization of all modes is a means of achieving these goals, government agencies clearly have a vested interest in promoting intermodalism. Since investment in intermodal projects may benefit users, motorists, and government entities responsible for maintaining the highway network, it is possible for benefits to exceed cost. For government transportation funds to be spent optimally on intermodal projects, the intermodal freight network must be analyzed. Conclusions reached from such analysis would determine where government funding may be most effectively spent on intermodal freight projects.

One approach in optimizing spending is to develop a ranking system for project investment selection. The research presented proposes an approach for intermodal freight planning which attempts to determine the terminals which are likely to benefit the most from government funded access improvements. Three prioritization strategies are suggested which should be chosen or altered according to a given agency's specific objectives. The context of the ranking system in the planning process is that once terminals are ranked, the agency officials ask the managers of the high ranking facilities to submit infrastructure projects that would improve the access to the facility. Then a cost benefit analysis would be performed for each proposed project and would be considered for inclusion on the agency's Transportation Improvement Plan (TIP) according to the priority set by the presented algorithm.

The rankings set by Strategy 1 is based primarily on the terminals' volume. The more containers and trailers a facility serves, more shippers will benefit. Strategy 2 ranks mainly according to the product of volume and the volume-to-capacity ratio. The reasoning for this product is that facilities operating near capacity are likely to expand in the future which is an indication of an opportunity for a public/private partnership. Strategy 3 ranks facilities with low volume-to-capacity ratios rank higher than the others. The use of this strategy applies if planning officials believe that the reason for under-utilization of capacity is due to reasons external to the terminals' operations such as poor highway access.

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DEFINITION

The term intermodal, in the context of freight transportation, refers to the coordinated utilization of more than one mode for a single journey. Intermodalism is the notion of reducing cost by selecting the most efficient combination of transportation modes between the origin and destination (Cambridge 1995b, 1-8). A critical component of intermodalism is the "seamless" transfer between modes made possible through good communications and the utilization of efficient terminal operations. Efficiency is achieved by shipping freight in standardized containers and trailers to permit the use of standard equipment system-wide.

The practices of hauling trailers and containers on rail flatcars are commonly referred to Trailer-on-Flatcar (TOFC) and Container-on-Flatcar (COFC) services. Containerization refers to the practice of packing freight in standardized containers and hauling them on ships, trucks, and trains. Intermodal freight in the context of this report refers any combination of container or trailer movements by ship, highway, and rail (see Figure 1.1).

PROBLEM STATEMENT

In 1997 rail intermodal freight is a $10 billion industry accounting for 2.2 percent of the domestic freight market (S&P 1998, 9). Volume in the United States has increased 167 percent from 1980 to 1996, a 6.3 percent compound annual rate (9) (See Figure 1.2 for intermodal rail growth). The increase in international trade, application of technologies, consolidation of hubs, advent of just-in-time inventory management, and a shortage of truck drivers are factors contributing to the increased growth. For such growth to sustain, improvements to intermodal freight transportation must continue to be made (Norris. 1994, 15). Bottlenecks at transfer hubs and poor practices will prevent the market share of intermodal freight from increasing significantly in the future (Cambridge 1995b, 1-1).

Many intermodal yards and container ports operate near or are rapidly approaching capacity. Increasing volumes will strain existing infrastructure (Cambridge 1995a, 1-11). Poor access to the highway network, in the form of circuiticious routes, traffic congestion, and poor geometric design reduce the desirability of intermodalism. As these problems worsen, the reduction in the benefits will shift away from intermodalism.

Figure 1.1 Types of Intermodal Movements

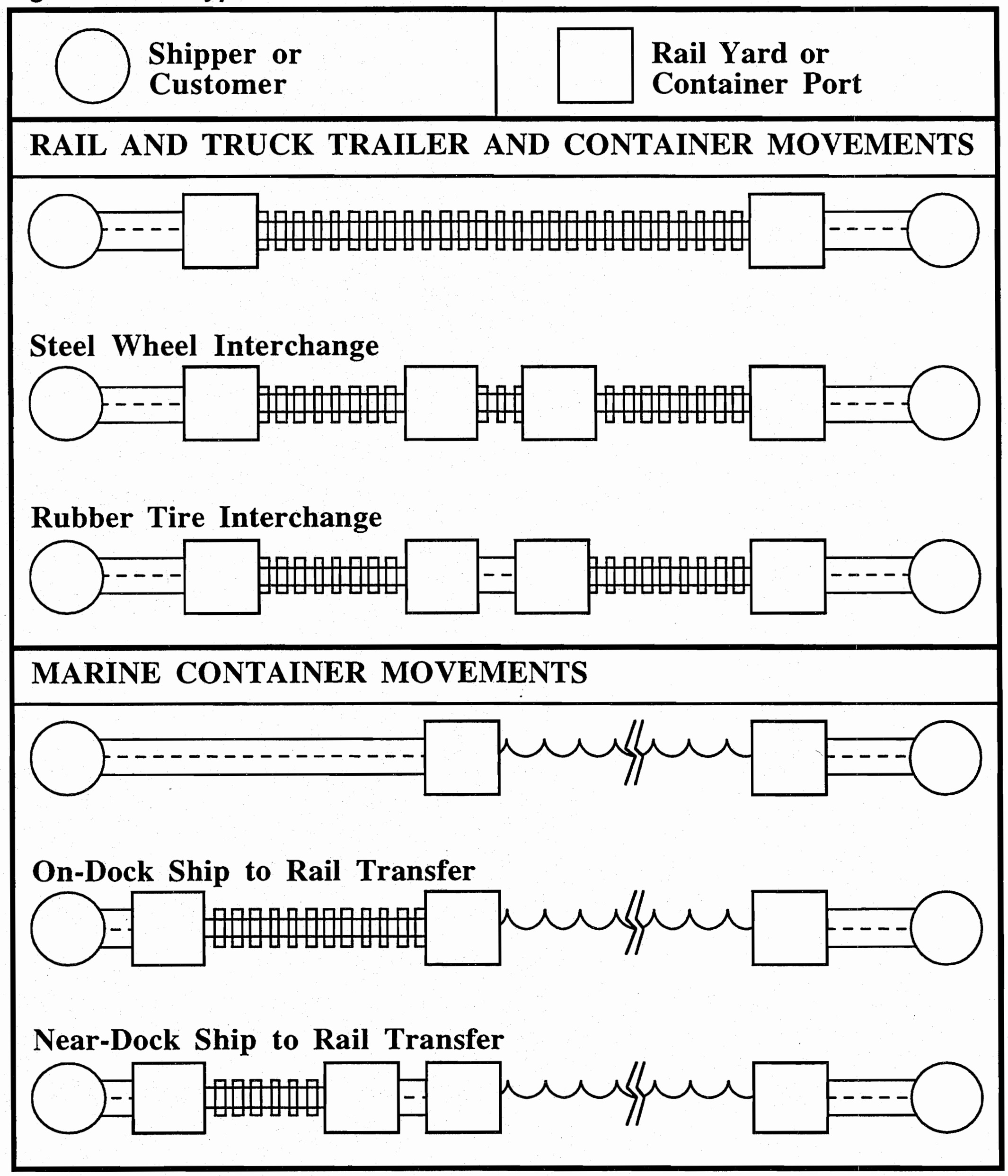
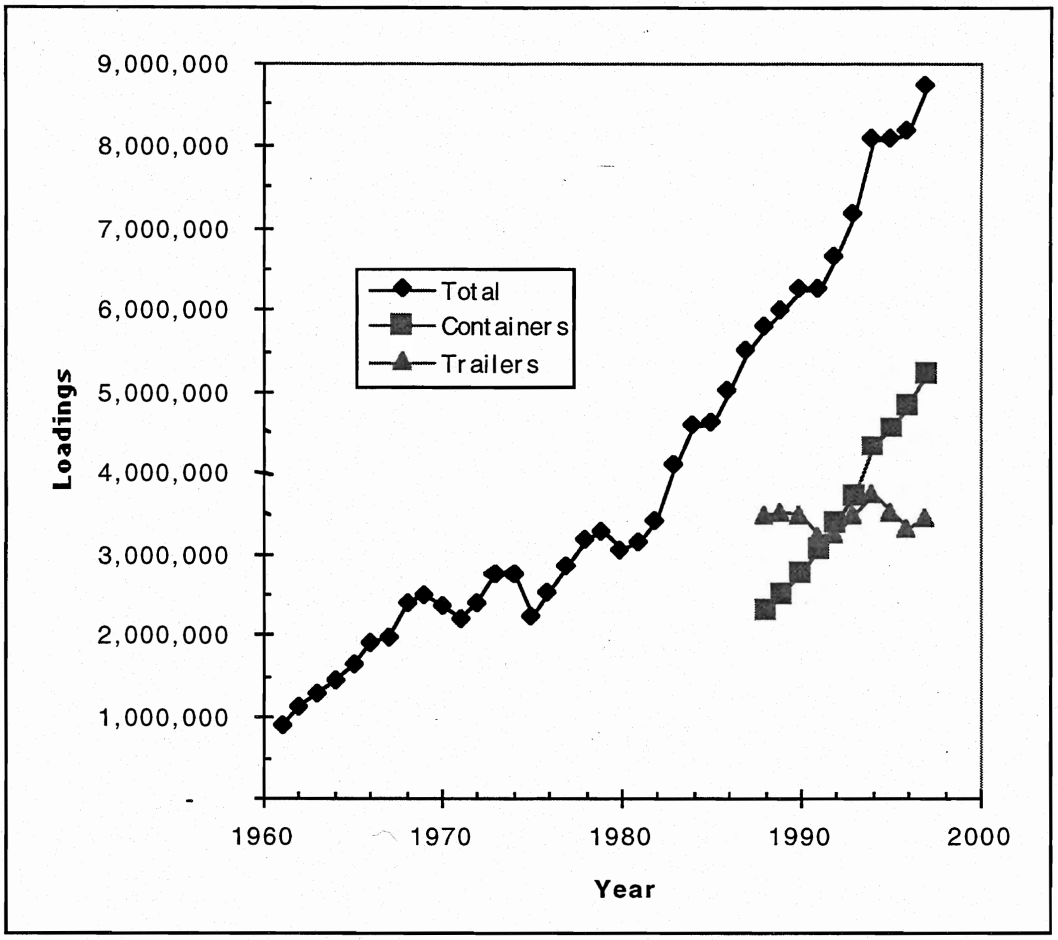


Figure 1.2 U.S. Intermodal Rail Loadings 1961 - 1997



Source: Association of American Railroads

Other system inefficiencies include under-utilization of rail service on international container trade. Many containers are driven to and from container ports that could be sent by rail because of poor rail access to ports. Considering that 60 percent of an ocean carrier's trip cost is landside activities (Norris 1994, 38), there is a potential to reduce that percentage by implementing on-dock transfers. An on-dock rail connection would make rail use more attractive resulting in increased productivity and reduced highway congestion near container ports. The high cost of construction and dock space limitations prevent many ports from building such a connection.

Another inefficient practice is rubber tire interchange between railroads. The average cost of rubber tire interchange, which is ultimately passed on to the shipper, amounts to $112 per container ($130 converted into current dollars adjusted by the June 1998 Consumer Price Index) according to Norris (32). In Chicago alone there were 200,000 of these moves in 1992 (40). Better cooperation between railroads may eliminate many trailers and containers from being hauled on the local streets between one railroad terminal to another. The benefits of steel wheel interchange include the reduction of local street congestion, faster travel time, and reduced costs.

Diffused responsibility in the intermodal industry is a problem for shippers. Participants in door-to-door service are railroads, trucking firms, and container ship lines. Often, these companies have conflicting interests such as differing schedules which prevent the intermodal network from operating system optimally. A 1994 survey conducted by the Intermodal Association of North America (IANA) found that 48 percent of shippers felt that intermodal transit time was too slow and unreliable (IANA 1994, 20). Reliability and transit time can be improved with developing better electronic data interchange (EDI) practices which would result in better coordination of shipments and ultimately better customer service in terms of reliability and delivery time.

Government agencies recognize intermodalism as a means of achieving certain goals including: "1) lowering transportation costs, 2) increasing national economic productivity, 3) more efficient use of transportation infrastructure, 4) increased benefit from public and private infrastructure investments, and 5) improve air quality and environmental conditions (Cambridge 1995a, 1-1). For example, a long haul intermodal shipment is 3.4 times more fuel efficient (1-3) and emits 20 percent less hydrocarbons and 50 percent less nitrogen oxides than a truck shipment (Norris 1994, 11). The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and subsequent legislation allow greater flexibility in government transportation spending. Investment in intermodal projects may benefit users, motorists, and government entities responsible for maintaining the highway network. For government transportation funds to be spent optimally on intermodal projects, the intermodal freight network must be analyzed. Conclusions reached from such analysis would determine where government funding may be most effectively spent on intermodal freight projects.

One approach in optimizing spending is to develop a ranking system for project investment selection. Information including volume served, load balance, and capacity will help determine the location of the bottlenecks associated with the terminal. Such data reveal the number of parties who stand to benefit and the duration a facility's current capacity will be adequate given growth trends. Analysis of a regional network of intermodal freight facilities may reveal opportunities for public/private partnerships to enhance a facility with the public sector improving the highway access to a terminal concurrently with a terminal expansion project performed by the terminal operators.

The research presented proposes an approach for intermodal freight planning which attempts to determine the terminals which are likely to benefit the most from government funded access improvements. Three prioritization strategies are suggested which should be chosen according to a given agency's specific objectives. The context of the algorithm in the planning process is that once terminals are ranked, the agency then asks the managers of the high ranking facilities to submit infrastructure projects that would improve the access to the facility. Then a cost benefit analysis would be performed for each proposed project and would be considered for inclusion on the agency's Transportation Improvement Plan (TIP) according to the priority set by the presented algorithm. Essentially, this algorithm is a screening process to reduce the number of projects considered. The intermodal freight facilities of Texas are analyzed and presented for illustration purposes. The intermodal management system could be applied on a local, state, regional, of federal level. The goal of this management system is to enable government planning agencies to spend limited transportation funds more effectively to increase productivity, thus promoting efficiency in freight movement.

CHAPTER 2. THE INTERMODAL FREIGHT SYSTEM

INTRODUCTION

Intermodal freight transportation is a complex system involving numerous steps and parties. A single shipment may include two or three modes, two or more mode transfers, and multiple parties including the customer, shipper, railroads, trucking firms, shipper's agents, and ocean shipping lines. With the number of parties involved there is no single process that characterizes all intermodal shipments (see Figure 1.1). This chapter presents the intermodal shipment processes and issues concerning the efficiency of the system. Such background knowledge will prepare government planners for making sound intermodal freight planning and policy decisions.

HISTORY

Among the first intermodal freight transportation concepts was the practice of hauling wagons on barges and ship in the Nineteenth Century. An example was the Pennsylvania Canal between Philadelphia and Pittsburgh, which transferred shipments between wagons and barges (Muller 1995, 7). The first specially designed water to rail intermodal system began in 1929 when Seatrain Lines, Inc. shipped full rail cars between New York and Havana. Specially designed ships with a 100 rail car capacity stored rail cars on multiple decks on tracks. The concept proved successful because vessel could unload and load in 10 hours as opposed to a 6 day turnaround a traditional ship hauling the same cargo would have required (8).

Rail to road intermodal freight transportation has existed almost as long as the railroads. The first intermodal rail shipments were stage coaches carried on flatcars. Circuses were an early user of intermodal freight as they loaded equipment on carts and wagons which were then pulled up a ramp on to the train. Since the circus would only be in town for several days, an efficient means for unloading the train was required so that the show could be set up quickly (Zimmer 1996, 99).

The first recorded TOFC service was in 1926 on the Chicago North Shore and Milwaukee Railroad (Muller 1995, 10). After a slow start, piggybacking became more popular in the 1950's due to several factors including the beginning of the lifting of rate regulations (10), a strong economy, and the development of commerce and industrial centers away from railroad lines. TOFC service was convenient for the railroads because less switching was required as trailers on flatcars did not require the individual deliveries by a road crew like boxcars. Also, minimal loading facilities were required initially so minimal capital investment was required to initiate service. Low volumes at early TOFC facilities required only two people for operations (Zimmer 1996, 99).

Malcolm McLean, founder of Pan Atlantic Steamship Corp., is credited for starting the container revolution in 1956 (Muller 1995, 15) by converting two tankers that could carry 58 35-foot containers. In 1957, the first container ship was delivered with a capacity of 226 35-foot containers. McLean's company subsequently became Sea-Land Services, one of the largest container ship lines in the world today. Prior to containerization, ships would carry cargo on crates and pallets, a much more labor intensive practice loading and unloading ships. Containers could be stacked on a ship and be unloaded onto a chassis and delivered directly to the customer without the need for costly and time consuming transloading in a warehouse at the port. Containerization greatly reduced the cost of international shipping thus fostering the development of the global economy. Today, 60 percent of the world's deep sea general cargo moves in containers and the figure is near 100 percent for trade between developed countries (23).

In the beginning of containerization, railroads were not well equipped for handling containers because specialized rail cars for containers did not exist and terminals were not equipped with mechanical lifts. The first double-stack car was developed by the American Car Foundry for Sea-Land containers hauled on the Southern Pacific Railroad (Zimmer 1996, 100). In 1984, American President Lines (APL) and the Thrall Car Company designed light weight articulated double-stack cars and offered weekly service between Los Angeles and Chicago (Muller 1995, 65). The concept proved to be popular. By 1988, 76 double-stack trains operated weekly between 20 city pairs carrying about 1500 Twenty-Foot-Equivalent-Units (TEU) weekly and by 1993, 241 weekly double-stack trains operated (65). Double-stacking on articulated rail cars reaps benefits of economies of scale because the tare weight is reduced and more containers can be moved by a single train. In addition, the ride quality is better, which results in less cargo damage. The growth of double-stacking was limited by the railroad infrastructure. Tunnel and bridge clearance restrictions prevented the utilization of double stack service on many corridors, but railroads have continually invested in providing double-stack clearance and track improvements. Standard and Poor's predicts intermodal rail growth to increase 5 percent in 1998.

SHIPPERS AND CUSTOMERS

Domestic intermodal freight service attracts many shippers, but the market share for shipments over 500 miles was only 18 percent in 1994 (IANA 1994, 18). To improve intermodal service, reasons why shippers might choose intermodal service over door-to-door trucking must be understood. An investigation of mode choice factors will give clues as to why intermodal freight attracts certain shippers, which will indicate what types of improvements would be effective.

Mode Choice Factors

The decision to utilize intermodal transportation depends on many factors. Long haul (over 1500 miles) domestic intermodal shipping tends to be cheaper than trucking, but tradeoffs may include loss in reliability, transit time, and ease of doing business. For overseas cargo, the shipping choices are limited. Air transportation is preferred for light weight and high value cargo that have a high time utility, but most other general cargo shipments utilize the efficiency and cost savings of containerized shipping. This section lists and describes the major mode choice factors.

Length of Haul. The decision to utilize rail, is based primarily on price and service. Since both price and service become more favorable as the shipping distance increases (Frazier 1996, 45), the length of haul can be considered the most significant mode choice factor. Frazier defines three categories for the length of hauls: short (under 500 miles), medium (between 500 and 1500 miles), and long (greater than 1500 miles). For most short hauls, truck service is both cheaper and faster. Intermodal tends to be cheaper for medium hauls, but trucks are faster. Long hauls are cheaper via intermodal rail than trucking (45). According to Standard and Poor's Industry Surveys, long haul intermodal is about 30 percent cheaper than trucking (S&P 1998, 11). Intermodal long hauls on some corridors are faster than single driver trucking because trains operate continuously unlike truck drivers who are limited to driving 10 hours per day under federal regulations. The time advantage depends on the corridor's average operating speed and the number of intermediate stops the train takes to pick up and to drop off containers and trailers (Frazier 1996, 45). There are a few short haul corridors, mainly on the East Coast, which intermodal is made competitive by Triple Crown's RoadRailer because of faster availability times and the facility costs are minimal as there is no need for lift equipment and only gravel surfaces are required (Norris 1994, 62).

Reliability. Service reliability is considered very important to 95 percent of surveyed shippers (IANA 1994, 3). Failures in service include trailers missing the next train or mix ups in the availability time. Therefore, companies that depend on on-time performance will be less likely to choose intermodal. Companies that are not as time conscious, will favor of savings over decreased reliability. One benefit of mergers is that service reliability should improve because railroads can combine to develop faster corridors (S&P 1998, 6). Unfortunately, the Union Pacific and Southern Pacific merger have decreased reliability with the congestion on key lines as a result of improperly integrating operations (Machalaba 97, A3). The Union Pacific reliability problems is considered a temporary condition by the company.

Driver Shortages. The short supply of over the highway drivers shifts trailer traffic onto the rails (Frazier 1996, 45). It is easier to find a driver for a drayage trip than for a long haul. Driver shortages affect larger companies more because, if a shipper has many loads, there will be difficulty in finding a driver for every shipment. The driver shortage gets worse in autumn when the approaching Christmas season causes a surge in retail sales. According to Standard and Poor's, high turnover rates, poor working conditions, and low wages contribute to the shortage (S&P 1998, 13). Lately, trucking firms have had to increase wages and offer signing bonuses to attract drivers. For example, J.B. Hunt raised wages by 30 percent to lure drivers (13). As drivers' wages increase, intermodal freight will become more attractive in terms of cost if railroads can hold costs and tariffs.

Backhaul Opportunity. The existence of a back haul opportunity will also be a factor. If a tractor deadhauls, no revenue is generated for the trucking firm which makes the effective cost of the haul much about twice as much. The lack of a backhaul opportunity favors intermodal because the intermodal rates are independent of backhaul opportunities (Frazier 1996, 45).

Terminal Location. If terminals are not near the trip origin and destination, drayage costs rise sharply. Forty percent of the price a shipper pays for a 1000 mile shipment is for the drayage (Norris 1994, 57). Also, the direction of the terminal relative to the direction of the destination plays a role. For example, if a trailer must be hauled east for a hundred miles to a terminal only to be headed west on the line haul, there is a corresponding loss in efficiency. Another aspect of location is congestion and access. If accessing the terminal is difficult due to traffic or poor road geometry, there is a corresponding loss in desirability (Frazier 1996, 46).

Total Logistics Cost. Large companies are most likely to consider total logistics costs, which factors inventory management and transportation cost together (45). Those companies utilize intermodalism as a moving warehouse. More frequent deliveries of smaller loads reduce the cost of storage. Transit time is not a main priority because shipment timing could be planned accordingly.

High Volume Customer Priority. Many rail terminals give priority to high volume customers as part of a partnering agreement. This priority includes exclusive gate facilities which UPS and J.B. Hunt often utilize (47). High volume customers have greater leverage in negotiating service. Such items include later cut off times, priority unloading, expedited check point operations, service delay notification, and standard parking locations within the terminal all increase the attractiveness of intermodalism by decreasing drayage and transit time (Muller 1995, 68).

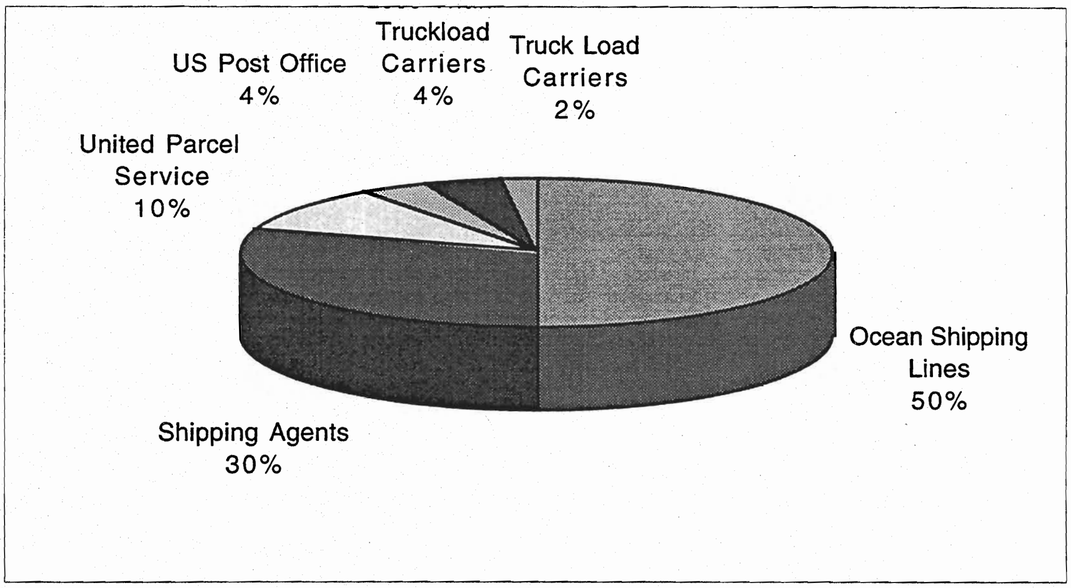
Ease of Doing Business. The ease of a delivery as perceived by the shipper is a factor of the decision to use intermodal. There is just one transportation company involved in trucking a shipment, while there could be three or more for intermodal shipments. Intermodal marketing companies (IMCs) are helping to reduce fragmentation by taking full responsibility for the entire journey of each shipment. Shippers that hire IMCs deal only with one party, which makes intermodal shipping seem less complicated.

Types of Customers

Intermodal customers include truckload carriers (TL), less than truckload carriers (LTL), ocean shipping lines, and IMCs (see Figure 2.1 for a breakdown of market share). This section briefly describes the nature of each type of customer.

Truckload. Several large trucking firms such as J.B. Hunt and Schneider National Carriers utilize TOFC service. J.B. Hunt often locates its hubs adjacent or near rail yards to reduce drayage times and have several locations, including the BNSF Corwith yard, which they have an exclusive check point gate. Intermodalism allows truckload companies to save money and to manage driver shortages. TL carriers negotiate special rates with the railroads to haul trailers. Truckload companies account for 10 percent of the intermodal market (S&P 1998, 9).

Figure 2.1 Sources of Railroad Intermodal Revenue



Source: Norris 1994 Note: The year of the data was unspecified.

Less Than Truckload. Less than truckload (LTL) companies consolidate small shipments into trailers which are hauled between consolidation hubs. United Parcel Service (UPS), which accounts for 10 percent of intermodal rail revenues, operates as an LTL carrier (Norris 1994, 20). Examples of LTL firms including, Roadway Express, Yellow Freight, and Consolidated Freightways that depend on TOFC service to haul trailers from one hub to another. It is likely that UPS and LTL companies would face driver shortages if it did not utilize railroad service. Teamster labor agreements cap the LTL utilization of intermodal rail at 28 percent and if a driver is available within a certain amount of time, the trailer must be trucked (S&P 1998, 9). In 1997, 21 percent of LTL miles were intermodal (9). Other LTL customers include retailers including Sears, K-Mart, and J.C. Penny which rely on intermodal transportation, in conjunction with LTL for their domestic distribution systems (Norris 1994, 26).

Shipping Lines. There are many steamship lines who contract with the railroads to haul containers to and from ports. Shipping lines including Atlantic Container Lines (ACL), American President Lines (APL), COSCO, Evergreen, Hyundai, Maersk, Sea-Land, and Hanjin utilize COFC to reach inland destinations.

Intermodal Marketing Companies (IMCs). These companies act as brokers of intermodal transportation. IMCs arrange the rail line-haul and independent contractors to dray the loads (Frazier 1996, 44). Railroads benefit from the IMCs by their marketing of the railroads' services. In return, the IMCs earn a profit from each container or trailer for which they were responsible. The $3.8 billion IMC industry accounts for 40 percent of intermodal moves (S&P 1998, 18).

COMMODITIES

The primary commodities shipped intermodally can be categorized as either break-bulk or neo-bulk cargo. Break-bulk cargo is merchandise in finished packaging and neo-bulk is cargo such as machine parts, lumber, and paper products (Norris 1994, 21). The most significant intermodal activity surge happens in autumn as retail establishments stock with merchandise to prepare for primarily the Christmas shopping season. Non-traditional containerized commodities such as coffee, sugar, and nuts are being targeted to help balance intermodal trade (Demetrio 1998). Those commodities typically are shipped at a discount rate to reduce the volume of empty containers returned. Chaquita and Dole import bananas from Latin America via the Port of Freeport (Port of Freeport 1997, 4).

INTERMODAL NETWORK SEGMENTS

The intermodal freight system can be considered a network of links and nodes. Links are the modes and the terminals, shippers, and receivers are the nodes. This section describes process involved in each segments, or mode, involved in intermodal freight transportation.

Drayage

There are four forms of drayage in intermodal freight operations. Dray from the shipper to a terminal, dray from the terminal to the customer, and interchange drays between railroads, and a dray between a port and a railroad. The drayage distance varies from a few hundred yards, to a distance usually within the metropolitan area. Several major intermodal customers including United Parcel Service and J.B. Hunt build their own consolidation hubs adjacent to the rail terminal to minimize drayage distance. Such large customers may account for between 10 and 30 percent of the rail yard's volume (Smith, R. Interview). While most drayage trips are within the metropolitan region of the rail yard, some may be headed to another city. For example, a shipment bound for California from Ohio may be trucked to an intermodal yard in Chicago instead of one in Ohio because an interchange between railroads may add too much time to the delivery for certain commodities (Frazier 1996, 47).

Much of the cost involved in drayage is the gate and waiting time at the terminal. Some rail yard gate operations are often inadequate to accommodate peak demand. A wait longer than an hour is not uncommon at some yards and with waiting time estimated to cost $40 per hour ($41.55 in current dollars) (Kelley 1996, 212). Container ports often have excess gate wait times due to the discrete nature of ship arrivals. Terminal operations have a great influence on drayage costs, and these will be discussed in a later section.

To gain better efficiency from truck drivers, shippers typically arrange for the driver to drop off a trailer and then pick one up during the same visit to the terminal. Deadhauling is inefficient because the drayage segment may double (Zimmer 1996, 52). A majority of trips to a rail yard and container ports involve both a drop off and a pick up for that reason.

Delays associated with drayage outside the terminal boundaries typically is the result of the street network near the terminal. Many rail yards are located in the city where traffic on the highways and arterial streets is heavy. Other problems include inadequate geometric design for the operation of commercial vehicles. Reducing the time and difficulty in accessing the rail terminals, by addressing the problems stated, offers a great potential for increasing the attractiveness and ultimately the utilization of intermodal rail transportation. In the case of marine containers, access problems will not cause much of a shift to another mode, but it may affect the choice of the port.

Railroads

Though initial capital cost is high, the rail mode is much more labor and resource efficient than trucking. Trains typically operate with two person crews and will haul about 300 containers or 200 trailers (Kelley 1996, 212). Trains can operate continuously stopping periodically to fuel and to change crews. Federal regulations require that truck drivers to rest daily so there is a limit of 10 hours of driving time per day. This enables some railroad line-haul segments to operate faster than single driver trucks over long hauls. This overall average speed is influenced by the frequency intermodal trains make intermediate stops to unload and to load additional containers and trailers. The use of team or relay drivers for long haul truck shipments are faster than any intermodal corridor, but the additional labor increases the ton-mile costs.

Railroads continue to eliminate operational constraints which limit the efficiency of intermodal freight. As railroad traffic continues to increase, some rail lines are rapidly approaching capacity. Some railroads are responding to increase traffic demand by constructing additional tracks to the mainline. Double stack clearance has been a problem especially for eastern railroads which have old tunnels that cannot accommodate the 20.5 feet of clearance required (Muller

1995, 51). Bridges are also a problem especially in older cities where old structures do not the double-stack height.

Mergers have been a major issue for the intermodal industry. The long term advantages of mergers include less fragmentation and shorter travel times (S&P 1998, 6). By consolidating railroads, there would be fewer interline interchanges which add to the overall travel time. Combining the operations of two railroads allow for a better utilization of rail lines between cities which could reduce travel times or increase the capacity. According to the Norfolk Southern Corporations Web site, the anticipated benefits of the Conrail split between the Norfolk Southern Railroad and CSX Transportation are increased competition in New York and New Jersey, reduction in North/South transit times due to better routing, and the expansion of Triple Crown's RoadRailer service into more markets. The public road agencies may benefit if Norfolk Southern's claim that the Conrail breakup will shift about 589,000 truck trips to the Norfolk Southern is true (NS 1998b).

One fear of railroad mergers would be the lack of competition. This fear is especially present for captive rail users especially power plants which burn coal. How mergers will affect the intermodal industry is a subject of debate. Some feel that because railroad intermodal service competes more directly with trucking firms than with other railroads, rate increases will be minimal because the trucking industry should keep the industry competitive. Others feel that mergers will lead to monopolistic pricing which would raise tariffs but keep them below trucking rates.

Marine

A container ship usually calls several ports on a single voyage. For example, APL has a regularly scheduled voyage calling Tokyo, Nagoya, Kobe, Quindao, and Shanghai in Asia and calling Oakland and LA in the U.S. (APL). This practice increases the shipping destination options from each port. Upon departure, a container ship will require a local pilot to navigate the ship channel from the berth to the open seas, then the regular crew navigates across the seas until it reaches the ship channel of the next port of call when another local pilot boards the ship and navigates until the ship is docked again. Typically, a shipping line wishes to reduce the sailing time in the ship channels because it is estimated that the extra 28 nautical miles from Texas City to Port of Houston's Barbours Cut Container Terminal costs between \$5000 and \$15,000 in vessel costs, and \$1000 to \$2000 in pilotage and tug costs, which add about \$20 per container (Vickerman 1998, 2.20). Most container ports provide at least a 42 foot depth which is adequate for most container ships, but as Megaships become reality, 50 foot channels will be required at some ports.

Currently, few containers travel by barge compared to rail and shipping lines. The Port of Lewiston, Idaho built a container barge facility to ship containers to the Port of Tacoma and now offers service twice weekly. In 1996, Lewiston processed 17,611 containers up from 11,392 in 1993 (Port of Lewiston 1998). Hale Intermodal Transport Company provides container on barge service on the East Coast. Each barge can hold 213 53-foot containers. According to the Journal of Commerce, a shipment of school furniture from Philadelphia and Jacksonville costs $3,800 by truck, $2000 by intermodal rail, and only $1000 by the barge service (Baldwin 1998). Though barges are the cheapest mode of domestic transportation (Cambridge 95b, 1-5), containers are not currently a significant fraction of volume largely due to the limited corridors barge service is available.

INTERMODAL NETWORK TERMINALS

Much of the cost in terms of both money and time delays of intermodal freight transportation is centered around the transfer terminals. Therefore, terminal operations are of vital interest in improving intermodal service. So that sources of delay and capacity constraints can be understood, the terminal operations will be described in this section.

Rail Yards

Operations at intermodal rail yards are crucial for keeping intermodal competitive with trucking. Access to the highway network, gate operations, yard layout, labor rules, management, and equipment all are major factors that determine the efficiency of the facilities. The average turnaround time is 30 to 45 minutes, but times greater than 90 minutes are not uncommon (Kelley 1996, 212). By reducing the cost of terminal operations or reducing the average turnaround time, the average break-even distance decreases which will lead to a corresponding increase in volume assuming savings are passed along. It is this reason that terminal efficiency is critical for the long term growth of intermodal traffic.

Most intermodal terminals are operated by contractors who are supervised by railroad officials. Typically, it is a turnkey contract in which all operations, with the likely exception of switching, are handled by the contracting company. Railroads contract out the services so that they can concentrate on their expertise which is operating the railroad and not the terminals (Gengler. Interview).

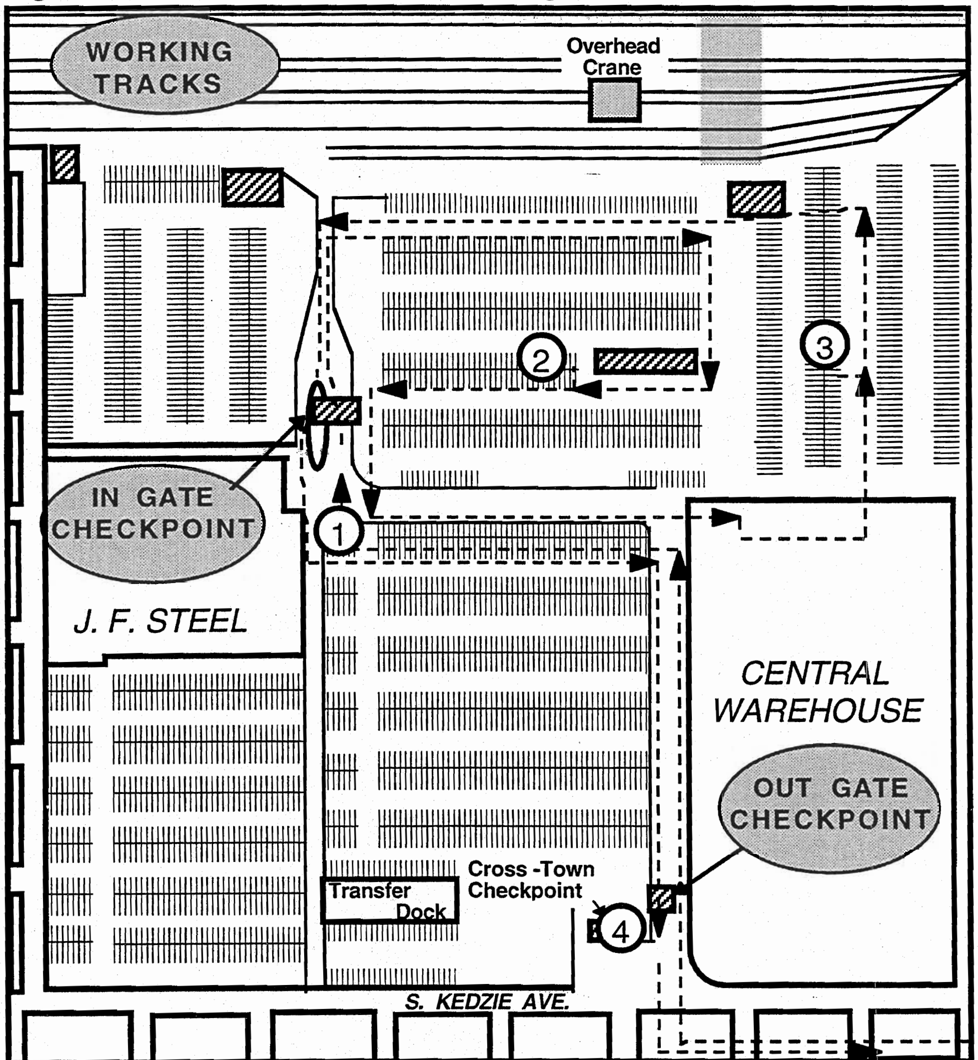
When a train arrives, the rail cars are switched on to "working tracks", also known as "intermodal tracks", where lift operations occur. Depending on the facility, the rail cars are moved by terminal employees or the mainline crews depending on the labor contract (Smith, G.

Interview). The trailers are lifted off the train onto the pavement where a yard tractor picks it up and drives it to a designated parking spot. A container is lifted off the train onto a chassis and then pulled by a yard tractor. Depending on the urgency of the load, a driver will come to pick up the cargo up within minutes, hours, or several days and will proceed to the check out gate and fill out the required forms. Railroads limit the amount of free time, the time a load is allowed in the terminal before extra daily fees are charged. Free time at BNSF yards is the two business days following the arrival (3rd day) and the per diem charge is $50 afterward (BNSF 1997, 25). For this reason, terminal operators are not overly concerned with decreasing the average dwell time (Patton. Interview). If parking capacity needs to be increased, an alternative to expanding the parking area would be to reduce dwell times somehow.

Outbound loads follow a reverse process as inbound loads. The driver checks in and is instructed where to park the container or trailer and leaves it in the designated spot. Then when it is time to load the train, the yard tractor will bring the container or trailer to the lift equipment which will place it on the flatcars. After the flatcars are loaded and the locomotives arrive, the flatcars are assembled to form a train and then the train departs. Cut-off times exist so the terminal operators are given adequate time to load the container onto the train. See Figure 2.2 for an illustration of the pick up process.

Larger terminals utilize advanced technologies for parking space assigning and for tracking the location of trailers and containers. The Union Pacific facility at Mesquite, Texas uses Optimization Alternatives Strategic Intermodal Scheduler (OASIS). which is a computer system which uses radio signals to transmit and to receive location information. Whenever a trailer or container is moved, it gets recorded into the system. This almost guarantees that the truck operator will find the container or trailer where the gate clerk said

Figure 2.2 Intermodal Rail Yard Diagram



Procedure	**BNSF Corwith Yard, Chicago**
1 Driver Checks In 2 Driver Parks Trailer 3 Driver Picks-Up Trailer 4 Driver Checks Out	This drawing is based on the layout of the Corwith facility. This shows a possible path of a truck serving this facility. Though yard layouts vary, most operate in a similar manner.

it should be. This facility has a system which alerts clerks if a driver has been in the yard over a specified duration so that they know to offer assistance (Smith, R. interview). The Burlington Northern Santa Fe Alliance facility near Fort Worth utilizes a different version of OASIS. Larger facilities depend on a computer based storage management system to keep track of container and trailer locations because they may have up to 2000 parking spaces.

From the truck operator's perspective, the terminal consists of the surrounding highway network, gate operations, and parking facilities. Adequate access to the facility is important so that less time is wasted following circuiticious routes or waiting in traffic. Minimizing check-in and check-out times is a critical for improving overall intermodal service. As mentioned earlier, it costs $40 per hour ($41.55 in current dollars) to operate a truck waiting in the queues so reducing wait and turnaround times would benefit shippers (Frazier 1996, 51). Efficient parking layouts also benefit drivers. If the assigned space for drop off and pick up are easy to find, less time is wasted. Good customer service is an often overlooked area. According to the American Trucking Association, knowledgeable and friendly gate clerks help make the process easier for the truck operator (ATA 1997, 14).

In effort to cut costs, railroads reduced the number of rail terminals from over 1500 in 1975 to 230 in 1992 (Cambridge 1995b, 1-8). Eliminating low volume yards and consolidating redundant yards make operations more efficient and therefore cheaper. One major drawback of such consolidation is that intermodal truck traffic is concentrated around fewer facilities which contributes to an even greater amount of highway congestion surrounding remaining facilities.

Container Ports

Container ports must be efficient to attract shipping lines. Unlike rail yards, container ports compete directly with other ports for business. The attributes which make a container port attractive for shipping lines are: the location relative to the market and to the open seas, the availability of rail service, the number and type of cranes available, container storage capacity, adequate channel depths, and the ability to turn around a truck driver in a timely manner. This section describes the port operations from the drivers perspective and from the port's perspective.

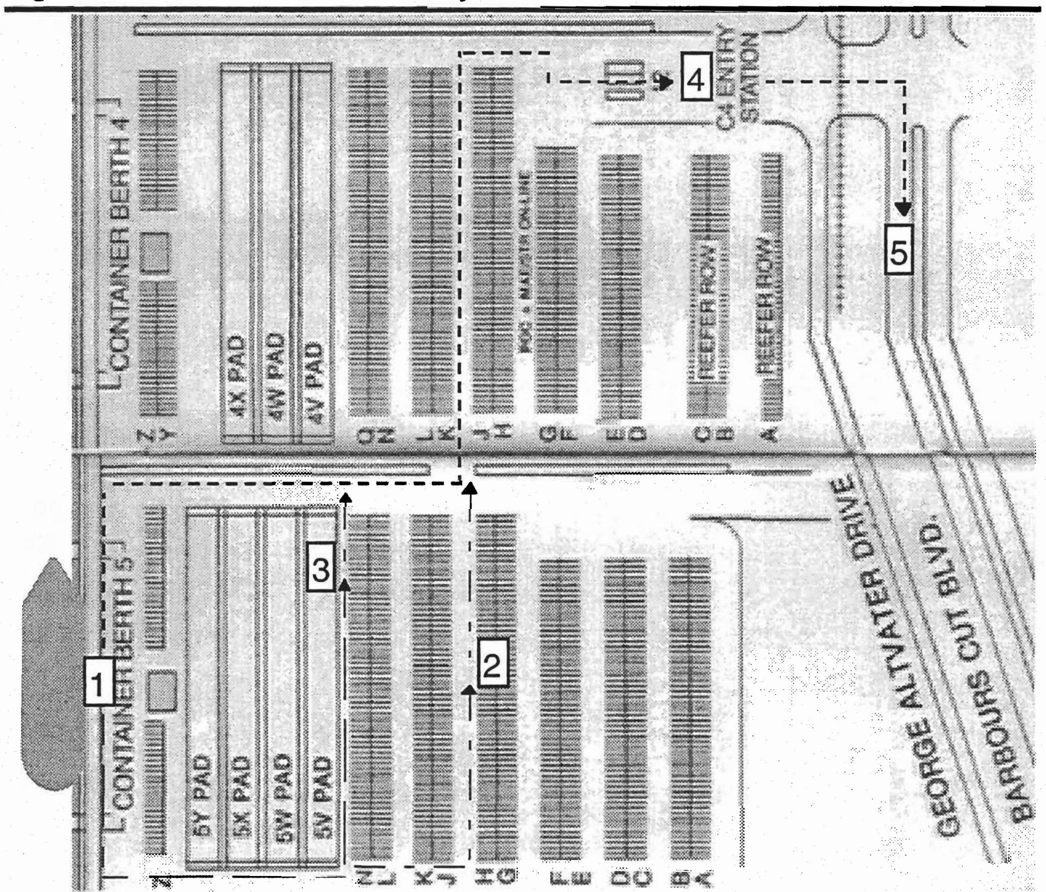
The concept of a container port is very similar to that of rail yards; containers are unloaded, stored, and picked up and vice versa. However, there are significant differences. The crane lifts the container off the ship and onto a chassis which is pulled away and then is either placed in storage or driven to the customer. Due to space limitations and long dwell times, a common practice of ports is to stack containers. Depending on the capability of the equipment, stack height can be up to 7 boxes high, but a stack height of 3 to 5 is typical. The container headed for storage is either parked on a chassis or lifted by a yard crane and stacked until a driver arrives to pick it up. When the driver arrives, the container must be retrieved from the stack. Often, other containers must be moved in the process causing extra delay for the waiting driver.

Some ports utilize on dock rail transfer which is more efficient that the more common practice of draying the container from the port to the nearby rail yard. Less labor is involved in moving the container and fewer containers need to pass through the check point gates. Public benefits include less congestion and road damage as a result of fewer truck miles being driven.

There is a division of responsibility of container port operations. Shipping lines coordinate the unloading of the ship while the port authority coordinates the land side activity. Shipping lines unload according to their own scheme and so may accommodate priority containers or "hot boxes" by placing a container on a waiting driver's chassis thereby skipping the storage process. Landside activity is typically left to the port authority because most containers are picked up long after the ship has left the port. The port authority provides the facilities for the shipping lines and acts as a storage contractor. Ports collect revenues based on various charges including crane time, berthing time, and a per container charge (Morgan, R. Interview). Refer to Table 2.1 for examples of typical charges. Some large container ship lines operate their own berths including Sea-Land which leases Berth 6 at the Port of Houston's Barbours Cut Container Terminal (Port of Houston 1997, 6).

The land side interface of the container port consists of the access roads, gate operations, and parking layout. Landside operations of container ports are similar to rail yards, but activity comes in more concentrated surges as container ships may hold over 6000 TEU at a few key ports. Entry gate waits tend to be longer during peak operations

Figure 2.3 Container Port Layout



Critical Locations	High Priority - - - - - - - -	
1: Container Crane	1-4-5	Transferred Directly to Waiting Truck
2: Wheeled Storage	**Medium Priority** — - — - — - —	
3: Stacked Storage	1-2-4-5	Transferred to Yard Tractor Parked in Slot Picked Up
4: Check-out Gate		
5: Driving to Customer	**Low Priority** - —— —— —— —	
Note: Typically trucks drop off containers during the same trip.	1-3-4-5	Transferred to Yard Tractor Stored in Stack Picked Up

Source: Terminal Diagram for berths 4 and 5, Port of Houston.

Table 2.1 Sample Charges for the Port of Houston

Container Crane (Operator furnished by user)	$ 466.20	per hour
Yard Tractor and Chassis	$ 30.50	per hour
Container Storage (in excess of 10 days)	$ 5.00	per day
Docking Charge (for 850'-900' vessels)	$ 7.75	per foot per day
Wharfage Charge (40' Container 3 to 35 tons)	$ 2.25	per short ton

Source: Port of Houston Authority Tariff No. 14 (effective 10/1/96)

and the total in and out time is longer as well due to storage recovery process already described. The gate wait can reach one hour and the turnaround time is one hour not including the wait (Morgan. Interview).

Traffic tends to be heavy near port facilities so drayage costs more than it would if traffic was minimal. Improving the road network around ports will benefit shippers, but unlike rail yards, improving the surrounding streets will not shift more traffic to the railroads. If the long term goal is to reduce overall road traffic, improving the surrounding road network will not be a solution, because unlike rail yards, such improvements will only lead to more port related traffic. To shift more traffic to rails, the port rail service must be improved if at all possible or feasible.

EQUIPMENT

There are numerous types of equipment involved in intermodal freight transportation. Equipment required varies according to the type of intermodal service. This section describes the equipment associated with intermodal freight including containers, flat cars, lift equipment, and container ships.

Containers

Standardized containers allows for efficient operations throughout an intermodal shipment. Stacking promotes efficiency by expediting the container ship loading and unloading process, by allowing for double-stacking on flatcars, and by reducing the storage space required at terminals. Containers come in several standard sizes. Marine containers are generally limited to 20', 40', and 45' sizes due to container ship layout. Larger container sizes which are utilized exclusively for domestic shipments include 48' and 53'. The larger containers typically hold less dense cargo than the smaller containers. The standard dimension for a domestic 48' container is 48 feet long, 8.5 feet tall, and 8.5 feet wide (Norris 1994, 19). "High Cube" containers are 9.5 feet in height for lower density shipments. Marine 20' containers either hold dense cargo or is a smaller shipment. Several specialty container types include, refrigerated units, open platform, and liquid tank containers. The open platform container has high ends as to be compatible with container lift equipment. This type of container is suitable for commodities not requiring a roof. The tank container is surrounded by a frame with the same dimensions as the standard 20' container.

Often third parties own container and chassis pools. This adds flexibility to containers, trailers, and flatcars. This allows for more practical interline hauls because the need for returning the equipment to the original railroad is eliminated. Most containers are owned by steamship lines or container pools. Fees are charged to the party who has possession (Smith, G. Interview). Most trailers are owned by trucking firms or trailer pools. A railroad may pay about $12 a day for an empty container, but when a shipper picks up the container from the railroad, the cost get charged to the shipper until the container returns to the railroad (Smith 1998, G. Interview). A similar arrangement works with the steamship lines. Railroads prefer not owning containers because of the large capital investment required and the depreciation and maintenance expenses.

There are three standard types of leases. Spot leases are short term agreements and price fluctuates depending on the season. Term leases are long term agreements which offer no service plans. Master leases are also long term, but fleet management, maintenance, and repositioning are included (Muller 1995, 132).

Chassis

So that a container can be hauled by a tractor, it is placed on a chassis forming a legal street trailer. The chassis come in several sizes according to the various container sizes, but adjustable versions are available. Often chassis are stored vertically at ports and rail yards to reduce the space required for storage when not in use. Chassis are often owned by third parties in a similar manner as containers and trailers and typically costs $9 to $12 per day to lease ($9.35 to $12.47 in current dollars) (Prince 1996, 250).

Trailers

Trailers are used exclusively for North American trade. Ownership of trailers range from TL and LTL shippers and by trailer pools. Trailers have an advantage of not requiring a chassis, thus requiring fewer steps than containers during the train loading and striping process. Trailers, like containers come in varying lengths. Typically trailers are 28, 40, 45, 48 and 53 feet long (Vandeveer 1996, 94). The main disadvantage of trailers is the inability to stack which corresponds to a greater cost to the railroads.

RoadRailer

Utilized mostly by TripleCrown and Amtrak, RoadRailer is a trailer which has both rubber tires and steel wheels. A RoadRailer trailer does not require lift equipment, train cars, or specialized terminal facilities. RoadRailers form a train by coupling with a trailer ahead of it. Trailers can be detached from the rain and driven away very quickly. Norfolk Southern and Conrail formed a partnership in 1986 called Triple Crown. This is the company which markets and operates the RoadRailer system in the east (NS 1998b). The efficiency of RoadRailer enables intermodal to compete in shorter haul markets in the East Coast. Figure 2.4 shows RoadRailer Trailers forming a train.

Flat Cars

Railroads carry intermodal freight on a variety of flatcars, but they can be divided into three categories: traditional piggyback flatcars for trailers, double-stack container flatcars, and combination flatcars. The typical flatcar length is 89 feet. Innovations including articulation have increased the efficiency of railroad operations by reducing the weight. Articulated units typically consist of five cars on six trucks and can carry up to 10 containers. This corresponds to a tare weight improvement over conventional flatcars of the payload-to-tare ratio from 0.69 to 1.91, which results in a 41 percent fuel savings (Muller 1995, 67).

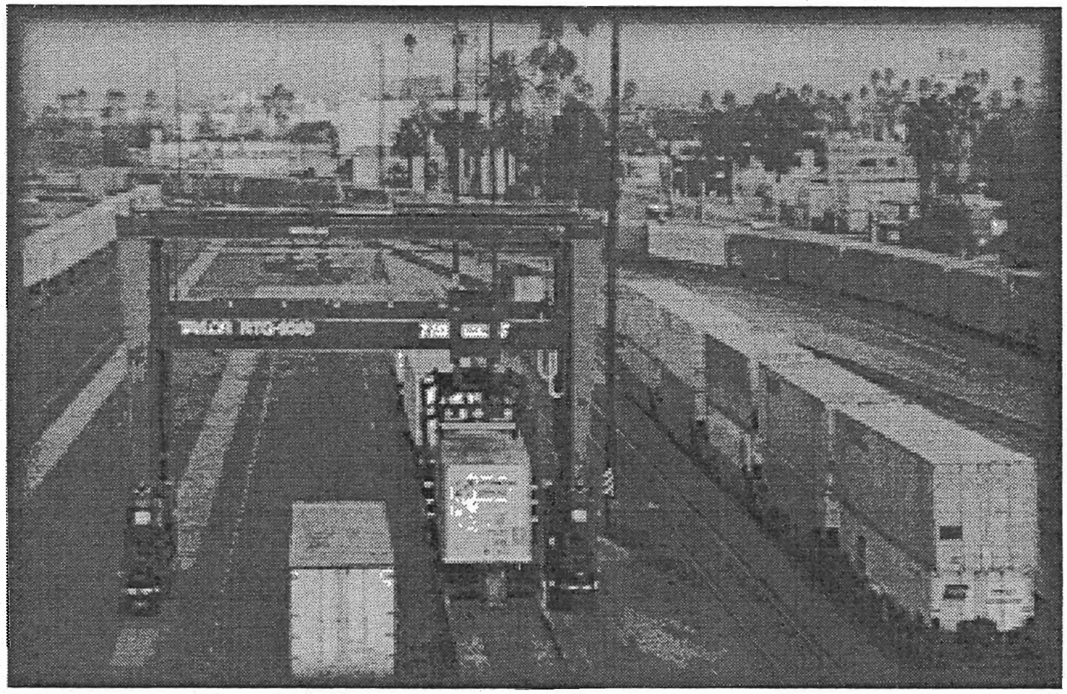
Figure 2.4 RoadRailer Trailer

Source: Triple Crown Service

Lift Equipment

A crucial element of intermodal terminal operations is the lift equipment which transfers containers and trailers between modes. The more cranes a terminal has, the terminal can process a greater capacity in addition to handling surges in volume better. There are two main types of lift equipment that rail yard utilize: overhead cranes and side lifts. Typically a rail yard will have either one or the other, but many have a combination of both. Overhead cranes are costly and therefore used mainly in high volume yards. Overhead cranes straddle both the track and pavement so that the operator can drive the machine down the track and while removing or adding trailers and containers.

Figure 2.5 Overhead Crane



Source: Taylor Machine Works

Lower volume yards typically utilize side lifts because they are less expensive than cranes. Other yards use a combination of both and use side lifts for priority loads and unloads as they can traverse the length of the track faster. Side lifts take more time to load and unload trains because of the turning required to load and unload a container or trailer. According to a rail yard manager, a good side lifts operator will take about 40 seconds longer than a crane operator to load or unload a single container or trailer (Morales, J. Interview).

Port lift equipment include cranes that load and unload ships, and lift equipment that stack containers in the yard. Gantry cranes for Panamax vessels reach 144 feet serving 106 foot beams 13 rows of container across. Post Panamax cranes reach up to 158 ft for 16 rows, and beyond post Panamax cranes must reach greater than 158 feet to serve 18 rows of containers (Vickerman 1997, 6). Yard cranes operate similarly to the overhead cranes at rail yards. Like rail yard cranes they may run on rubber tires of on rails, but instead of loading and striping trains, yard cranes stack containers into storage.

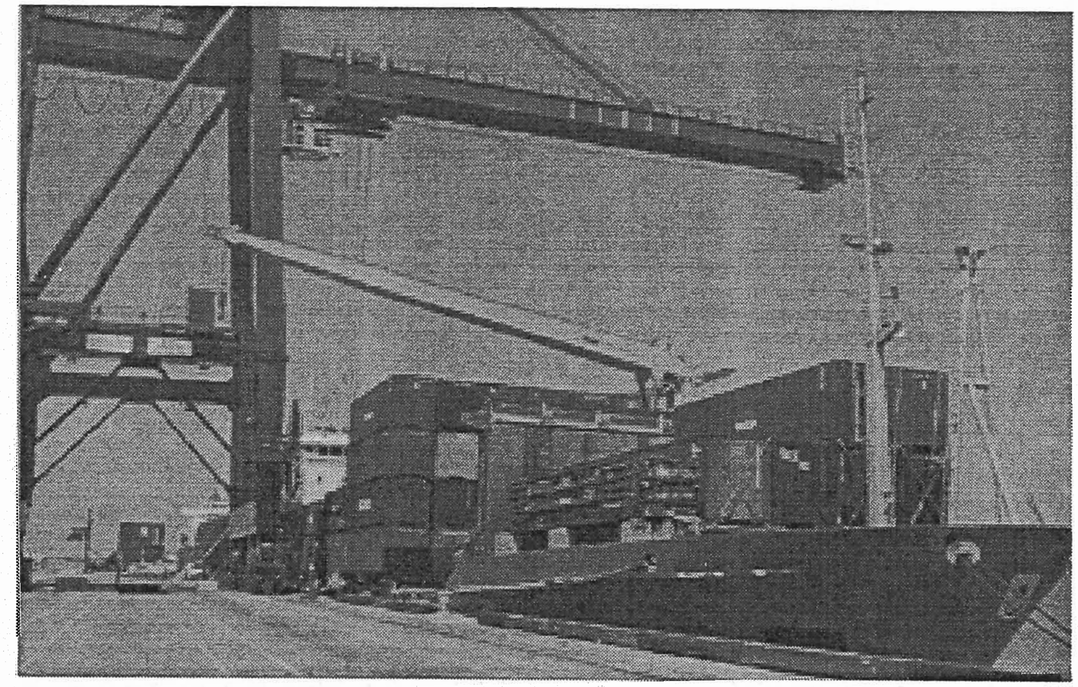
Figure 2.6 Side Lift

Source: Taylor Machine Works

Container Ships

There are a variety of container ship sizes categorized with respect to the Panama Canal. Panamax ships are the maximum size that can fit through the Panama canal. Post-Panamax ships are those that are too large to traverse the canal. With the availability of rail service to "land bridge" containers across the continent, being able to traverse the Panama Canal is no longer a critical issue. The post-Panamax ships will become more common because they benefit from economies of scale.

Figure 2.7 Port Container Crane



Source: Port of Houston Authority

Table 2.2 Container Ship Generations

Generation	Type	Capacity	Length	Draft
1st	Converted Dry Cargo Vessel	1000 TEU	630 ft	variable
2nd	Converted Oil Tanker	2000 TEU	700 ft	variable
3rd	Cellular Container Ship	4000 TEU	950 ft	42 ft
4th	Post-Panamax	5000 TEU	1,000 ft	45 ft
5th	Megaship	6000 TEU	1,100 ft	50 ft

Source: Vickerman Zachary Miller

Figure 2.8 Container Ship

Source: Port of Houston Authority

FUTURE DEVELOPMENTS

The future of intermodalism will see the application of advanced technologies and the application of new concepts. Faster and bigger ships will change the nature of operations. Advanced technologies may help equipment tracking especially within the rail yard. Certain advancements in ship size and speed will require some drastic changes in port operations. This section will list some of these advancements and the consequence ports, railroads, and shippers face as a result.

Amtrak Intermodal

With recent cuts in federal funding, Amtrak is forced to find new revenue sources to continue providing the current level of service. One reliable source of revenue for Amtrak is its Amtrak Express freight service. Amtrak entered intermodal freight industry when it began hauling RoadRailer units at the end of its passenger trains to carry mail. Amtrak's RoadRailer units increases revenue for the money losing company. The railroads oppose such plans because the government forces them to let a competitor use its rails for freight purposes. Amtrak RoadRailer service includes reefer (refrigerated) units between Philadelphia and Chicago and between Philadelphia and Jacksonville (Amtrak 1998c).

Though the Rail Passenger Service Act of 1970 allows Amtrak to generate revenue from mail and "express" freight, the term "express" was not explicitly defined. The freight railroads view express as being small shipments. The May 28, 1998 ruling by the US Surface Transportation Board affirmed that Amtrak can continue its trailer load-sized express shipments on its scheduled passenger service (Amtrak 1998b). Since Amtrak can provide 4 day coast-to-coast service, it provides a service other railroads cannot. Due to the infrequent train schedules and limited fleet size of 291 RoadRailer units (Amtrak 1998a), Amtrak will not claim a significant share of intermodal volume.

Fastships

Advances in hull design technology and propulsion systems will result in faster ships. The Fastship will utilize gas turbine propulsion and its concept enables the vessel to maintain speed no matter the weather, unlike conventional vessels. It is predicted that Fastships will cross the Atlantic Ocean in 7 days compared with 14 to 35 days for a conventional ship (Giles 1997). Such fast voyage time would require calling only one port per voyage and quick loading and unloading procedures to increase voyages so revenue could be maximized. A proposed loading method would be to roll rail cars on and off the ship. Users of this service would pay a premium, but Fastships will offer a cheaper, yet reasonably fast alternative to air cargo.

Megaships

As ship building technology improves, bigger vessels can be built. Larger vessels have a greater container capacity and corresponding decrease in unit cost. "Megaships" will be the next generation container ship with an approximate capacity of 6000 TEU. Accommodating larger ships will require many ports to increase channel depths to at least 50 feet and improve efficiency so that the ships may have a more rapid turn around time. With greater capacity, there will be a greater surge in volume that must be processed. If ports are going to accommodate Megaships, they must utilize on dock rail connections, have a minimum of 3 cranes per berth, and have state-of-the-art gate processing to provide faster ship turnaround times (Vickerman, 1997, 1-3). Due to higher opportunity costs, Megaships operators would choose ports nearer to shipping lanes. Accommodation of Megaships will require substantial investment and cooperation among ports. It may be cheaper for one port to double capacity than to increase similarly sized ports by 50%, for example. Since, smaller vessels will still continue operations, shallow draft ports will still handle traffic, there should be cooperation between ports in the same region in Megaship planning.

Other Technologies

Advancements in Electronic Data Interchange (EDI), Global Positioning Systems (GPS), and automated terminal operations will likely enhance intermodal transportation efficiency. Gate processing will be expedited with greater dependence on EDI. Inventory and locating the assigned parking spots for drop-off and pick-up will be easier with GPS technology. Automated lift equipment and container storage systems will increase the efficiency of facilities in terms of both labor and time. The higher volume intermodal facilities will be the first to implement new technologies.

SUMMARY

This review of the intermodal freight industry should help planners understand the industry so that effective freight planning decisions can be made. Reducing cost and travel times are the primary areas that will increase intermodal freight's market share which benefits the following groups: highway agencies due of reduced highway damage; motorists due to fewer trucks to conflict with; and the general public for reduced pollution and lowered retail costs due to more efficient freight logistics. Improving the access to intermodal freight terminals is a method to reduce costs and travel times for intermodal freight. Future chapters will further investigate how government agencies can better promote and plan intermodal freight transportation.

CHAPTER 3. INTERMODAL IMPEDIMENTS

The rapid growth of intermodal freight cannot continue without addressing the impediments that will eventually prevent continued growth. Congestion, inadequate infrastructure, operational deficiencies, regulatory hurdles all hinder the full utilization of intermodalism. This chapter contains an investigation of the impediments of intermodal freight transportation. Of special interest are impediments which can be influenced by public policy. Understanding how policy and public sector funding can influence the industry will prepare public officials to make wise planning decisions. The chapter defines categories of impediments categories and discusses relevant role of public policy.

INFRASTRUCTURE

Of 25 ports surveyed by the American Association of Port Authorities (AAPA), 64 percent considered traffic on the access roads to their terminals a major concern (Mongelluzo 1998, 1A). Funding surrounding infrastructure enhancements is means for the public sector to promote intermodal freight transportation and attain the public benefits of an efficient intermodal transportation system. This section lists common infrastructure impediments and how they can be fixed.

Highway Congestion

Many intermodal rail yards and container ports are currently located in highly congested urban areas because development grew around railroad and port owned property. Associated delays with increase the cost of the drayage segments of intermodal trips. Solutions for reducing the congestion problem include adding more traffic lanes, adding turn lanes, improving signal timing schemes, and adding traffic signals near the entrances to the intermodal rail yards. Often, physical improvements of the roadway are not feasible due to the development of the area.

Many terminals do not have traffic signals to allow trucks to safely turn into or out of the terminal. Without traffic signals, congestion on the arterial street near the entrance to the facility will permit infrequent left turn opportunities for trucks waiting to exit. Queues lengthen as the number of adequate gaps fails to meet demand. When there finally is a sufficient gap, queued trucks waiting to leave will follow the first truck so all the trucks in the queue execute the turn thus blocking traffic. A similar process happens as trucks queue on the arterial street waiting to execute a left turn into the facility. The lack of signalized intersections where needed causes delays for both trucker operators and other motorists.

Highway Access and Geometric Design

Many intermodal terminals lack adequate highway access. Cicuiticious routes, low bridge clearance, poor signage, and narrow lanes are some access issues. Though a highway may be adjacent to the facility, the nearest highway ramp may require a drive of a mile. For some facilities in Chicago and other locations, the most direct route to the highway can not be utilized by trucks because low viaduct clearance on the shortest route requires trucks to take a longer alternative route (Norris 1994, 36). Narrow lanes, short turning radii, and the lack of left turn bays also making commercial vehicle operation difficult. Enhancing terminal access by addressing geometric design and congestion concerns is an opportunity for the public sector to aid intermodal transportation.

On-Dock Rail Facilities

Typically, container ports are served by a nearby rail yard requiring drayage operations. Few have on-dock ship-to-rail transfer facilities which eliminates the need for drayage from the port to the rail yard. With 10 to 30 percent of movements through individual ports utilizing intermodal rail (Vickerman 1997, 4), the volume of short drayage trips can be significantly reduced with on-dock transfers. In addition, the percentage utilizing rail would increase as the cost of the rail segment would be less than before. Despite the gain in efficiency and elimination of drayage costs associated with on-dock ship-to-rail transfers, it is an uncommon practice in the U.S. The ports of Tacoma, Portland, Long Beach, Norfolk, and Baltimore are some of the few that utilize the of on-dock rail connections (Norris 1994, 38). A difficulty of implementing on-dock transfers is that it requires greater coordination between shipping lines and railroads. The public and private sector benefits of on-dock rail transfer should make it a priority for government involvement.

OPERATIONAL ASPECTS

The responsibility of operating the intermodal freight system lies with private sector. Most deficiencies in operations cannot usually be influenced by public policy, but understanding them will make government officials better qualified to make freight planning decisions. Listed below the major operational problems facing the intermodal industry.

Terminal Capacity

As a rail yard or port approaches capacity, it requires one or more of the following: greater efficiency, more equipment, expanded parking space, more check point gates, and more employees. Each requires financial investment, but providing more parking space may not always be feasible. As development spread, available space around existing terminals have disappeared. Terminals operating near capacity which cannot expand will have to relocate or provide sub-standard service.

Interline Interchange

Intermodal shipments often require interchange between two railroads. This is typically required for shipments that cross the Mississippi River. Eastern railroads interchange with western railroads in Chicago, Memphis, Kansas City, and New Orleans (33). Ideally, interline interchange would be merely changing the crew and locomotives which is referred to steel wheel interchange, but often interchange involves removing the container or trailer at one railroads terminal, and then draying it to the other railroad's terminal. This adds significantly more truck traffic in those cities, where there were 400,000 rubber tire interchanges 1989 (40). Not only does rubber tire interchange add traffic to the streets, it also is an average of $112 per move ($139 in current dollars) (32). Public benefits of steel wheel interchange include fewer truck miles and cheaper transportation. Private sector benefits include cost cutting and reduced terminal capacity requirements. Convincing railroads to cooperate more in cities with high volume of rubber tire interchange would reduce the 400,000 annual cross town truck trips nation wide.

Rail Line Capacity Constraints

Tunnels and bridges have limited the expansion of double-stack train routes. Without the ability to double stack containers, the operating cost is higher which is ultimately passed onto the shipper. Railroads have been working to raise tunnel and bridge clearance to 20.5 feet to accommodate double-stack trains. Clearance problems are generally worse on eastern railroads because they were built earlier, but problems have been greatly reduced as a result of railroad efforts, so there are few locations left where clearance is a major problem in terms of the entire intermodal network.

Other railroad capacity limitations include short siding lengths and track capacity. Double-stack trains can be 9000 feet long, but often are subject to siding constraints which force trains to be shorter. Railroads have been adding tracks to mainlines creating double and triple track mainlines to accommodate increased traffic. A result of mergers and subsequent line abandonment, increasing capacity on the corridors that are left will be required to accommodate increasing rail traffic (Muller 1995, 51). Consolidating operations is cost effective, but reduces ultimate capacity.

Surges in Volume

Constant volume levels would simplify terminal operations and design. Extra cost is associated by providing extra capacity to handle periodic fluctuations in volume. Extra parking space, lift equipment, and gate personnel must be provided to maintain the level of service during peak periods. Peak demand often cannot be supplied by the railroads because of limited train capacity so some shipments cannot be hauled by the train on the desired day (Copeland. Interview).

Service Schedules

Railroads operate trains according to set schedules. Because of the nature of scheduling trains that travel hundreds of miles, optimal departure and arrival times cannot be provided at every city along the rail line. Late in the day departures would be ideal for many manufacturers as they could ship the day's production in a container and deliver it to the rail yard and have it depart that night (Norris 1994, 42). Such scheduling decreases flexibility and may result in a shipment taking an extra day merely because of the train schedule.

Terminal Service

According to the American Trucking Association (ATA), the importance of customer service is underestimated. The ATA surveyed many truck drivers about specific intermodal terminals and received 5151 responses. Many terminals scored low marks because of a lack of courtesy and respect to the drivers (ATA 1997, 14). If terminal staff was knowledgeable, and cooperative, the terminal got high scores. A common customer service related complaint was the lack of additional clerks during peak periods. One driver reported on the survey, "an additional clerk or two for just 30 minutes at peak times can mean the difference between open windows and drivers standing in line for paperwork all day" (21). A simple improvement in customer service would improve the reputation of intermodal transportation, which may ultimately result in greater intermodal utilization.

On-time Performance

Timely delivery is considered crucial for shippers. Faster transit time may not critical to all as long as the delivery will be on time so logistical plans can be made accordingly. Often, especially during peak periods, train space is limited which causes some containers and trailers to be held over a day. Some shippers rely on short delivery time windows. To attract more of those customers, on time performance must be improved. With the trucking industry's 95 to 99 percent on time performance, railroads have a tough standard to follow (Norris 1994, 42).

High Drayage Cost

Drayage accounts for as much as 40 percent of an intermodal shipment's cost, which runs between \$80 and \$300 per trip (\$88 to \$330 in current dollars) (41). A reduction in drayage cost would make intermodal a more attractive shipping option. This illustrates the importance of improving facility access and terminal turnaround time because it can significantly reduce the cost of drayage.

Merger Integration

The merger of the Union Pacific and Southern Pacific Railroads resulted in a catastrophic operational failure. The failure to integrate the Southern Pacific system properly caused traffic jams in the Houston area which soon rippled throughout the entire system. Delays for shipments reached over 30 days for shipments that were supposed to take 3 days. The railroad lost track of tank cars and containers which have cost customers business. A merger that was supposed to save the railroads over \$800 million a year has cost US companies over \$2 billion according to economists (O'Reilly 1998). Because the Union Pacific could not deliver, intermodal users either shifted business to the BNSF or to trucking firms. The intermodal industry which already had a reputation for low service quality suffered as a result.

INSTITUTIONAL ARRANGEMENTS

Some barriers to greater utilization of intermodal freight transportation are institutional arrangements. Public policy cannot have much influence on institutional relationships within the industry, but these issues are relevant in the context of intermodal freight planning.

Fragmentation

Intermodal freight transportation is a fragmented process. Each party acts in its own best interest which may not be in the best interest of the industry. A result of fragmentation is diffused responsibility especially over damage claims. Conflict over damage responsibility between railroads, shipping lines, and truckers go unresolved resulting in customer neglect (Norris 1994, 44). Better cooperation between modes will help reduce problems and negative perceptions regarding damage responsibility. IMCs are helping to reduce the perceived fragmentation with respect to the shipper by assuming responsibility of the entire intermodal journey.

Labor

Railroad and port labor are typically unionized which decreases flexibility of operations. Newly constructed facilities are not usually subject to unionized labor which results in a reduction in labor costs due to greater job assignment flexibility and even lower wages. At the BNSF Alliance rail yard near Fort Worth, non-union employees can handle most facets of terminal operations including switching flatcars, driving hostling tractors, and operating the lift equipment (Smith, G. Interview). This allows for a faster response time if certain tasks are required to be performed immediately.

Other labor issues include LTL carriers and port operators. LTL labor contracts limits the amount of LTL volume that can utilize intermodal rail to 28 percent. The Teamster union contract with LTL shippers prevent greater utilization of intermodal because the contract states if a driver will be available within 2 hours, then the shipment must be driven by a union driver (S&P 1998, 7). At ports, longshoreman labor rules sometimes constrain port operations. Limited schedules, hours, and crew size regulations either restrict flexibility or increase labor costs (Norris 1994, 44).

REGULATORY HURDLES

There are numerous regulations and policies which impede intermodal freight. Detailed analysis of regulatory hurdles is beyond the scope of this research, but a basic understanding of such policies is important in the context of intermodal freight planing.

Jones Act

The Merchant Marine Act of 1920, also known as the Jones Act, requires that all domestic goods be shipped on US built, owned, operated, and flagged vessels. The purpose of this act was to promote a modern merchant marine fleet, but the consequence was a small domestic fleet which acts as a monopoly for domestic shipping (Jones Act Coalition 1998). Because few vessels are qualified to haul shipments domestically, the cost of shipping grain to Hawaii from the mainland is between 190 and 400 percent greater according to The Jones Act Reform Coalition. The repeal of the Jones Act could make domestic ocean intermodal shipping a more feasible option for domestic shippers through reduction in domestic rates.

Local Regulations and Restrictions

Local communities impose several types of restrictions which adversely affect intermodal operations. Hours of operation are often constrained to minimize noise during the night (Norris 1994, 46). Truck and rail operations are prohibited during these times. Weight restrictions on certain local roads adversely affect access as trucks will have to take a alternative longer route. Limiting the regulations local authorities can impose would increase operational flexibility.

Some local and state authorities, in searching for new revenue sources, have turned to dipping into port authorities trust funds that were collected by users for port improvements (46). "Revenue grabs" as they are called, decrease the ability for ports to plan expansions as their revenue sources are subject to a form of taxation. One consequence of such actions is that California port bond ratings are dropped due to the now uncertain revenue stream (Helberg 1996, 25).

Environmental Standards

Protection of the environment hinders expansion of terminals and dredging of waterways. The Clean Water Act (Section 404) may hamper some ports from accommodating post-Panamax container ships due to dredging restrictions. Often, dredging is not ultimately prohibited, but regulatory hurdles are numerous as dredging permits may be required not only from the U.S. Army Corps of Engineers, but the Environmental Protection Agency, U.S. Fish and Wildlife Service, the National Marine Fisheries Service, as well as other state agencies (Norris 1994, 47). Ports subject to tougher environmental regulations may loose future business to other ports. Wetland protection prevent or increase the cost of expansion and new construction of port facilities. The Port of Long Beach paid an extra $28,000 per acre ($29,100 in current dollars) to meet environmental requirements (Sheppard 1996, 40). Blocking expansion at critical terminals will hinder the utilization of intermodalism.

SUMMARY

Impediments of interest in this study focus on the roadway infrastructure. However, other impediments which can be influenced by public policy must be considered integral to the intermodal freight planning process. Improvements to the surrounding highway network should be implemented to relieve access problems. Certain regulations which restrict terminal operations and access should be reviewed as a means for improving intermodal freight transportation. Other impediments must be addressed by the railroads, shipping lines, and trucking firms so that intermodalism becomes even more efficient. Government participation will help increase the utilization of intermodal freight, but the private sector must continue to address impediments as well.

CHAPTER 4

GOVERNMENT INTERMODAL FREIGHT PARTICIPATION

With the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, intermodal freight transportation has become a national priority through incorporation of freight objectives in the planning process. Government involvement in a private sector industry must be justified by serving public interest. Otherwise, competing modes would object to the government subsidy to intermodal freight. According to the Federal Highway Administration (FHWA) the advantages of intermodalism which serve the national public interest include: 1) lowering transportation costs by allowing each mode to be used for the part of the trip for which it is best suited; 2) increasing national economic productivity and efficiency; 3) more efficient use of existing transportation infrastructure; 4) increased benefit from public and private infrastructure investments; and 5) improved air quality and environmental conditions, such as by reducing energy consumption (Cambridge 1995a, 1-1). The Norfolk Southern claims highway agencies would save $0.12 per truck mile shifted to the rails (NS 1998). These benefits clearly justify why government investment should be used to encourage intermodal freight transportation. To avoid directly subsidizing the private sector, such investment is typically limited to the surrounding roadway network at intermodal freight terminals. This chapter investigates intermodal freight funding mechanisms and the freight planning process at the federal, state, and local levels and concludes with how such knowledge should be applied to the proposed planning procedure.

INTERMODAL FREIGHT PLANNING UNDER ISTEA

In 1991, Congress passed the Intermodal Surface Transportation Efficiency Act which was a drastic departure from the transportation bills of the past. Historically, the periodic transportation bills dedicated most funds toward highway construction mostly on the Interstate System and U.S. Routes. The authors of ISTEA recognized the importance of the entire transportation system to the nation's economy. With the passage of ISTEA, greater authority over spending federal funds were given to the states and Metropolitan Planning Organizations (MPOs). New Federal programming and planning regulations required states and MPOs to consider urban congestion, the environment, air quality, freight, and growth in their planning process (NCIT 1994, 27). Flexibility of certain funding mechanisms enable states and MPOs to obtain federal funds for improving the roadway network to benefit freight transportation including intermodal terminals.

Intermodal Management Systems

States and MPOs must follow federal planning guidelines to receive federal funding for all projects. Original requirements of ISTEA included the development and use of Intermodal Management Systems (IMS) and Congestion Management Systems (CMS) to monitor and evaluate the performance of the transportation system. The systems were a means to actively integrate freight mobility issues into the mainstream process. National Highway System (NHS) Designation Act of 1995 removed the IMS and CMS mandates, but some states have kept some form of those management systems (Coogan 1996 ,4). The purpose of performance measures is to take action based on deficiencies made apparent by such measures. Exactly how to quantify performance has been a subject of debate (9). Numerous approaches have been proposed including the application of traffic engineering concepts such as volume-to-capacity ratios (V/C) and delay, but often these measures do not translate well between each other and other modes. Some measures such as door-to-door delivery time or costs would not enable accurate comparison as the system offers too many services that can be quantified by those basic measurements. The NCHRP suggests that an IMS should measure network connectivity, access impediments, link capacity, safety, line-haul speed, door-to-door delivery time, costs per ton-mile, facility lift capacity, gate operations as well as others. Gathering data for all the performance measures by Coogan, would be expensive or difficult to obtain.

According to the Transportation Research Board ISTEA and Intermodal conference proceedings, the management system should include an inventory of modal and intermodal elements, use of performance measures for system performance feedback, establish priorities, include private sector and identify strategies that will improve intermodal efficiency including non-investment options including regulatory changes (TRB 1993, 11). The private sector could help identify regulations and freight mobility issues in general and in specific locations. Years of performance measures data could identify trends that could aid future intermodal planning including growth forecasting and future facility needs. Barriers listed by the same conference include traditional institutional modal bias, lack of intermodal planning experience, proprietary nature of potential performance measure data, difficulty in maintaining a meaningful definition of system performance, and the lack of a clear process for developing the management system (TRB 1993, 12). Such barriers can be overcome if the system is kept simple. If performance measures are developed in terms of volume and capacity information, the data can be easily obtained and the measure is in meaningful units thereby keeping the system simple.

ISTEA Project Selection Process

ISTEA also mandates that states and MPOs must develop Transportation Improvement Plans (TIP) which is a list of projects for which federal funding is requested. Criteria considered for projects to be placed on the TIP include freight issues, especially access to ports, airports, and other intermodal facilities (Cambridge 1995b, 2-3). The high priority of TIP projects must be justified if the project will actually receive the requested funding. States and MPO cooperate in developing TIPs for the urban areas. Though the Federal government provides much of the funds for intermodal projects, selection is the responsibility of the states and MPOs. Federal provisions allow states to spend federal funds for intermodal projects, but many states, due to their own laws against applying fuel tax towards non-highway projects, cannot apply the required matching funds to the freight enhancement projects (Cambridge 1995a, 2-5).

As mentioned in an earlier section, to obtain federal funding, a prescribed process must be followed. A project sponsor develops a proposal and submits it to the state and to the MPO. The state and MPO consult with each other and decide whether or not to include the proposed project on the TIP. Then the Department of Transportation (DOT) reviews the eligibility of the project and approves or denies funding (Cambridge 1995b, 2-11). In the case of Congestion Mitigation and Air Quality Program (CMAQ) funds, the EPA consults with the DOT on the air quality benefits that were estimated.

ISTEA Funding Mechanisms

In developing the TIPs, states and MPOs consider the funding mechanism a for which a given project may qualify. A small amount of Federal assistance can be a "catalyst to advance a partnership project" (Cambridge 1995a, 2-5). Improving highway access for a terminal may encourage private sector investment in the terminal. The combination of private expansion and publicly financed road network improvements could be a marketing tool for a terminal to attract new business. The ISTEA funding mechanisms are designed to be flexible so projects intended to reduce congestion and emissions and to enhance intermodal mobility are eligible. The following are such funding mechanisms.

National Highway System (NHS). This program applies to road construction and rehabilitation on the National Highway System which includes the Interstate System, U.S. Routes, and many other major arterial streets. Though not specifically designed to consider freight, this program can be used to for general highway improvements which coincidentally benefit freight movement.

Surface Transportation Program (STP) General Grants. This applies to roadway improvements to most of the NHS. Improvements for other modes are also eligible.

Congestion Mitigation and Air Quality (CMAQ) Improvement. The purpose of this program is to reduce emissions in Clean Air Act non-attainment areas. Intermodal freight terminals are eligible as they are considered alternatives to trucking. Signalization of an intersection near the entrance of the BNSF Corwith Facility in Chicago is an example of CMAQ funding applications (Zavattera 1998, 10).

Bridge Replacement and Rehabilitation Program. All bridges on public roads are eligible for this program. This program will provide means to improving access for both rail and truck movements including providing clearance for double-stack operations and drayage of containers and trailers.

Priority Intermodal Projects. This program was intended for 51 congressional specified projects including interchange improvements, grade separation, and rail line relocation. This category cannot be considered as a potential source for new projects, but this program serves as a demonstration which may prove the success of government intermodal funding.

State Freight Planning Under ISTEA in Florida

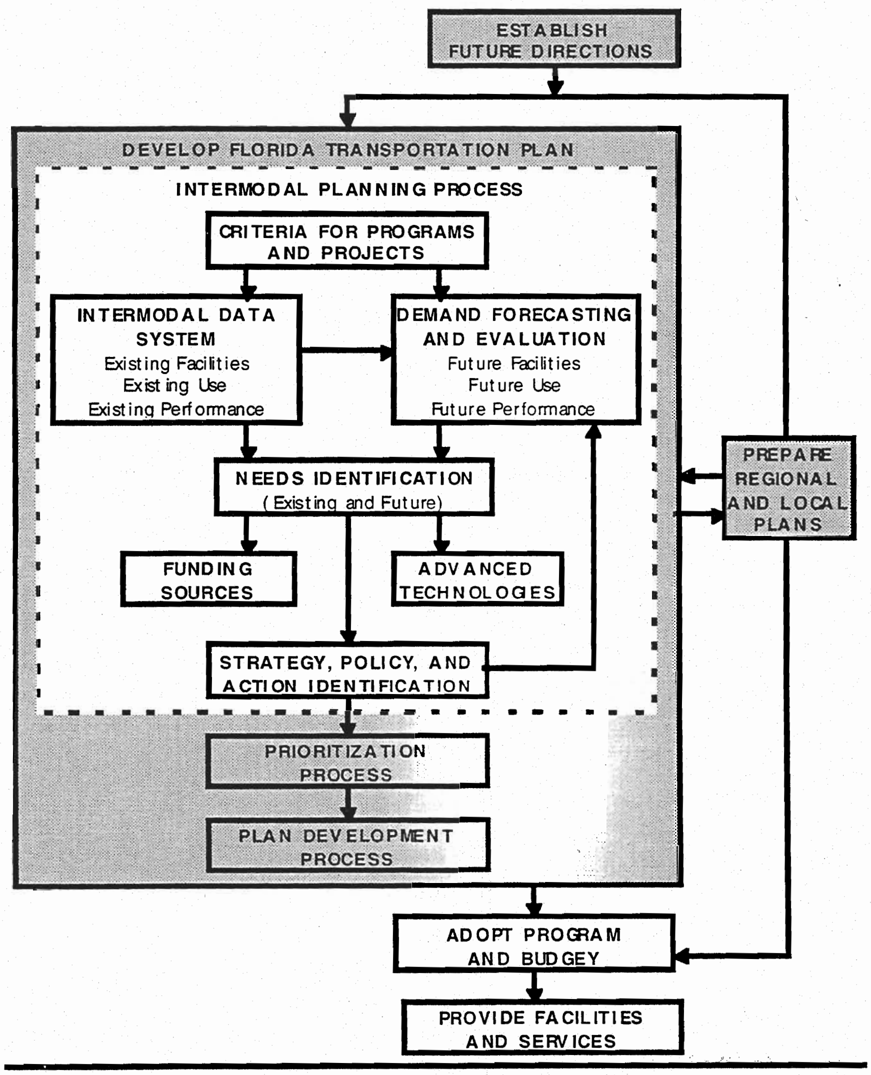
Though the IMS mandate was repealed, the examples of the initial work in developing an IMS is worth investigating. Concepts and ideas can be transferred from the IMS to an intermodal freight planning process. The Florida DOT produced *A Model Intermodal Transportation Plan: Implementing Florida's Intermodal Planning Process*, a document that set strategies and a plan of how to incorporate intermodalism in state level transportation planning. Included in the state's key objectives were identified as: integrating all modes, coordinating transportation investments in major travel corridors, minimize adverse environmental impacts, utilize existing seaport facilities to the maximum extent possible, and provide travelers and freight carriers with timely and efficient access to destinations (FDOT 1994, 2-5). Florida identified the following steps in the intermodal planning process (1-4):

1. Criteria for Programs and Projects.
2. Data Management System.
3. Demand Forecasting Process.

4. Needs Identification Process.
5. Funding.
6. Advanced Technologies and Innovative Techniques.
7. Strategy and Action Identification
8. Prioritization.
9. Implementation Plan.

The intermodal planning process was designed to meet the stated key objectives (see Figure 4.1). The complexity and the enormity of gathering data and analyzing data from multiple modes makes following steps a difficult task.

Figure 4.1 Florida's Planning Process in 1994



Source: Florida DOT, *Implementing Florida's Intermodal Planning Process*

Though the intermodal planning process considers passenger and freight movement over virtually all modes, elements from Florida's intermodal planning process are applicable to the planning process proposed in this report. The key objectives and many of the planning steps apply to intermodal freight planning. The intermodal freight planning process defined in Chapter 5 was based largely on Florida's example.

MPO Freight Planning Under ISTEA

ISTEA gave MPO a greater role in freight planning in economic development through improved infrastructure (Coogan 1996, 30). MPOs have been involved with numerous freight related transportation projects including improving access to ports and rail yards as well as studying combining rail terminals (Cambridge 1997). Freight Advisory Committees have been created some MPOs to establish a forum to insure the private sector interests are considered in freight planning (FHWA 1998b). These committees transfer knowledge between the private and public sector providing benefits to each. MPOs have knowledge of Federal aid funding mechanisms to implement projects and the private sector have knowledge in freight bottlenecks. The Public/Private Freight Planning Guidelines suggest methods of including and maintaining the interest of the private sector including the development of a list of 40 easily implemented and cost effective improvements which would then be implemented. The theory behind this short term plan to improve efficiency motivates the private sector to become involved for the long term.

TRANSPORTATION EQUITY ACT FOR THE 21ST CENTURY

On June 9, 1998, President Clinton Signed HR 2400, The Transportation Equity Act for the 21st Century (TEA-21). The act allocates $217.6 billion over 6 years for transportation projects and research. The new features of this act of Congress is an emphasis on safety and research programs. According to the DOT, TEA-21 features the "continuation of proven and effective program structure established for the highways and transit under the landmark ISTEA legislation" (FHWA 1998c). Thus, many of the funding programs, including NHS, STP, and CMAQ, remain in tact and intermodal freight planning under TEA-21 will follow the guidelines of ISTEA.

INNOVATIVE FUNDING MECHANISMS

One example of innovative funding programs is the State Infrastructure Bank (SIB). Foreseeing continuing limited availability of transportation funds, Congress created an innovative financing program to help offset the shortfall. The SIB program was established through the National Highway System Designation Act of 1995. To increase overall transportation infrastructure investment, the SIB allows for increased funding flexibility through offering low interest loans or credit enhancements to local authorities and the private sector for transportation projects. The original 10 states have since expanded to 39 participants (FHWA 1998a).

Each state must legislature must formally create its state's SIB and designate who operates the SIB. Typically the SIB falls under a state's DOT. With an initial capital seed from the federal government of between $1 million and $12 million (FHWA 1998a), states can add to the banks funds by allocation up to 10 percent of certain federal aid highway or transit funds and match 25 percent of the federal contribution (20 percent of the total funds). States have varying rules and priorities with their SIB, but must follow federal guidelines. By enhancing credit or offering low interest loans, the SIBs can make a project possible that otherwise would not happen. This discount potentially may attract private investment in the transportation infrastructure such as improvements to intermodal rail yards. By leveraging private funds, the SIB will increase the private share of transportation investment. Funds are paid back over a variable term through various means. Upon return, the funds are then lent out to new projects. This recycling of funds assures the continued success of the program.

Projects are to be selected based on federally suggested criteria which include: 1) the transportation problem the proposed project addresses; 2) The impact on public mobility; 3) The ability to leverage new funding sources; 4) the technical and financial strength of the project sponsor; 5) the ability to accelerate the completion of a high priority transportation project; and 6) the status of environmental and construction approvals (FHWA 1998a).

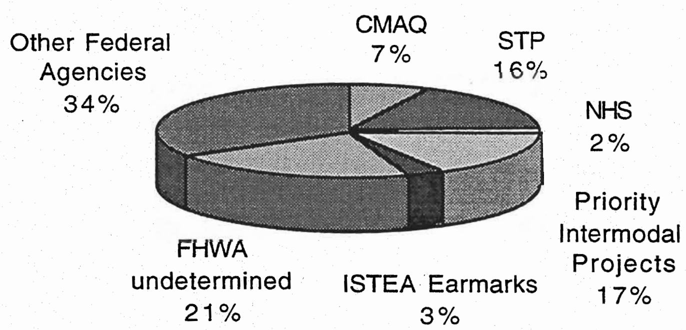
The SIB program is a great opportunity for future intermodal projects because the goals of the program are highly compatible with intermodal freight issues. The availability of SIB funds may enable a railroad or a port to execute a project with public benefit such as expanding the use of intermodal freight. An example of innovative financing similar to the SIB was the intermodal rail terminal in Stark County, Ohio. CMAQ funds formed a revolving loan fund which a $10 surcharge per load was assessed to pay off the fund (Cambridge 1997a, 138). More details about this project are in the next section.

EXAMPLES OF INTERMODAL FREIGHT PROJECTS

Various government agencies have participated in intermodal freight projects including state DOTs, municipalities, and MPOs often in conjunction with the private sector. Often, Federal funds through CMAQ, STP, and NHS programs are sought by the state and local level agencies.

The following list of intermodal freight projects were selected from *The Compendium of Intermodal Freight Projects* to illustrate various types of projects including corridor construction, new terminal construction, grade crossing separation, and access improvements.

Figure 4.2 Sources of Federal Funding for Intermodal Projects



Source: FHWA, *Compendium of Intermodal Freight Projects* (Cambridge 1997)

Rail Corridor Enhancements

At $1.9 billion, the construction of the Alemeda Corridor in Los Angeles is perhaps one of the most costly intermodal freight projects. The 20 mile corridor consolidates over 90 miles of branch lines and will be the primary rail access to the ports of Los Angeles and Long Beach for both the BNSF and UP Railroads. Ten miles of the corridor will be below grade to eliminate over 200 grade crossings which claims a savings of over 15,000 vehicle hours per day. Included in the project is the construction of on-dock ship to rail facilities at both ports so that drayage trips are reduced. The cost, which is subject to overruns, will come from Federal MTA ($350 million), ISTEA earmarks ($45 million), revenue bonds ($711 million), state funds ($667 million). The primary public benefits include reduced truck traffic and rail crossing delays, both enhance safety (Cambridge 1997, 31).

The Port of Seattle, as a part of the Harbor Island Project, expanded the container port facility from 110 acres to 200 acres. A major component of the $270 million expansion project was the construction of an on-dock rail connection. Funding was provided by the Port of Seattle (18).

Since the corridor was considered important for Ohio's exports, the state and the Norfolk Southern Railroad have joined forces to add a 3.5 mile third main line track and to reconstruct bridges to reduce train delays and to improve clearance for double-stack operations. NS funded the entire $15 million project with the intention of receiving a reimbursement of CMAQ funds of about $5 million (132).

Access Improvements

Intersection Signalization. The Chicago Department of Transportation (CDOT) and the Chicago Area Transportation Study (CATS) reconstructed and re-signaled Kedzie Avenue from Interstate 55 to 47th Street. Included in the project was the signalization Kedzie Avenue near the entrance of the BNSF Corwith rail yard. The $4.3 million project was funded primarily by CDOT, but $750 thousand in CMAQ funds were used for signal enhancements (63).

Grade Separation. To reduce the conflict between trucks and trains, the Virginia DOT has programmed for 1999 the elimination of two grade crossings near the Norfolk International Terminal at a cost of $12.8 million (171).

Bridge Clearance. CATS upgraded Cicero Avenue by raising clearance and providing additional lanes to improve access to nearby rail yards. Cost data were not listed because the projects were committed prior to ISTEA (61).

New Highway Ramp. Access to the UP rail yard in Laredo, Texas was improved by the construction of a closer exit ramp off Interstate 35. Prior to that ramp, trucks would have to exit several miles south and traverse a narrow two-way frontage road. Cost was approximately $300 thousand with $240 thousand in NHS funds and the balance by Texas DOT (164).

Additional Highway Capacity. The Port of New Orleans is constructing the Tchoupitoulas Corridor to provide better truck access to the port and to reduce approximately 1300 daily truck trips through residential neighborhoods. The corridor separates port traffic from local traffic. The total cost of the project is approximately $70 million is funded through the State of Louisiana ($35 million), STP funds (13.7 million), city bonds ($8 million), and there was an unresolved shortfall of about $12 million (73).

CalTrans programmed the addition of two miles of an auxiliary lane to improve truck access to the Fresno intermodal rail yard. NHS funds will pay for the $4.7 million project (40).

Public Private Partnership

Though it could be placed in other categories, the Chicago Area Consolidation Hub for UPS is a good example of a Public/Private partnership, so it warrants its own category. The UPS facility, which sorts 3 million parcels daily, is adjacent to the BNSF Willow Springs intermodal yard. UPS is the biggest customer at the Willow Springs rail yard. To accommodate the UPS facility, a new highway interchange and a grade separated intersection were constructed. UPS spent $150 million for the facility and for its share of the grade separation project. Illinois DOT contributed $10.5 million for the grade separation and interchange, the tollway authority contributed $2.8 million, and $5.5 million was paid by the City of Hodgkins (60). As a result, both UPS and the BNSF yard benefit.

New Terminal Construction

In 1993, an intermodal rail yard in Stark County, Ohio was proposed by the Ohio DOT in effort to convince Flemming Companies, Inc. to expand its food distribution facility instead of moving to a larger facility elsewhere. Ohio DOT applied for $7 million in CMAQ funds and proposed it to be a revolving fund to be paid back from off loading fees of $10 per trailer. The public funds leveraged $24 million in private investment including new warehouses and distribution centers adjacent to the terminal (138). The intermodal facility, with a 150,000 annual lift capacity, is utilized by the NS, CSX Transportation, and the Wheeling and Lake Erie Railway (IANA 1997, 68).

Other government sponsored terminal construction projects or proposals in the compendium include: Grand Forks, North Dakota ($2.2 million); Twin Falls, Idaho ($3.25 million); Waterville, Maine ($3 million); Minneapolis ($110 million); and Detroit ($92 million). Those projects and proposals were presented with varying levels of detail.

Alternative Mode Utilization

The Port Authority of New York and New Jersey now operate a barge service for ferrying containers between Red Hook Container Port in Brooklyn and Port Elizabeth, New Jersey (TAM 1998). Over 50,000 truck are eliminated with the four weekly barge trips. The project which included a marketability study cost $13.6 million, with $3.1 million in CMAQ funds and the balance from the Port Authority, State, and Local funds (Cambridge 1997, 111).

SUMMARY

This research in government intermodal freight planning yielded several important considerations for developing a government intermodal freight planning process. The private sector should be included in the freight planning process. Without private sector participation, the planning process would not include an important perspective. Private sector representatives including port officials, terminal managers, and trucking operators can identify bottlenecks in terms of regulations and access to freight facilities that hinder the industry. Another consideration is that projects should be ones which can be funded through federal aid programs. To incorporate these suggestions, the planning process proposed in this research will incorporate the private sector, establish a set of terminal performance measures, and will use these measures to prioritize on the facility level basis.

CHAPTER 5. METHODOLOGY

As mentioned in Chapter 1, intermodal freight transportation has numerous public benefits including reductions in highway maintenance costs, trip emissions, and overall transportation costs. These benefits should motivate government planning agencies to assist intermodal freight transportation by integrating intermodal freight issues in the planning process. This strategy operates under the assumption that spending to improve access to intermodal terminals will increase intermodal utilization, ultimately reaping returns exceeding the investment in the form of reduced highway maintenance costs and transportation costs.

One issue which made the implementation of the ISTEA mandated Intermodal Management Systems (IMS) controversial was that it would be complex. The volume of required data when developing performance measures for comparing modes made the implementation of the IMS a difficult task. The State of Florida's 1994 Intermodal Management System model, described in Chapter 4, is relatively complicated, but it contains elements applicable for a simpler intermodal freight planning procedure. Therefore Florida's system was the model for the process proposed in this research. Proposed in this report is a simpler version of the IMS used exclusively as an intermodal freight transportation planning tool.

PLANNING PROCEDURE APPROACH

One desired feature of the planning procedure is to recruit representatives from the private sector because cooperation between the public and private sectors would insure that different perspective are considered. In addition, a visible planning process may encourage terminal managers to participate and provide the data necessary. Private sector participation could help identify projects that would benefit freight mobility near the terminals. The types of access improvement include, left turn bays, improved signal timing, additional traffic signal, construction of a closer highway ramp, widening lanes, increasing curb radii, and increasing clearance.

A method to encourage participation is to have a "quick fix" program as (FHWA 1998a) suggests. Promising to offer a short term access project plan would easily be implemented and would motivate terminal managers to provide data and to suggest access improvements.

Another requirement is that there must be a method to prioritize projects. Since analyzing every possible intermodal access enhancement project requires considerable effort, a terminal ranking scheme would screen which terminals warrant further study. The main factor in prioritization is the volume of traffic the terminal serves; the more traffic it serves, the more beneficiaries there are. However, other factors should be considered depending on the strategy.

Because a facility has a high rank, it does not necessarily mean the facility will have projects worth implementing. The cost to effectively improve access to some high volume terminals may be too great, so the prioritization scheme should include a measure to determine whether investment will be effective. The shorter the distance from the limited access highway to the facility, the more likely an access enhancement will be immediately effective. The terminal rank should be considered in the project selection criteria, but other factors may shift a project from a lower ranked facility to a higher priority than a higher ranked facility. The resulting list of intermodal freight projects would then be submitted for consideration for inclusion in the Transportation Improvement Plan (TIP) and then would be weighed against other non-freight related transportation enhancement projects.

There are numerous factors to consider in analyzing projects on the individual basis. Projects that may qualify for specific federal funding programs such as CMAQ would be more likely to get federal funding. Other factors that are difficult to quantify including safety and neighborhood impacts or benefits should be considered. Finally, relocation of a facility can be considered as an alternative to access enhancement projects. It may be in the best interest of both a city and railroad to relocate to a site that expansion is possible.

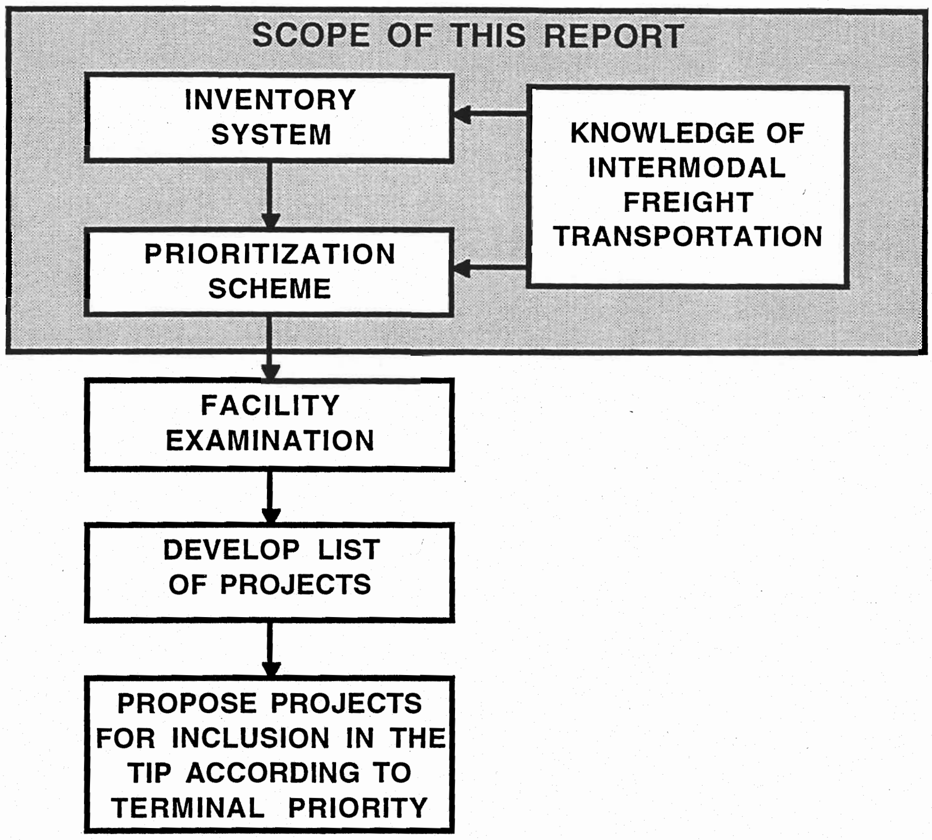
PROPOSED IM FREIGHT PLANNING PROCEDURE

The proposed intermodal freight planning procedure follows steps shown on Figure 5.1 The scope of this report is limited to the background information gathering, data collection (inventory), and prioritization scheme development steps. Subsequent steps are explained to show how the inventory and prioritization fit into the planning procedure. Listed below are steps for implementing the proposed intermodal freight planning procedure.

Background Information Gathering. The background information presented give provides knowledge of intermodal freight transportation so that planners are qualified to make freight planning decisions.

Inventory of System. The facilities within the system of interest are identified and operational and physical data are collected for the prioritization step. The State of Texas intermodal terminals are presented for illustration purposes. Data collection strategies are discussed in Chapter 6.

Figure 5.1 Proposed Intermodal Freight Planning Process



Prioritization Scheme Development. Facilities are prioritized according to the preferences of the planning agency. Access enhancements surrounding high ranking terminals are considered first. The main factor of priority is the volume of intermodal movement facilities serve. The development of three prioritization schemes is presented in Chapter 8.

Terminal Examination. Terminal managers of facilities which priority score exceeds the minimum are asked to submit a list of terminal access improvements that would benefit their location. Projects might include: signage, signal improvements, signalization, lane widths, left turn bays, or turning radii.

Proposed Project Examination. Once a list of all projects is compiled, it should be ordered initially according to the associated facility's priority rank. There are several possible approaches in determining how to change the order of the list. One method would be to determine a set of criteria including maximum cost and minimum benefit-cost ratio each project would have to meet. Proposed project which fail to meet both criteria are eliminated from the list. Then the remaining projects are then proposed for inclusion on the TIP. Another method to re-order the list of projects is to categorize projects by approximate cost. Projects would be ordered according to terminal priority within each cost category. The list would order projects by cost category then by terminal priority. Projects which fail to meet a set minimum B/C ratio or other criteria, it would be eliminated from the list. The exact approach used is up to the planning agency.

Inclusion of Best Projects in TIP. The highest ranking projects which meet certain criteria would then be added to the TIP. The number of projects submitted depends on the availability of funding.

SUMMARY

This chapter prescribes a simple intermodal freight planning procedure which helps determine where to effectively spend limited transportation funds. Florida's Intermodal Management System was loosely followed, but the proposed process is simpler because it considers intermodal freight exclusively. The remainder of this report explains the data collection and prioritization schemes in the context of the procedure shown.

CHAPTER 6. DATA COLLECTION

To implement the prescribed intermodal freight planning process, an inventory of the rail yards and container ports must be conducted. Analysis of attribute data collected from each facility will determine the priority of each terminal. Data from the Texas network were used to illustrate how the proposed planning process ranks an actual system. Texas makes it a good example because of its numerous intermodal yards and container ports. This chapter covers the inclusion criteria for the intermodal network, data collection strategies, and a summary of each railroad and container port operating in Texas.

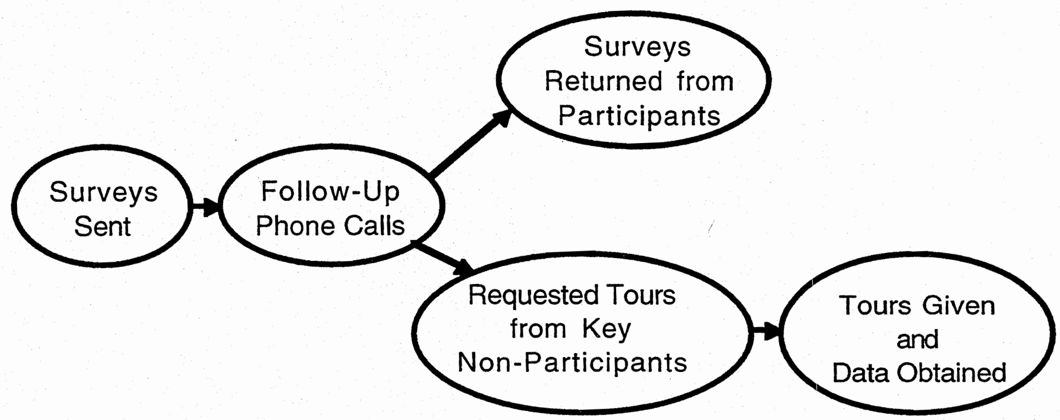
DATA REQUIREMENTS

To determine how to prioritize terminals, an analysis of data reflecting for terminal efficiency was performed. After identifying strategic areas of terminal operations as being loading and stripping, container and trailer storage, and gate processing, a list of desired data that reflect the efficiency and nature of each area of operations was created so that such analysis could be performed. Such data included: type and number of lift equipment, average dwell time, number of check point gates, parking space, and volume served. Other data of interest that reflect efficiency include load balance, container size mix, and trailer/container mix. Access roads and their lengths were identified as a gauge for how effective access improvements would be. The shorter the route, the less has to be invested to improve it. Such information gathered would help estimate volume-to-capacity ratios which is an index of terminal operations.

DATA COLLECTION STRATEGIES

The first step in collecting the data for Texas was obtaining the 1997 IANA Intermodal Terminal Directory. The directory lists the following information for each terminal in the United States and Canada: addresses, contact names, reported capacity, type and number of lift equipment, parking spaces, and hours of operation. After preliminary research of the industry and the site visit to the BNSF Corwith Facility, a list of additional desired information was created. A survey was then created which sought to obtain much of the desired information not in the directory, but was kept as brief as possible in hope maximize participation. The terminal manager at the Corwith facility reviewed the survey to make sure the questions would not be considered proprietary information. After some modifications, the survey and cover letter were faxed to each facility listed in Texas (See Appendix A for the survey). Follow up telephone calls were made, but the terminal managers were difficult to reach. Once the managers were reached, they were generally cooperative. After two months and more follow up telephone calls eight of fourteen surveys were finally returned. The remainder were not returned either because of the UP merger problem in and around Houston terminals or because the manager said that it was against policy to answer such questions. Because of this non-participation, an alternative data collection strategy was necessary. This strategy was to visit to the sites of key non-participants whose managers might have time to give tours. Though two of four Dallas and Fort Worth area terminals were non-participants, tours of all four Dallas area rail yards were arranged. In addition, one of the San Antonio yards was visited. Managers provided tours of their facilities and addressed basic operational questions about the yard. The site visits also yielded possible plans for hub consolidations, relocation, and new facilities being built elsewhere in the state.

Figure 6.1 Data Collection Process



Collecting data from terminal managers would be the first step in including intermodal industry representatives in the planning process. The planners should explain that it is investigating how it can enhance freight mobility by funding access improvements. Asking the terminal manager to propose access related projects that would benefit the terminal may increase the participation rate.

Port data collection required much less effort. In general, the port contacts were very willing to help. After visiting the Port of Houston's Container Terminal and further research of industry, a list of desired port operational information was developed. A survey similar to the rail yard survey were faxed to the ports. After one or two reminder phone calls, each survey was returned completed (see Appendix B for a sample survey).

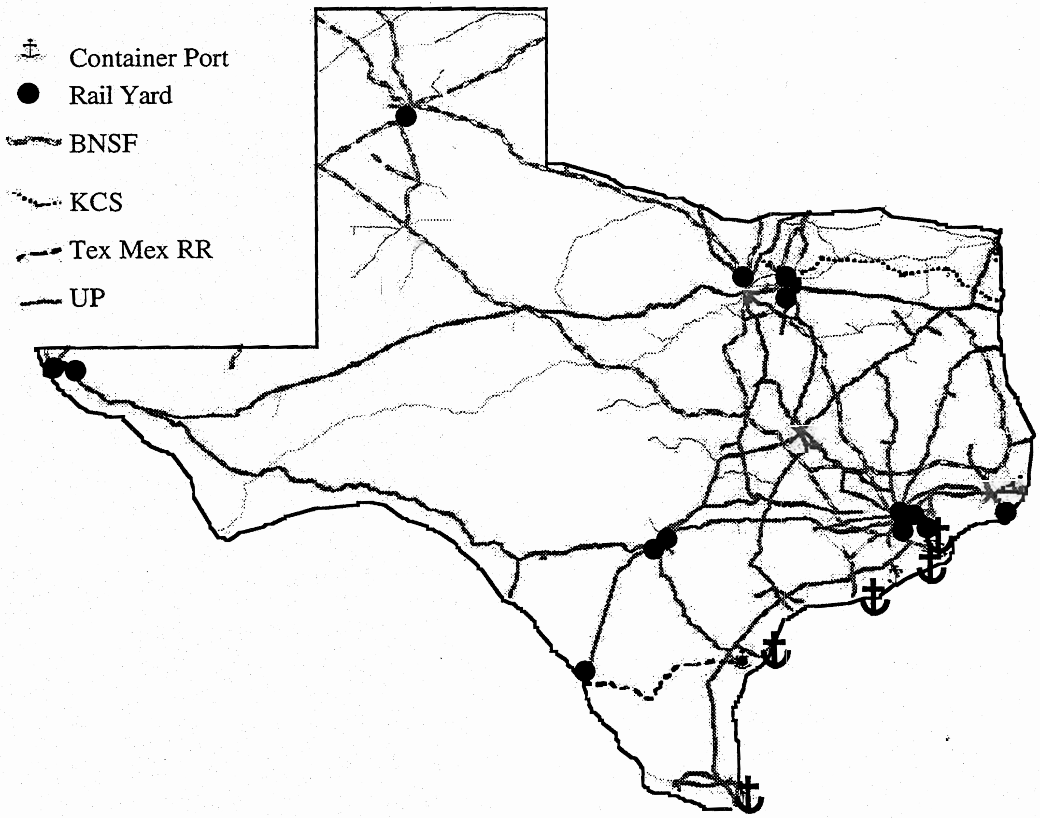
PHYSICAL NETWORK

Since many ports have the ability to handle containers, but do not specialize in container operations, a criteria for inclusion had to be developed. To be considered as a significant container handler in the analysis, a port must handle at least 5000 TEU annually. This figure was chosen because any amount less than it would mean the port serves fewer than about 60 containers per week. It was learned that several ports in Texas recently entered the container business. Though they rank low in terms of volume, gathering available data from these ports would be useful in long range planning.

It was the intention that all intermodal yards were to be included in the network unless upon further review, it was learned that the volume was insignificant. Upon investigating several small railroad TOFC operations in Diboll and Lufkin, they were circus ramp facilities serving an insignificant volume according to representatives of those railroads. Figure 6.1 shows the rail yards, container ports, and railroads in Texas. The ports which recently entered the container business are shown on the figure below and described in a subsequent section, but are not included in the prioritization example.

The links of the intermodal network are the railroads, highways, and ship channels. The only links considered in the proposed planning procedure were the roads surrounding the terminals. The U.S. Department of Transportation (DOT) identified NHS intermodal connectors to many of these ports and rail yards. These connectors were routes from the terminal to the nearest NHS road. If an intermodal terminal did not have an NHS intermodal connector listed, the shortest path from the facility to the nearest major highway, usually an interstate, was identified as a part of the network. For analysis purposes, the surrounding road network at each terminal was considered as a part of the terminal.

Figure 6.2 Intermodal Freight Terminals and Railroads in Texas



Railroads Of Texas

Texas has over 12,000 miles of mainline track, more than all other states (TRRC). Given the large rail network and the numerous markets served, the railroads are vital to the economy of Texas. The three Class I railroads serve the state are Burlington Northern Santa Fe (BNSF), Kansas City Southern, and Union Pacific. Though there is debate whether railroad mergers would benefit intermodalism, according to Standard and Poor's, the recent merger of the UP/SP and Conrail breakup between NS and CSX should eventually result in faster, more reliable service (S&P, 6). The short term affect of the UP/SP merger has resulted in poorer service levels that is assumed to be temporary for the purposes of the Texas demonstration of the planning procedure. On Table 6.1 is a listing of Texas intermodal yards. Due to the lack of specific information regarding individual rail yards, aside from survey data presented in Appendix C, individual rail yards are not discussed in detail. This remainder of this section gives general information about the railroads that provide intermodal service in Texas.

Table 6.1 Intermodal Rail Yards in Texas 1998

Facility	Reported Capacity	Annual Volume
Dallas		
BNSF (Alliance)	400,000	293,000
UP (Mesquite)	200,000	165,000
UP (Dallas)	220,000	160,000
KCS	144,000	120,000
Houston		
UP (Wallisville)	252,000	NA
UP (Kirkpatrick)	200,000	NA
BNSF	168,000	99,000
UP (Barbours Cut)	72,000	NA
KCS (Port Arthur)	60,000	NA
San Antonio		
UP (Sherman)	70,000	50,000
UP (Quintana)	7,000	7,000
El Paso		
UP	90,000	74,000
BNSF	36,000	24,000
Laredo		
UP	130,000	NA
TMRW	NA	NA
Amarillo		
BNSF	20,000	12,000

Source: Surveys, Interviews, and IANA 1997 Rail Intermodal Directory.

Burlington Northern Santa Fe Railroad. The Burlington Northern Santa Fe operates a rail network serving 24 states. The system serves the Western United States from Chicago, the West Coast, and the Gulf Coast. Its 71 intermodal facilities includes 39 BNSF operated yards, 19 market extensions, and 13 eastern railroad partner facilities. In 1997, 27 percent of BNSF annual revenue was from intermodal traffic, 23 percent was from coal , and 13 percent was from agricultural commodities (BNSF 1998). Four BNSF intermodal yards serve Texas including Alliance (Fort Worth), Amarillo, El Paso, and Houston.

Kansas City Southern Railway. The Kansas City Southern Railway is the smallest Class I railroad serving Texas. The KCS system in a North South corridor from Kansas City to the Gulf Coast. The intermodal operations consists of a system of 8 intermodal yards, but the railroad interchanges with other railroads thus expanding the network. The KCS intermodal presence in Texas has been recent. In 1995, the KCS began operating the intermodal facility in Dallas after purchasing it from the BNSF when the railroad consolidated area operations to the Alliance facility (Gengler. Interview). In April, 1998 the KCS and NS opened a joint facility at Port Arthur, Texas to tap into the Houston market (NS 1998d). The KCS operates a facility in Houston from where trailers and containers are drayed to the yard in Port Arthur by the KCS. The Kansas City Southern markets itself as the NAFTA railroad with its joint venture with Transportacion Maritima Mexicano (TMM). Together they operate the recently privatized Ferrocarrilda Noresta, or the Northeast Railway. With its operating agreement with the Texas Mexican Railway, the KCS system serves 6500 miles linking Kansas City with Mexico City. The KCS anticipates that intermodal traffic to and from Mexico will be a substantial part of its traffic operations (KCS 1998).

Texas Mexican Railway. The Texas Mexican Railway (TMRW) operates a line between Laredo and Corpus Christi. The railroad serves as the Kansas City Southern's gateway to Mexico. A new intermodal yard in Laredo is currently under construction (ARR 1998). As a vital link for the Kansas City Southern's "NAFTA Railroad", the TMRW will be an important intermodal railroad in Texas.

Union Pacific Railroad. With over 6000 miles of trackage and over 8700 employees, the Union Pacific Railroad is the biggest railroad in Texas. The Union Pacific System has trackage in 23 states connecting the west coast, gulf coast, and the midwest. Intermodal traffic accounts for 20 percent of the Union Pacific's revenue (Miller 1997). The intermodal network consists of 43 hubs in 26 metropolitan areas. The Union Pacific serves 9 ramps in Texas at Dallas, El Paso, Houston, Laredo, and San Antonio. The international gateways at El Paso, Laredo, Eagle Pass, and Brownsville serve much of the rail traffic between the U.S. and Mexico. The biggest Texas customers are Chrysler de Mexico, Lower Colorado River Authority, and American President Lines (APL), an intermodal customer (UPRR 1998).

The merger of the Southern Pacific and Union Pacific was hard on Texas. The UP failed to integrate the SP in the Houston area properly and delays resulting from clogged lines rippled throughout the UP system. Intermodal traffic was delayed and power and chemical companies suffered from delayed shipments. As a result many shippers shifted their traffic to trucks so their shipments would be timely.

Container Ports Of Texas

According to the Journal of Commerce's PIERS volume data, three Texas ports, Houston, Freeport, and Galveston, handle container volume in excess of 5000 TEU (refer to Table 6.2). Two other ports, Brownsville and Corpus Christi have not had significant container activity in the past, but seek to attract greater container volume through container facility enhancements and marketing according to port representatives. At least four other ports have handled a trace amount of containers within the last two years which include, Port Arthur, Point Comfort, Beaumont and Orange. The port of Texas City has not handled containers, but is being studied as candidate to serve Megaships. For inclusion as a container port in the illustrated Texas example the port must serve a volume of at least 5000 TEU. Other container ports new to the business should be investigated on the individual basis. There may be factors which should make a particular port rank high which would not be reflected in the prioritization schemes proposed in Chapter 8. Though a port may not be considered in the prioritization scheme, information should be kept in the database to aid centralized port planning.

A trait each Texas container port have in common according to the surveys is that virtually all trade is with Central and South America. Each port claims to have advantages over others ports. By understanding advantages of each port, centralized decision making may help Texas container ports avoid system-redundant port improvements. For example, instead of dredging two ports so that Megaships can be accommodated, use the same funds to dredge one port and enhance the another to provide greater efficiency for smaller ships. The rest of this section gives a brief profile of each container port of interest. Additional port information is presented in Appendix D.

Table 6.2 Container Volume Through Texas Ports in 1997

Port	Volume (TEU)	Metric Tons
Houston	634,466	6,445,994
Freeport	29,606	275,704
Galveston	7,213	64,409
Brownsville	296	2,059
Corpus Christi	167	849
Orange	12	21
Port Arthur	2	44
Point Comfort	1	10

Source: Journal of Commerce- PIERS.

Port Of Houston Barbours Cut. The Port of Houston's Barbours Cut Container Facility is by far the largest container port in Texas serving about 800,000 TEU in 1997 according to the completed survey. Six berths and twelve container cranes make it a prominent container facility. Barbours Cut opened in 1977, and initially steamship lines were reluctant to shift to the new terminal from the old Turning Basin Terminal, but when Sea-Land Services shifted operations to Barbours Cut, others followed. Berth 6 is leased by Sea-Land Service. Sea-Land is the port's largest customer processing nearly 23 percent of the port's container activity in 1996 (Port of Houston 1997, 6). The terminal also has a roll-on/ roll-off facility on the premises.

The main advantages of the Barbours Cut are the facilities according to the completed survey. The container terminal has six berths while all but one other Texas container ports have just one. The port also has 12 container cranes between the six berths making it better able to process a ship faster than the ports with just one container crane. The port is served by the Barbours Cut UP rail yard which is 2000 feet away. Though not an on-dock service, the drayage distance is minimal. According to the completed survey, about 15 percent of the volume handled utilizes this rail connection. The main disadvantage of Barbours Cut is the congestion. During peak operations, gate wait could be in excess of one hour and the average turnaround time for truck operators is one hour not including gate wait according to the survey. Smaller ports require less time to process each truck because of the smaller parking area and less congestion.

Port of Freeport. The Port of Freeport is the second largest container port in Texas. Its primary customers are Dole and Chiquita for banana imports. In 1985, Dole moved container operations from Galveston to Freeport thus initiating Freeport as a "Banana Port" (Port of Freeport 1997, 4&10). Each have their own facilities adjacent to the container berths. The refrigerated containers (reefers) are trucked throughout the Southwest and Midwest. Dole backhauls commodities such as automobiles, fertilizers, and agricultural machinery (10). Due to the 36' channel depth, the Port of Freeport serves smaller vessels. According to the completed survey, the main advantages of the Port of Freeport container terminal are the quick truck turnaround times, short sailing time to the Gulf, refrigeration specialty, and the access to divide highways. Though an on-dock rail connection exists, it is not utilized.

Port of Galveston. The Port of Galveston's Container terminal is leased and operated by the Port of Houston. Prior to the Port of Houston's lease, Galveston's terminal had been idle for several years because the drayage cost over Houston's was too high. It once handled over 90,000 TEU according to the Port Import Export Reporting Service (PIERS). Though Galveston terminal is about 25 miles farther from central Houston than Barbours Cut, the truck processing time is faster and sailing time to the Gulf is less than a third (1 hour versus 3.5 hours) than from Port of Houston's Barbours Cut terminal. Though only the facility has only one berth, four container cranes enable ships to be processed quickly. The primary cargo inbound is fruits and vegetables and primary outbound cargo is paper products. Though an on dock rail connection exists, it is not utilized.

Port of Corpus Christi. The Port of Corpus Christi have recently started to develop container activity and are currently marketing their container operations so that activity will probably increase in the future. The main export commodities are chemicals, glass, and project cargo, but due to the recent inauguration of service, 100 percent of the inbound containers are empties. The main advantages of this port is the availability of 3 railroads, good highways, and proximity to Northern Mexico.

Port of Brownsville. The Port of Brownsville is in the process of finishing a project called "Dock 15" which gives the Port of Brownsville heavy lift and container handling capabilities. With its location within 3 miles of the Mexican border, the Port of Brownsville is targeting traffic between Europe and Mexico. The port plans to build an additional international bridge crossing which would make the distance from Dock 15 to Mexico 3.5 miles. By providing better port service than any port in Northern Mexico, the

Port of Brownsville hopes to be the port of choice for cargo bound for and from for Monterey, Saltillo, and Monclova (Salinas. Correspondence).

Port of Texas City. In 1997, The City of Texas City commissioned VZM TransSystems in association with Leeper, Cambridge, Campbell and Associates to create the Phase I conceptual Development Study of Shoal Point. The study examines the potential of Texas City developing a container terminal. With its advantages of proximity to the gulf, highway connections, and potential rail service, the Shoal Point may be considered a prime location for the development of a container terminal designed to accommodate Megaships. Since Shoal Point is only 15 nautical miles via the Houston Ship Channel versus the 38 nautical miles for the Barbours Cut, it offers ship operations cost savings (Vickerman 1998, 2-22). The VZM study claims that the additional channel time would cost between $5000 and $15,000 in vessel cost and $1000 to $2000 for piloting and tug cost which comes to an additional $20 per container moved. The port would accommodate a 50 foot channel and an on dock or near dock rail connection to accommodate Megaships. If the terminal were to be developed it would likely have one berth with 40 to 50 acres. One possibility suggested in the VZM study is that the Port of Houston could develop the terminal.

SUMMARY

Data collection is the first step in involving the private sector in this intermodal freight planning procedure. Though not every rail yard returned the survey, participation is crucial so that the complete system is represented for an actual implementation of the proposed planning process. Site visits were the most successful approach to collect the desired information. Conversations during the tours also provided additional information which may be useful such as possible consolidations or other future plans. The data collected are analyzed in the Chapter 7 and used to illustrate the ranking system in Chapter 8.

CHAPTER 7. TERMINAL CAPACITY ANALYSIS

The efficiency of intermodal terminal operations depends on a variety of factors including physical layout, size, management, and equipment. Due to unique local conditions, intermodal yards and container ports each operate in a different way thus terminal capacity cannot be estimated with precision using a single formula. Since capacity analysis of yard operation will yield clues of how efficiently individual terminals are operating, capacity estimation would be helpful in planning activities. Capacity formulas presented in this chapter, though they do not account for all relevant factors, will be suitable for the proposed planning procedure.

Terminal operations can be divided into several areas in which a capacity can be estimated. For intermodal yards the areas are: lift operations, gate operations, working track, hostling tractors, and parking space. Container port operate similarly, but parking may involve lift equipment for stacking. Additionally, ports do not use working tracks unless it has an on-dock transfers. There are two types of capacity mentioned in the capacity analyses: ultimate and realistic. Capacity is the maximum volume the component can process assuming 24 hour daily utilization. Realistic capacity is defined as the likely maximum volume the item can process under normal operating conditions. This chapter shows the capacity analysis of rail yards and ports to be used by the prioritization procedure, but would also be useful in system monitoring as well.

INTERMODAL YARD CAPACITY

Data for rail yard capacity analysis come from two sources: the Intermodal Association of North America *1997 Rail Intermodal Terminal Directory*, and from surveys sent to the intermodal yards of Texas. Included in the IANA directory was a listing of lift equipment, parking space data from 299 rail yards in the U.S. and Canada. The actual number of rail yards is less because jointly operated terminals were listed by each railroad it served. The factors influencing capacity is then discussed. Finally, a formula for capacity estimation for that area of operation is proposed.

One approach used to estimate capacity of the various operations of rail yards was to plot capacity versus the productivity variable and regressing “the frontier envelope”. It is the assumption that the frontier envelope represents the upper limit of productivity. For example, capacity was plotted against the number of overhead cranes. The maximum capacity values listed under each number of cranes, excluding outliers, was the frontier envelope. For an illustration of the frontier envelope, refer to Figures 7.1 and 7.2. Outliers would have shifted the frontier envelope unless they were removed. The procedure used to identify and eliminate outliers was the “fourth spread” method (Devore 1991, 22). This procedure applies to the construction of boxplots which are resistant to the presence of outliers. The lower fourth is defined by the median of the lower half of observations and the upper fourth is defined as the median of the higher half of observations. The difference of the two is called the fourth spread (f_s). Mild outliers were defined as observations which are between 1.5 f_s and 3.0 f_s away from the upper and lower fourths. Extreme outliers were defined as observations beyond 3.0 f_s from the upper and lower fourths.

Lift Equipment

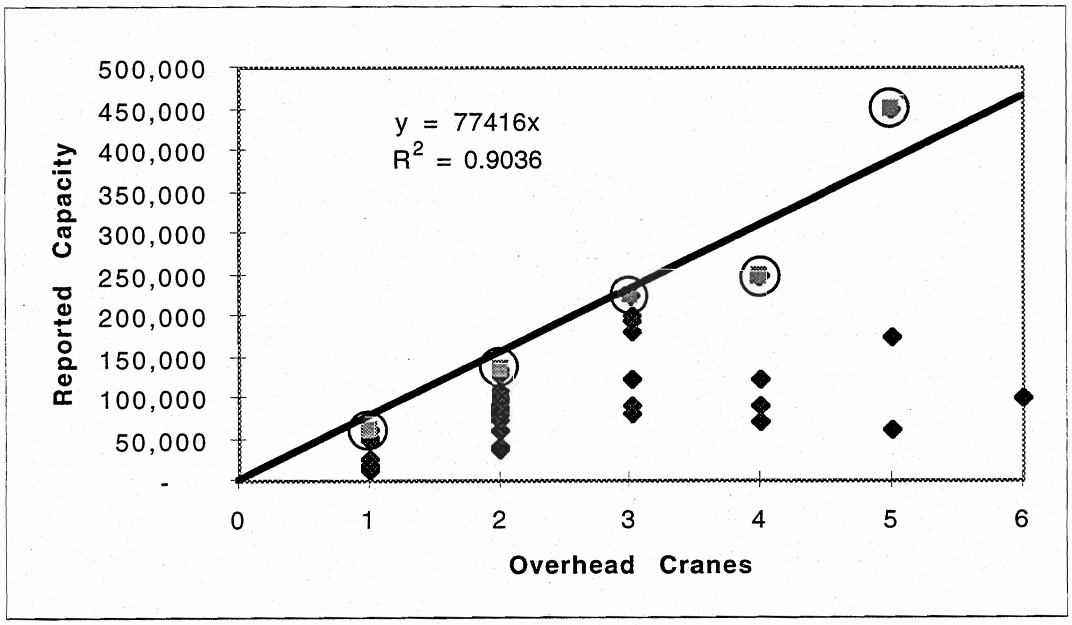
The IANA directory listed the number of each type of lift equipment for every terminal in the United States and Canada. Terminals that had no lift equipment listed were either a circus ramp operation or a Triple Crown RoadRailer facility. The three types of equipment were listed in the directory: overhead cranes, side lifts, and top lifts. Though the directory makes a distinction between "top picks" and "side lifts" in the directory, they both are mobile lifts which load and strip on the side of the train. Since few terminals utilized top picks, those facilities were not included in the analysis.

The reported capacity listed for each terminal was provided by the terminal managers to IANA. Since there was no indication if a standard capacity estimation procedure was followed, so the reported capacity figures had the presence of outliers which needed to be eliminated. To determine outliers in these data sets, a measure for productivity per lift equipment unit was obtained so that the values could be compared. In these analyses, all outliers exceeded the upper fourth end. Mild and extreme outliers were both removed from the data set. To determine capacity based on lift equipment, regressions of the "frontier envelope" values were performed. The frontier envelope represents terminals which the constraining factor for capacity is lift equipment and lower value data points represent terminals which are constrained by factors other than lift equipment.

From the interviews during site visits, terminal managers indicated that overhead cranes could lift one unit on or off the train every 2 to 2.5 minutes (24 to 30 per hour) and side lifts take about 2.5 to 3 minutes per lift (20 to 24 per hour) (Morales and Smith, G. Interviews). This translates into a maximum capacity of between 210,240 and 262,800 lifts per year for overhead cranes and between 175,200 and 210,240 lifts per year for side lifts assuming 24 hour per day operation. Because machines require maintenance and train arrivals do not always permit continuous operations, a more realistic capacity analysis is required.

Overhead Cranes. To obtain a population of rail yards to estimate overhead crane capacity, facilities not utilizing overhead cranes exclusively were eliminated. The remaining population of terminals utilizing overhead exclusively cranes was 46. The fourth spread procedure identified four outliers: two mild and two extreme. Though the number of overhead cranes ranged from one through six, the frontier envelope of one through five overhead cranes was regressed versus reported capacity because only one facility with 6 cranes exists. See Figure 7.1 for the plot of the crane data. The resulting slope, or maximum crane productivity, was 77,416 lifts/year. The ratio of to realistic to ultimate capacity is between 29 and 37 percent. Assuming cranes operate at full hourly productivity, they are operated about a third of the time.

Figure 7.1 Regression of Overhead Cranes Versus Reported Capacity

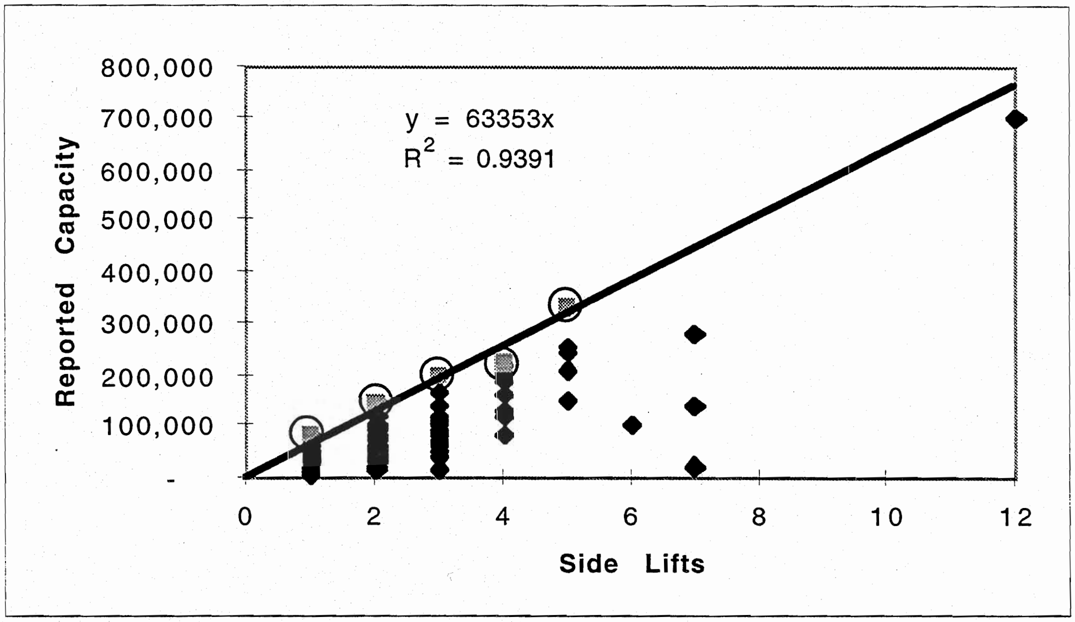


Source: Analysis of IANA *1997 Rail Intermodal Directory*

Side Lifts. After similar elimination of facilities as in overhead cranes, the population of terminals in the IANA directory exclusively using side lifts was 115. The fourth spread procedure identified two outliers: one mild and one extreme. The frontier envelope of facilities with between one and five side lifts was regressed versus reported capacity. Due to the limited observations of facilities with 6 or more lifts, those were not included in the frontier envelope. See Figure 7.2 for the plot of the side lift data. The resulting slope, or maximum side lift productivity, was 63,300 lifts per year. The ratio of realistic capacity to maximum capacity is between 30 and 36 percent, values close to ones obtained for overhead cranes. This is an indication that like overhead cranes, side lifts operate about third of the time.

The equipment productivity given by terminal managers are consistent with the IANA directory data analysis. Many terminals have extra lift equipment to load and strip flatcars faster making them better able to handle peak periods. Due to the variations in terminal operations and lift equipment brands and features, it may not be completely accurate to assume the capacity per lift is the same at all rail yards, but the values will suit the purposes of this analysis.

Figure 7.2 Regression of Side Lifts Versus Reported Capacity



Source: Analysis of IANA *1997 Rail Intermodal Directory*

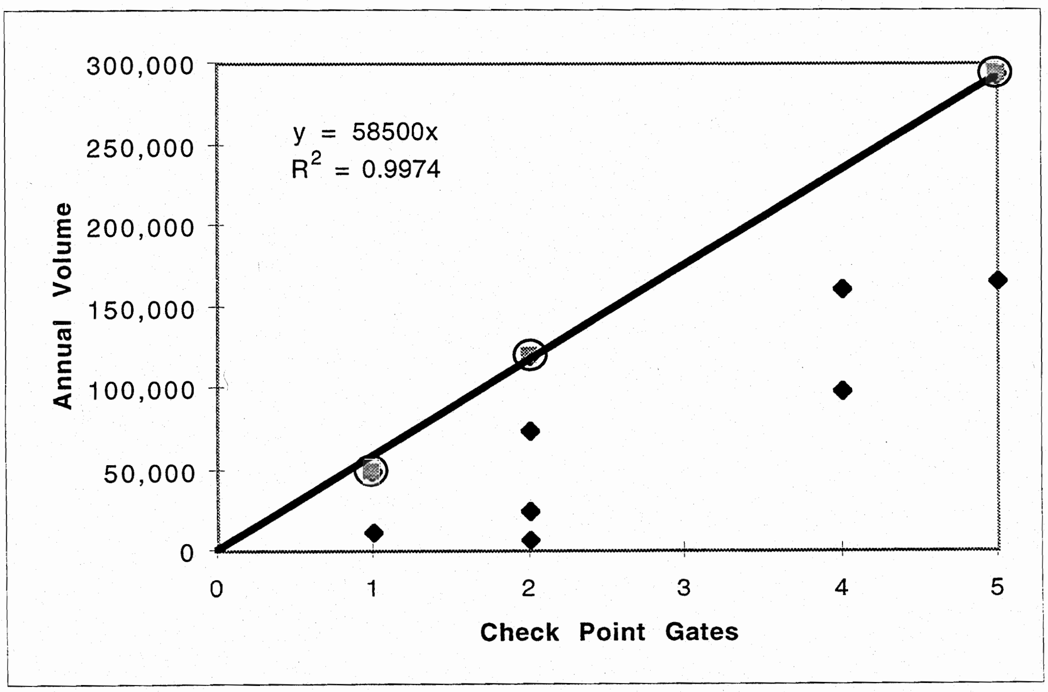
$C_{LIFT\ EQUIPMENT}$ = 63,300 SL + 77,400 OC (Equation 7.1)

Where: C = Annual Capacity
SL = Number of Side Lifts
OC = Number of Overhead Cranes

Gate Operations

The IANA Directory does not include any gate information, so the data analyzed were collected from the Texas intermodal yards. Due to the small number of observations, the frontier envelope regression will not be as reliable as the lift capacity data. From interviews, it was learned that the duration of a gate transaction is about 5 to 7 minutes, but some even take longer. Assuming five minutes per transaction, each gate lane can process a maximum of 105,120 transactions per year assuming 24 hour operations. However, traffic is not constant throughout all hours of operation, so the ultimate capacity is not a realistic capacity figure. In addition, due to random arrivals, a queue may form indicating that demand has exceeded capacity. From frontier regression of the 11 intermodal yards in Texas, as seen in Figure 7.3, the value for gate capacity is estimated to be 58,500 transactions per year. Terminals not open 168 hour per week would have a lower capacity, but to estimate just how much lower, an analysis of average hourly arrivals at 24 hour terminal must be performed. Since a minority of transactions occur during the night, the productivity adjustment should not be very great.

Figure 7.3 Regression of Check Point Gate Versus Volume



Source: Data from Surveys and Interviews

$$C_{GATE\ OPERATIONS} = 58,500\ G$$

Where C = Transactions / Year
G = Number of Gates

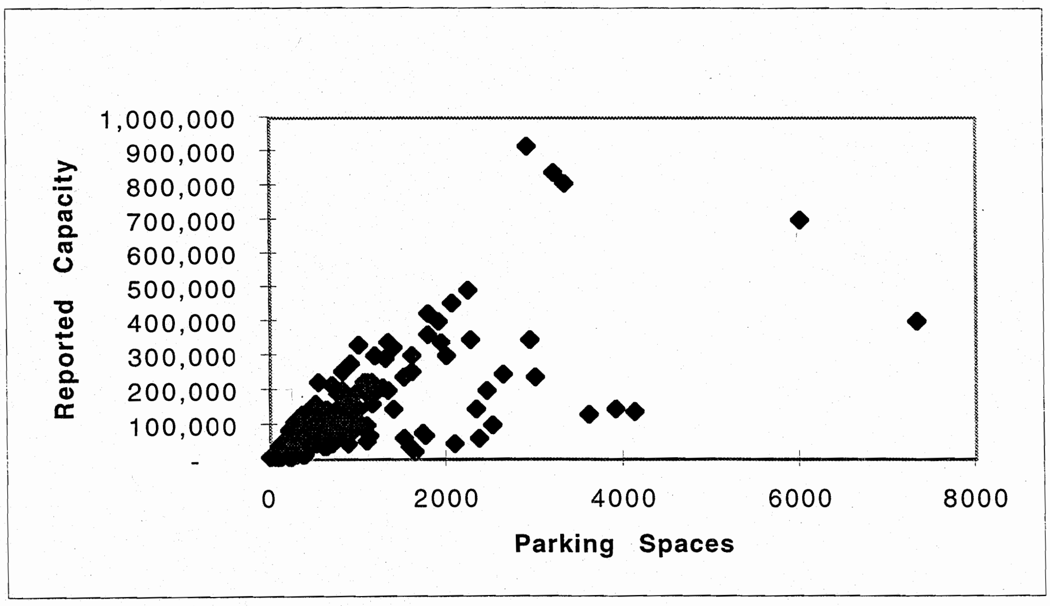
Parking Area

The annual parking capacity in terms of volume processed of an intermodal yard is a function of the number of spaces and the average dwell time of a facility. Longer dwell times decrease productivity per parking space. The ultimate productivity per space would be 365 moves per year assuming each space was used by a different trailer once per day. Analysis of IANA directory capacity and parking space data indicate an average capacity 200 times the number of parking spots. Parking capacity for loaded containers is reduced as the number of stored empties are parked in the terminal. A frontier envelope analysis was not practical because it was not clearly defined (see Figure 7.4). Since volume peaks, surges must also be accounted for so that a more realistic value for capacity can be estimated. According to one yard manager, containers may peak about 5 percent above normal levels while trailers peak about 15 percent (Gengler. Interview). The capacity formula accounts for this surge. The parking capacity formula below accounts for dwell time and volume surges.

$$C_{PARKING\ AREA} = P\ (365\ /\ DT)\ /\ (1.05 + 0.1\ F_T) \qquad \text{(Equation 7.2)}$$

Where:
- DT = Average Dwell Time (days)
- F_T = Fraction Trailers (between 0.0 and 1.0)
- P = Number of Parking Spaces

Figure 7.4 Plot of Parking Spaces Versus Reported Capacity

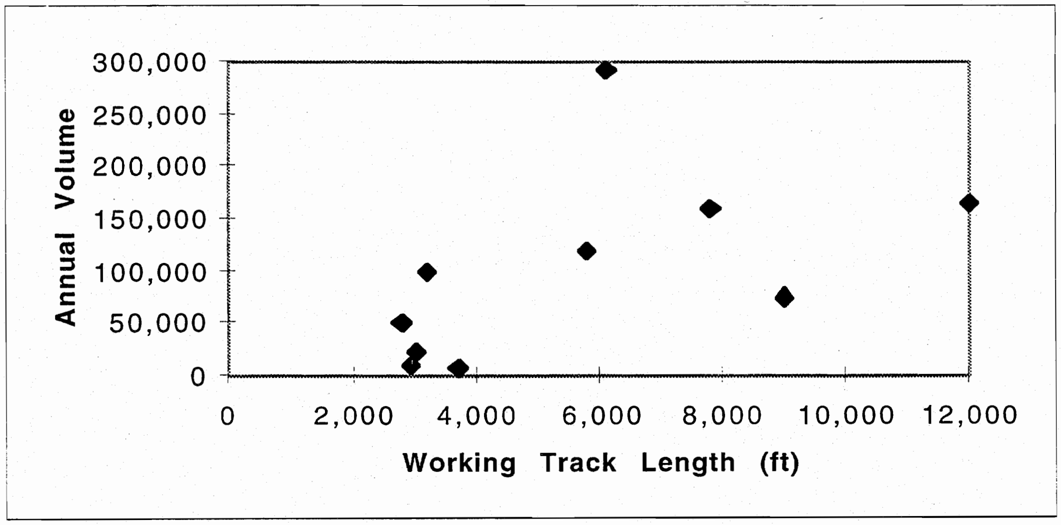


Source: Data from IANA 1997 Rail Intermodal Directory

Working Track

Productivity of working track depends mainly on train schedules, yard layout and track length. A high volume yard may load and strip 20 trains per day, while others may handle just one. A busy yard's working track may be utilized 2 or 3 times daily while others are utilized only once daily (Vandeveer 1996, 94). An 89 foot flatcar may hold 2 trailers and a 305 foot double-stack car may hold up to 10 containers. Loading and stripping fully loaded flatcars once daily on each track will yield productivity of 16 trailers and 24 containers annually per foot of working track. Assuming that three loads and strips daily, the ultimate track productivity would be about 48 trailers and 72 containers per foot per year. Since flatcars of other sizes are used, these values are only ballpark figures. Because it would be difficult to obtain data on how often switching occurs, working track volume to capacity for this analysis would not be very reliable. The plot of working track versus capacity does not indicate an obvious relationship (see Figure 7.5). Track capacity will not be used in the subsequent prioritization schemes, but it would be useful for an estimation of how much working track would be required if a new facility was to be built.

Figure 7.5 Plot of Working Track Length Versus Volume



Source: Data from surveys and interviews.

$$C_{WORKING\ TRACK} = [16\ (F_T) + 24\ (1-F_T)]\ (T)\ (U) \qquad \text{(Equation 7.3)}$$

Where: F_T = Fraction Trailers (between 0.0 and 1.0)
T = Working Track Length (ft)
U = Number of Times Tracks are Utilized Daily

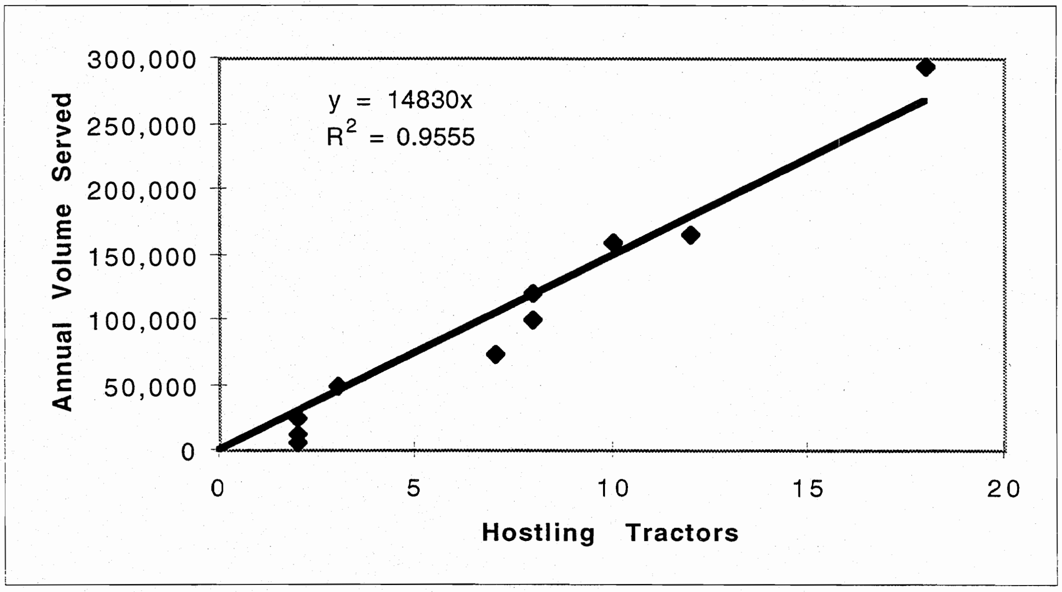
Hostling Tractors

Because the incremental investment is minimal, hostling (yard) tractors are not a big consideration in determining yard capacity. Minimal deviation from the regression is an indication that terminals purchase tractors as volume requires. Data were collected on the number of hostling tractors from the rail yards in Texas. The number of tractors was regressed against the volume served at each facility (See Figure 7.6). The result is that a hostling tractor is required for about every 15,000 in volume served.

$$C_{HOSTLING\ TRACTORS} = 14{,}830\ T \qquad \text{(Equation 7.4)}$$

Where: T = Number of Tractors

Figure 7.6 Regression of Hostling Tractors Versus Annual Volume



Source: Data from Surveys and Interviews.

CONTAINER PORT CAPACITY

The activities at container ports are more complex than rail yards. Ship arrivals cause great surges in activity. Since docks are not utilized 100 percent of the time, estimating values for capacity is even less reliable than for rail yards. Each subsection briefly describes the operational considerations of each operational category. The factors influencing capacity is then discussed. Finally, a formula for capacity estimation for that area of operation is proposed.

Container Cranes

The efficiency and number of container cranes is a major factor in determining container port. Since some ships have lift equipment on board, crane capacity at some ports may not be a constraining capacity factor depending on the frequency a ship with its own cranes calls. Some container ships have lifting capabilities so that they can call ports which do not have container cranes. The Louisiana Statewide Intermodal Plan shows a crane capacity estimation procedure (NPWI 1995, V-29). Assuming a transfer rate of 30 lifts per hour and 15 hour working days, and a utilization ratio of 0.46 results in a capacity of 75,500 lifts per year. Actual crane capacities at each port can vary due to variation in technological features between ports, but this estimate will suit the proposed planning procedure.

$$C_{CONTAINER\ CRANE} = 75{,}555\ CC \qquad \text{(Equation 7.5)}$$

Where: C = Capacity (lifts per Year)
CC = Number of Container Cranes

Gate Operations

Gate operations perhaps is the most straight forward area of operation at a container port. Capacity is based on average processing time per check point lane and the number of lanes. However, similar to rail yards, volume peaking causes queues. Since information from only four Texas ports are available, gate capacity analysis based on them will not be reliable. Since queues in excess of an hour are regular occurrences at the Port of Houston Barbours Cut Terminal, it can be argued that the gates operate at capacity (Morgan. Interview). The port's 800,000 TEU in 1997 converts to about 500,000 containers handled if adjusted according to container size mix. The 21 total gates averaged about 23,800 transactions in 1997. Assuming the Port of Houston's gates operate at capacity, 23,800 transactions per year per gate is reasonable estimate suitable for the planning procedure's purposes.

$$C_{GATE\ OPERATIONS} = (23{,}800\ G) \qquad \text{(Equation 7.6)}$$

Where C = Capacity (Transactions / Year)
G = Number of Gates

Parking Area

Estimating parking capacity for container ports is not as straight forward as intermodal yards. Ports often mix wheeled parking and stacking so that some higher priority containers do not have to be retrieved from the stacks. Estimating parking capacity with great accuracy would require detailed data collection. To reduce the data to be collected, certain values and the capacity estimation procedure presented in the Louisiana Statewide Intermodal Plan (NPWI 1995, V-29) will be the model from which the parking capacity formula shown (Equation 7.7) below is based on. Like rail yard parking capacity, port parking capacity is also a function of dwell time, but is also a function of container size mix. The formula calculates the productivity per parking slot per year and multiplies that by the number of slots in TEU. Other factors reflect space empty containers take (0.85 means 0.15 fraction of parking is empty containers), operating margins, and peak volume.

$$C_{PARKING\ AREA} = \frac{(365 / 1.3\ DT)\ (0.85)\ (0.8)\ (SS)}{(F_{20'} + (2)\ F_{40'} + (2.25)\ F_{45'})} \qquad \text{(Equation 7.7)}$$

Where:

C	=	Parking Capacity (Containers per Year)
DT	=	Average Dwell Time (days)
SS	=	Storage Space in TEU
$F_{20'}$	=	Fraction 20' Containers
$F_{40'}$	=	Fraction 40' Containers
$F_{45'}$	=	Fraction 45' Containers
1.3	=	Peak Factor for "Vessel Bunching"
0.85	=	Fraction of Space for Non-Empty Containers
0.8	=	Modifier for Operating Margins

OVERALL TERMINAL CAPACITY

A formula for overall terminal capacity must be developed for the prioritization process. A terminal's capacity is subject to the capacity of the weakest area of operation. Therefore, a terminal's capacity is a minimum function as shown in Equation 7.9.

$$C = \text{minimum}\ (C_{Lift\ Equipment} + C_{Parking} + C_{Gate\ Operations}) \qquad \text{(Equation 7.8)}$$

The Louisiana State Intermodal Plan does not estimate gate operations capacity because gate operations can "easily be expanded" (NPWI 1995, V-34). If gate operations are at capacity, then it is an indication that capacity is constrained elsewhere. For that reason, gate capacity is included in the overall capacity formula. Working track length is not a factor in Equation 7.9 because the analysis did not yield clear results. The number of hostling tractors is not a factor because tractors can be purchased without significant yard changes or capital cost as volume increases. Table 7.1 shows the capacity for the three capacity factors in Equation 7.9 of the intermodal terminals of Texas. It would be expected that volumes do not exceed capacity by much, but slightly inaccurate information and the fact that these are estimates may cause underestimates of capacity.

Table 7.1 Estimated Capacity of Texas Intermodal Terminals

Rail Yard	Annual Volume	Estimated Capacity		
		C_{LIFTS}	$C_{PARKING}$	C_{GATES}
BNSF Alliance	293,000	387,000	382,170	292,500
UP Mesquite	165,000	387,000	161,211	292,500
UP Dallas	160,000	232,200	103,457	234,000
KCS Dallas	120,000	232,200	142,310	117,000
BNSF Houston	99,000	218,100	239,153	234,000
UP San Antonio (Sher.)	50,000	63,300	173,710	58,500
UP San Antonio (Quint.)	7,000	63,300	36,588	117,000
UP El Paso	74,000	126,600	61,764	117,000
BNSF El Paso	24,000	154,800	48,667	117,000
BNSF Amarillo	12,000	77,400	53,434	58,500
Port				
Houston	496,124	906,660	443,729	499,800
Freeport	23,100	75,555	27,456	95,200
Galveston	5,714	302,220	56,480	142,800

Note: Shaded Capacity Figures is the Constraining Area.

SUMMARY

The capacity estimates presented in this chapter are estimates for use in the prioritization procedure presented in Chapter 8. Factors unique to individual terminals limit the validity of capacity estimation to other applications. More data, especially for port capacity analysis would improve these capacity estimation formulas. Other agencies can make these estimates more reliable by collecting data of their own and combining it with Texas data shown in the appendices. Such additional data would result in a more reliable working track, gate, and container port parking capacity analyses. Another possibility to avoid this capacity analysis work would be to ask terminal managers how they estimate capacity of their own terminal. State and local planners may be more successful in obtaining capacity estimates for the various areas of terminal operations. The potential drawback is that each manager would probably use a different procedure in estimating capacity. At least with the capacity analysis shown, the estimation procedure would be consistent.

CHAPTER 8. THE TERMINAL RANKING INDEX

Since government transportation funds are limited, methods to prioritize proposed projects are necessary in attempt to maximize benefits. This chapter presents the prioritization procedure as prescribed by Chapter 5. Since a single strategy will not be suitable for all planning agencies, this chapter proposes three prioritization strategies for access improvements on the facility level basis.

THE INDEX FORM

A prioritization algorithm should utilize a consistent and sensible scoring mechanism. The general form of the model shown below. Equation 8.1 is a parallel model with the characteristic that individual attributes are independent of each other in determining the score. Equation 8.2 represents a series model which each attribute affects others in the total score. A combination of the two equations result in Equation 8.3, which allows properties of both types to work together in one.

$$I = w_1 F_1 + w_2 F_2 + w_3 F_3 + \ldots + w_n F_n \qquad \text{(Equation 8.1)}$$
$$\text{Subject to: } \sum w_i = 1.0$$

$$I = F_1^{w1} F_2^{w2} F_3^{w3} \qquad \text{(Equation 8.2)}$$

$$I = w_1 F_1 + w_2 F_2 + w_3 F_3 + \ldots + w_n F_n + w_{i+1} F_a^{wa} F_b^{wb} F_c^{wc} \qquad \text{(Equation 8.3)}$$
$$\text{Subject to: } \sum w_i = 1.0$$

Each factor, F, has a weight, w, so that different attributes will have a greater or lesser influence depending on the user's preferences. So that container ports and intermodal yards can be compared in common terms, the index value, I, will be in terms of annual volume. Terms in the index formula will either give a bonus or impose a penalty to annual volume index score. Because of the index score units in the proposed prioritization schemes, the weight factors will not be subject to a formal constraint.

PRIORITIZATION STRATEGIES

Individual government entities may have their own desired approach in prioritizing the intermodal facilities. Possible strategies include benefiting the most intermodal freight users, developing a public private partnership, and improving underutilized facilities. The following sections will rationalize these three different strategies and develop the index score formulas.

The presented strategies and the associated indices may be modified to reflect the organization's priorities. Weights for each factor will be suggested, but they should be determined by the individual planning agency.

An assumption common to all three strategies is that fewer access improvements are required to reap the same benefit for terminals with shorter access routes than those with longer ones. For example, improving the only intersection along a 1000 foot access route would be more cost effective than improving multiple intersections along a 5 mile access route. As the distance increases, the less terminal traffic follows a single route. Because this assumption is not fool-proof, the penalty for having a long access route should not be an absolute one. For example, a facility with a 5 mile access route may benefit from a signalized intersection near the entrance and not need improvements anywhere else along the route. Equation 8.4 is the access route length "penalty function".

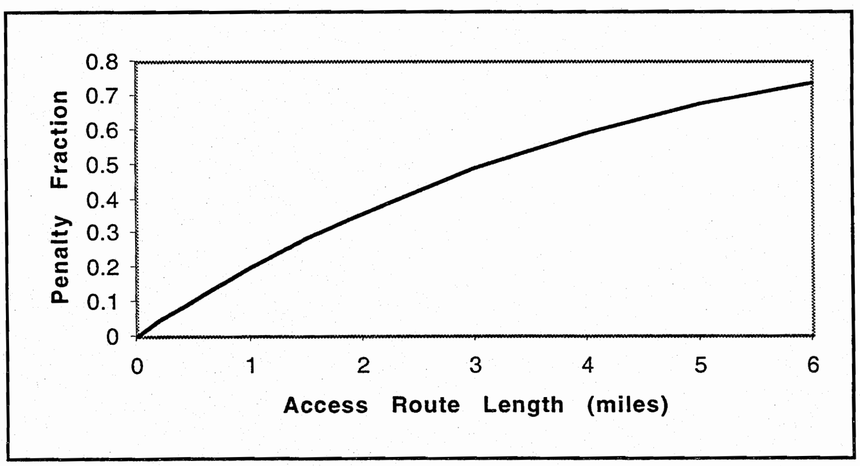
$$\mathbf{f = w\ (1\text{-}\alpha^{L})(V)} \qquad \text{(Equation 8.4)}$$

Where:

- w = Relative Importance Access Route Length (0-1)
- α = User Defined Parameter
- L = Length of Primary Access Route
- V = Facility Annual Volume

Access routes are typically between 0.2 and 5.0 miles in Texas, so picking an alpha (α) value between 0.8 an 0.9 would keep the distance penalty from being huge. The weight factor, w, determines the maximum percent penalty and alpha determines the shape of the penalty curve. Shown in Figure 8.1 illustrates the "penalty function" used in the Texas analysis.

Figure 8.1 Access Route Length Penalty Function



Strategy 1: Enhance Intermodal Freight Mobility

The simplest prioritization strategy would be to rank terminals by volume subject to the access route length adjustment. This assumes that the more containers and trailers handled, the more parties stand to benefit from access improvements. This strategy would enhance freight mobility for many users, but it is not the best strategy to if it is desired to encourage greater private intermodal investment because there is no incentive for terminals to make internal terminal improvements. An adjustment for future growth would apply to the index. The growth factor to use depends on the trends of a particular region. Both the ports of Houston and Freeport doubled container volume from 1993 through 1997 (Appendix D), a conservative growth factor for Texas ports would be 10 percent per year. The increase in intermodal rail traffic in Texas has not been consistent. Assuming a continuation of past performance, the growth factor for rail yards would be about 5 to 6 percent per year.

$$I = V + w_1 (V)(G) - w_2 (1-\alpha^L)(V) \qquad \text{(Equation 8.5)}$$

Subject to: $0.0 < \alpha < 1.0$

Where:

V	=	Terminal Volume
PC	=	Percent Containers
G	=	Growth Factor (1.10, for 10% per year)
α	=	User Defined Parameter
L	=	Length of Primary Access Route
w_1	=	Number of Years Worth of Growth Considered
w_2	=	Relative Importance Access Route Length (0-1)

The weight factors are not subject to a constraint. The weights must be chosen as to reflect the priorities of the agency. The volume growth factor, w_1, factor should not be much greater than 3 years because past growth trends is not a guarantee for future growth. In addition, w_1 should not exceed the planning horizon.

Strategy 2: Public Private Partnership Potential

A recent application of innovative financing for government projects has been the use of public/private partnerships. The theory is that government funding will leverage private funds as well. A possible application of partnerships to intermodal freight would be government improving access to an intermodal terminal concurrently with private investment in the expansion of the terminal. Such improvement could be strategically marketed to attract greater volume by current users and even new intermodal customers. The main factors in this strategy are volume and volume-to-capacity (V/C) ratio. A facility with high volume and V/C ratio ranks high because is an indication that a facility is likely to expand in the near future. Thus there exists a public/private partnership opportunity.

$$\mathbf{I = (V^2 / C) - w\,(1-\alpha^L)(V)} \qquad \text{(Equation 8.6)}$$

Subject to: $0.0 < \alpha < 1.0$

Where:
- w = Relative Importance Access Route Length
- L = Length of Primary Access Route
- α = User Defined Parameter
- V = Terminal Volume
- C = Terminal Capacity

Like in Strategy 1, a weight reflecting the importance of access route length must be chosen. High volume facilities with excess capacity are penalized significantly. In most cases, an individual yard will not gain or lose too many places with respect to its volume ranking (Strategy 1).

Strategy 3: Promote Underutilized Facilities

The third proposed strategy is to rank terminals according to under-utilization. Low volume-to-capacity ratio indicates either that the yard utilizes excess equipment, space, or gates to provide a high level of service, or that there are other factors contributing to its under-utilization. One such factor could be the access to the terminal. Perhaps if access is improved, the volume would increase because less time and hassle is required to make an intermodal shipment. This strategy rewards rail yards which provide excess capacity and therefore, good level of service. The possibility of government access improvements may be an effective incentive to motivate railroads and ports to obtain additional equipment or to add check point lanes, for example. This strategy ranks according to excess capacity subject to access length adjustment. Once the terminals are ranked, the use of this strategy requires an investigation of what causes the excess capacity at each high ranking facility. The potential to increase volume at individual terminals by improving access must be studied to be certain funds are spent wisely.

$$\mathbf{I = (C - V) - w\,(1 - \alpha^L)(C - V)} \qquad \text{(Equation 8.7)}$$

Subject to: $0.0 < \alpha < 1.0$

Where:
- w = Relative Importance Access Route Length
- L = Length of Primary Access Route
- α = User Defined Parameter
- V = Terminal Volume
- C = Terminal Capacity

ILLUSTRATION OF RANKING PROCEDURE

The Texas example will illustrate how these priority functions rate facilities of various sizes and types. The example shown should not be by Texas transportation officials, because data were collected over a period of time which may result in an inaccurate comparison due to recent equipment purchases or expansion. This example will use the most recent data collected from each yard in Texas.

Strategy 1

Table 8.1 shows how prioritization Strategy one ranks the intermodal terminals of Texas. As expected, the index orders the terminals almost according to volume served. The fraction containers and the access route length adjustments caused only four facilities to change order. Since the future growth of container and trailer intermodal traffic is unknown, the fraction containers term only factored one year of increased volume. Basically, the term gives a modest bonus for facilities handling more containers than trailers. The access route length has a very significant effect on the index score, but in the case of Texas, it did not cause a substantial losses or gains in ranking.

Table 8.1 Ranking of Texas Facilities Under Strategy 1

	V	FC	L	I
Facility	**Annual Volume**	**Fraction Containers**	**Route Length (mi.)**	**Index**
Port of Houston	496,124	1.00	1.8	381,623
BNSF Alliance (Fort Worth)	293,000	0.58	2.2	196,329
UP Dallas	160,000	0.90	0.3	164,040
UP Mesquite (Dallas)	165,000	0.30	1.0	136,950
KCS Dallas	120,000	0.55	0.7	109,247
BNSF Houston	99,000	0.91	1.2	84,752
UP El Paso	74,000	0.60	2.1	50,755
UP San Antonio (Sherman)	50,000	0.60	0.7	45,769
Port of Freeport	23,100	1.00	1.0	20,790
BNSF El Paso	24,000	0.00	0.9	19,633
BNSF Amarillo	12,000	0.90	3.3	6,826
UP San Antonio (Quintana)	7,000	0.10	2.7	3,902
Port of Galveston	5,714	1.00	2.5	3,842

Strategy 2

Table 8.2 shows the resulting ranks of Texas terminals under Strategy 2. Facilities with high volumes and high volume to capacity ratios rank high. High volume Texas facilities tend to also have a high V/C ratio. With this being the case, the change in ranking with respect to volume served is not substantial. Changes in rank of 1 to 2 at the most are observed.

Table 8.2 Ranking of Texas facilities Under Strategy 2

	V	C	L	I
Facility	**Annual Volume**	**Critical Capacity**	**Route Length (mi.)**	**Index**
Port of Houston	496,124	443,729	1.8	332,011
BNSF Alliance (Fort Worth)	293,000	292,500	2.2	179,335
UP Mesquite (Dallas)	165,000	161,211	0.3	154,316
UP Dallas	160,000	103,457	0.7	136,862
KCS Dallas	120,000	117,000	1.0	96,000
UP El Paso	74,000	61,764	0.9	60,536
UP San Antonio (Sherman)	50,000	58,500	0.7	35,504
Port of Freeport	23,100	27,456	1.0	14,815
BNSF Houston	99,000	218,100	2.1	7,900
BNSF El Paso	24,000	48,667	2.7	974
UP San Antonio (Quintana)	7,000	36,588	1.2	-305
Port of Galveston	5,714	56,480	2.5	-1,865
BNSF Amarillo	12,000	53,434	3.3	-3,559

Strategy 3

The ranking according to Strategy 3 is shown on Table 8.3. The change in ranking with respect to volume is quite significant. A facility's high ranks does not guarantee that an access improvement would impact volume served, but those should be investigated because there may be reasons for low utilization with respect to capacity caused by issues in which public sector may be able to resolve.

Table 8.3 Ranking of Texas facilities Under Strategy 3

	V	C	L	I
Facility	**Annual Volume**	**Annual Capacity**	**Route Length (mi.)**	**Index**
BNSF Houston	99,000	218,100	1.2	105,111
Port of Galveston	5,714	56,480	2.5	39,913
BNSF Amarillo	12,000	53,434	3.3	30,637
UP San Antonio (Quintana)	7,000	36,588	2.7	22,893
BNSF El Paso	24,000	48,667	0.9	22,423
UP San Antonio (Sherman)	50,000	58,500	0.7	7,885
Port of Freeport	23,100	27,456	1.0	3,920
Port of Houston	496,124	443,729	1.8	0
BNSF Alliance (Fort Worth)	293,000	292,500	2.2	0
UP Mesquite (Dallas)	165,000	161,211	1.0	0
UP Dallas	160,000	103,457	0.3	0
KCS Dallas	120,000	117,000	0.7	0
UP El Paso	74,000	61,764	2.1	0

SUMMARY

The prioritization strategies presented are straight forward. They require only basic information from terminal managers. If public agencies have success obtaining more operational data, then there may be more relevant terms to include in the prioritization schemes. The weights should be assigned according to how the agency views the relative importance of certain terms in the strategies. All weight factors used for the ranking of Texas terminals were assigned the value of one. The terms were designed to add or subtract a percentage of the score. Once the terminals are ranked, the procedure prescribed in Chapter 5 is followed.

CHAPTER 9. CONCLUSION

SUMMARY

Efficient freight transportation benefits both the private and public sector. Intermodal freight transportation depends on the advantages of multiple modes to haul shipments more economically. Problems which reduce the economy of intermodal freight transportation prevent the greater utilization of the system. Since the public sector has a stake in efficient transportation, certain freight mobility issues including access to the mode transfer terminals should be addressed by the public sector. It is predicted that, by reducing hassle and transit time through improving the highway access to the terminals, intermodal freight will capture a greater market share. This ultimately reduces the number of truck miles which results in saved highway maintenance costs, reduced emissions, and reduced overall transportation costs for consumers.

With reasons for public sector participation in freight planning established, a strategy of how to invest limited transportation funds must be developed. Originally States were mandated by ISTEA to develop an Intermodal Management System (IMS). One of the purposes of the IMS was to integrate freight planning into mainstream transportation planning. Though the IMS mandate was repealed mainly due to the complexity and enormity of data collection, some states developed frameworks that have elements that are applicable to intermodal freight planning. The intermodal freight planning procedure proposed in this report, followed some guidelines set by the IMS mandate, but reduced the scope so the system requires much less data.

The planning procedure prioritizes intermodal rail yards and container ports for funding of access improvements. Terminal managers would be asked to submit access projects that would enhance freight mobility around their facilities. The projects would be prioritize according to the associated terminals rank subject to benefit-cost ratio and feasibility requirements. One approach would be to identify easily implemented enhancements and program them and then identify larger projects and implement them according to terminal priority. Three prioritization strategies are proposed to reflect possible goals of planning agencies. A capacity analysis was performed as two of the three strategies required it. Such analysis not only is useful in prioritization, but also for monitoring the system's performance over time. Data from Texas facilities were collected from surveys and site visits for the prioritization schemes and capacity analysis. The Texas systems were analyzed according to the prescribed prioritization process to illustration purposes. The data required for this planning procedure were designed to be collected with out great effort as the data were not proprietary.

Implementation of this intermodal freight planning procedure would help government planners to allocate transportation funds towards intermodal freight mobility more effectively. The resulting improvements in intermodal freight mobility would benefit both the public and private sectors by reducing transportation costs, truck miles, and motorist conflicts with commercial vehicles.

RECOMMENDATIONS

The planning process presented has several opportunities for enhancement. Integrating the planning process into a Geographic Information System (GIS) database would provide an opportunity to incorporate the links of the intermodal freight system. Road attributes in the database such as average daily traffic, lane widths and configuration, bridge clearance, and average speed would be useful in analyzing access to intermodal freight facilities. Such information tells more than just the length of an access route to the intermodal terminal. Additional information gathered that was not used by the ranking scheme such as load balance, previous annual volume can be stored in the GIS database as a performance monitoring system.

One type of containerized freight terminals not included in the analysis was container barge facilities. Not enough information was available on barge operations to determine how to include it in the planning process. As popularity of barge service grows, more literature will become available, which would enable inclusion. Intermodal operations often included in literature is that was not included in this work is air to highway transportation. By using the presented planning process as a base, other forms of intermodal transportation could be subsequently added to it. The presented intermodal freight planning framework, combined with a GIS database, would be useful for government transportation agencies in achieving its goals of reducing emissions, fuel consumption, and highway congestion.

APPENDIX A. INTERMODAL RAIL YARD SURVEY

Intermodal Yard Survey

Facility Name: ______________________________ **Railroad:** ________________________________

First year as an intermodal yard: ____________ **Year of last major overhaul:** ____________

Facility Type (Check all that apply)

☐ Port(s) Served. Which? ____

☐ On Dock Loading ☐ Near Dock Loading ☐ Drayage Required

☐ Intermediate Stop for Intermodal Trains ☐ Interchange point with another RR

Location: ☐ Residential ☐ Industrial ☐ Commercial ☐ Other

Approximate Employment: ______________

Yearly Volume Served:

1996: __________ 1995: __________ 1994: __________ 1993: __________ 1992: __________

Percent Containers: ______________% Percent Trailers: _________________%

Percent that are Loadings: _________% Percent that are Unloadings: _________%

Estimated Capacity: ______________________ (Lifts per year)

Capacity Constrained by:

☐ Train Capacity ☐ Equipment Limitations ☐ Gate Operations

☐ Parking Space ☐ Other (please explain): ____________________________________

Number of Intermodal Tracks: __________ **Total Length of Intermodal Tracks:** ____________

Number of Hostling Tractors: __________

Number of Check-In Gates: _____________ **Number of Check-Out Gates:** ____________

If gates are reversible, the total number of gates: ____________

What is the approximate distribution of dwell times? (% of volume picked up on the...)

_____% Same Day _____% 2nd Day _____% 3rd Day_____% 4th Day+

What is the average gate wait for truck drivers during peak periods?

☐ <15 min. ☐ 16-30 min. ☐ 31-45 min. ☐ 46-60 min. ☐ 61-90 min. ☐ 90+ min.

What is the average entry to exit time for truck drivers during peak periods?

☐ <30 min. ☐ 31-45 min. ☐ 46-60 min. ☐ 61-90 min. ☐ 91-120 min. ☐ 2 hrs+

What is the average entry to exit time for truck drivers during non-peak periods?

☐ <30 min. ☐ 16-30 min. ☐ 31-60 min. ☐ 61-90 min. ☐ 91-120 min. ☐ 2 hrs+

How often do peak demand periods exceed Capacity?

☐ Rarely ☐ Seasonally ☐ Monthly ☐ Weekly ☐ Daily

How much during the day do train operations affect traffic on local streets?

☐ Never ☐ 0-1 hours ☐ 1-2 hours ☐ 2-3 hours ☐ >3 hours

Is Noise an issue to area residents? ____________

What security measures are taken at the facility? (Lighting, patrol, etc.)

What special treatment are given to priority containers or trailers?

What operational or access issues are of primary concern at the intermodal yard?

What are the future plans for improvements or expansion?

APPENDIX B. CONTAINER PORT SURVEY

Container Port Survey
Port of Port Arthur

University of Texas at Austin
Kevin Anderson (512) 471-1414
FAX (512) 471-4995

Facility Type (Check all that apply to the Berth(s) that handle Containers)

☐ Dedicated Container Port.
☐ Seeking to Increase Container Activity.
☐ Emphasis on Containers, but Handles Other Traffic.
☐ Not Seeking Additional Container Volume.
☐ Emphasis on other Traffic, but Handles Containers.

Approximate Employment: ____________ (container terminal only)

Yearly Volume Served: (TEUs)

1997: _________ 1996: __________ 1995: __________ 1994: _________ 1993: _________

Approximate Percent of containers that are inbound: __________% **outbound:** ______________%

Estimated Capacity: ______________ (TEUs per year) **Average Weight per TEU:**________________

Capacity Constrained by:

☐ Gate Operations ☐ Parking Capacity ☐ Number of Berths
☐ Container Cranes Capacity ☐ Other (please list): ______________________________________

Primary Trading Regions

_____% **Europe and Mediterranean**
_____% **Latin America**
_____% **Pacific Rim**
_____% **Domestic / Other** _________

List Percent of inbound containers by Container Size	**List Percent of outbound containers by Container Size**
_____ **% 20'**	_____ **% 20'**
_____ **% 40'**	_____ **% 40'**
_____ **% 45'**	_____ **% 45'**

Nearby Railroad Intermodal Facilities: **Percent of Containers go by rail:** _______%

Location: _________________ _________________ ________________
Railroad : _________________ _________________ ________________
Length of Drayage: _________________ _________________ ________________

Sailing time to Gulf of Mexico: ________________________ (hours)

Number of Check-In Gates: ______________ **Number of Check-Out Gates:** _____________

If gates are reversible, the total number of gates: ____________

Number of Yard Tractors: _____________ **Number of Berths:** _____________

Number of Container Cranes: __________ **Reach of Largest Crane:** ________ (ft)

Area of Parking: ______________ (acres) **Container Parking Capacity:** _____ (TEU's)

Channel Depth: ____________ (ft) **Typical Stacking Height:** ________ (units)

What is the approximate distribution of dwell times? (% of volume picked up on the...) ______% Same Day ______% 2nd Day ______% 3-14 Days ______% 14 Days + **Average dwell time:** ____________	
List the Top Commodities Inbound:	**List the Top Commodities Outbound:**
Average gate wait for truck drivers during peak periods? ____________________ **Average entry to exit time for truck drivers. . .** **during peak periods?** _____________ **during non-peak periods?** ___________	
What advantages does this port have over others on the Gulf Coast? (ie location, rail access, etc.) **What special treatment, if any, are given to priority containers?** **What operational or access issues are of primary concern at the port?** **What are the future plans for improvements or expansion of the container terminal?**	

APPENDIX C. INTERMODAL RAIL YARD PROFILES

Table C.1 Summary of Texas Intermodal Rail Yards

	City	RR	Reported Annual Capacity	Recent Volume Figure	Lift Equipment SL	Lift Equipment OC	Parking Spaces
*	Mesquite	UP	200,000	165,000	0	5	835
*	Alliance	BNSF	400,000	293,000	0	5	2,200
*	Dallas	KCS	144,000	120,000	0	3	1,024
*	Dallas	UP	220,000	160,000	0	3	1,400
*	Houston	BNSF	168,000	99,000	1	2	1,928
*	San Antonio (Sherman)	UP	70,000	50,000	1	0	600
*	San Antonio (Quintana)	UP	7,000	7,000	1	0	300
*	El Paso	UP	90,000	74,000	2	0	800
*	El Paso	BNSF	36,000	24,000	0	2	280
*	Amarillo	BNSF	20,000	12,000	0	1	200
	Houston (Wallisville)	UP	252,000		1	3	1,600
	Houston (Kirkpatrick)	UP	200,000		2	3	7,600
	Barbours Cut	UP	72,000		3	0	200
	Port Arthur	KCS	60,000		0	1	350
	Laredo	UP	130,000		0	2	890
	Laredo	TM					

Source: IANA 1997 Rail Intermodal Terminal Directory unless updated by surveys or site visits.

* Rail yard either returned the survey or was visited.

Notes: SL: Side Lift
OC: Overhead Crane

Recent Volume Figure either is 1996 or 1997.

KCS's Port Arthur facility opened in April 1998.
Texas Mexican Railway's Laredo facility is currently under construction.

Maps on the profile pages are courtesy of Texas Department of Transportation.

Alliance BNSF

Hours of Operation: 24/7 — 2400 Westport Parkway, Hastlet 76052

Capacity 400,000 **Parking** 2200 **Acreage** 281 **Year** / **Volume** 1992 0 1993 0 1994 204,000 1995 278,000 1996 293,000 1997 NA	**Equipment** 0 Side Lifts 5 Overhead Cranes 18 Hostling Tractors **Check Point Gates** 3 Check-In Gates 2 Check-Out Gates Total Gates (if Reversible)	**Working Track** Number of Tracks: 8 Total Length (ft): 6,100 **% Trailers:** 42 **% Containers:** 58 **% Loadings:** 50 **% Unloadings:** 50 **Ave. Dwell Time:** 1.8 **(Days)**
Frequency Volume Exceeds Capacity X Rarely Seasonally Monthly Weekly Daily	**Capacity Constrained By:** Train Space Parking Space Gate Operations Equipment Track Length	**Container Port Served** None Distance: - Connection: -

Recent Expansion	**Access Route Length** 2.2 miles NHS connector
Future Expansion Plans to add additional check point lanes.	
Other Notes	

Dallas KCS

Hours of Operation: 24/7 — 11931 Shiloh Rd., Dallas 75228

Capacity	144,000
Parking	1024
Acreage	80

Year	Volume
1992	NA
1993	NA
1994	NA
1995	NA
1996*	120,000
1997*	120,000

*Approximate

Equipment

0 Side Lifts
3 Overhead Cranes
8 Hostling Tractors

Working Track

Number of Tracks: 3
Total Length (ft): 5,800

Check Point Gates

1 Check-In Gates
1 Check-Out Gates
0 Total Gates
(if Reversible)

% Trailers: 45
% Containers: 55

% Loadings: 59
% Unloadings: 41

Ave. Dwell Time: 2.5
(Days)

Frequency Volume Exceeds Capacity

Rarely
X Seasonally
Monthly
Weekly
Daily

Capacity Constrained By:

Train Space
X Parking Space
Gate Operations
Equipment
Track Length

Container Port Served

None

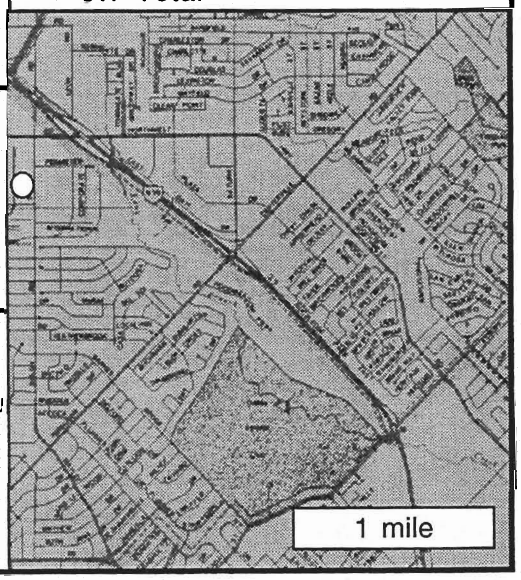
Distance: -
Connection: -

Recent Expansion

New to KCS

Access Route Length

0.5 miles non-NHS
0.2 miles NHS
0.7 Total



Future Expansion

Possible Relocation in Wylie, TX

Other Notes

No Room for Expansion
Rut Maps on the profile pages are cou
of Transportation.

Dallas UP

Hours of Operation: 24/7 — 7600 South Central Expressway, Dallas 75216

Capacity 220,000
Parking 1400
Acreage 70

Year	Volume
1992	150,000
1993	160,000
1994	170,000
1995	170,000
1996	160,000
1997	150,000

Equipment
- 0 Side Lifts
- 3 Overhead Cranes
- 10 Hostling Tractors

Working Track
Number of Tracks: 6
Total Length (ft): 7,800

Check Point Gates
- 2 Check-In Gates
- 2 Check-Out Gates
- Total Gates (if Reversible)

% Trailers: 10
% Containers: 90

% Loadings: 50
% Unloadings: 50

Ave. Dwell Time: 4.7 **(Days)**

Frequency Volume Exceeds Capacity
- X Rarely
- Seasonally
- Monthly
- Weekly
- Daily

Capacity Constrained By:
- Train Space
- Parking Space
- Gate Operations
- Equipment
- Track Length

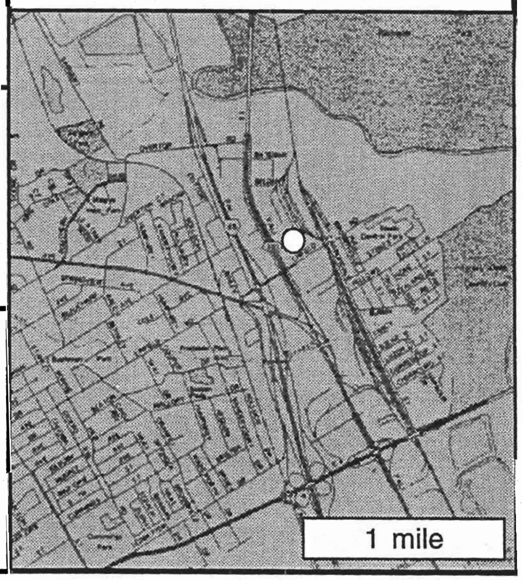
Container Port Served
None

Distance: -
Connection: -

Recent Expansion

Access Route Length

0.3 miles non-NHS



Future Expansion
Possible Consolidation at Mesquite.

Other Notes
Intersection to facility has difficult geometry for truck traffic.

90% International out of CA

Mesquite UP

Hours of Operation: 24/7 — 4425 Forney, Mesquite 75149

Capacity 200,000 **Parking** 835 **Acreage** 60	**Equipment** 0 Side Lifts 5 Overhead Cranes 12 Hostling Tractors	**Working Track** Number of Tracks: 4 Total Length (ft): 12,000
Year / **Volume** 1992 128,532 1993 145,567 1994 190,983 1995 171417 1996 165,249 1997 NA	**Check Point Gates** 3 Check-In Gates 2 Check-Out Gates Total Gates (if Reversible)	**% Trailers:** 70 **% Containers:** 30 **% Loadings:** 60 **% Unloadings:** 40 **Ave. Dwell Time:** 1.75 **(Days)**
Frequency Volume Exceeds Capacity Rarely Seasonally Monthly X Weekly Daily	**Capacity Constrained By:** Train Space X Parking Space Gate Operations X Equipment Track Length	**Container Port Served** None Distance: - Connection: -

Recent Expansion

Access Route Length

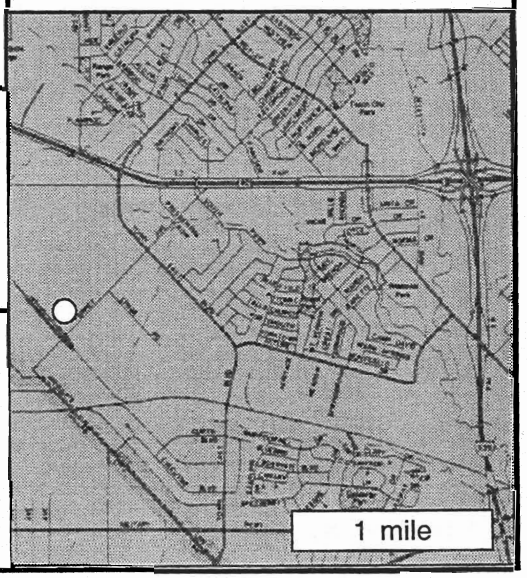
1.0 miles NHS Connector

Future Expansion

Currently expanding by 50 acres, 1200 parking spaces and 10,000 ft of working tracks.

Other Notes

Since collecting Survey, 2 cranes were added.



Houston BNSF

Hours of Operation: M-F 24hrs, Sat 'til 7p, Sun 7a-12m   214 Brisbane, 77061

Capacity 168,000
Parking 1928
Acreage 85

Year	Volume
1992	87,301
1993	82,885
1994	91,757
1995	90,484
1996	98,936
1997	NA

Equipment

1 Side Lifts
2 Overhead Cranes
8 Hostling Tractors

Working Track

Number of Tracks: 4
Total Length (ft): 3,200

Check Point Gates

Check-In Gates
Check-Out Gates
4 Total Gates
(if Reversible)

% Trailers: 9
% Containers: 91

% Loadings: 55
% Unloadings: 45

Ave. Dwell Time: 2.75 **(Days)**

Frequency Volume Exceeds Capacity

Rarely
Seasonally
Monthly
Weekly
Daily

Capacity Constrained By:

Train Space
Parking Space
Gate Operations
Equipment
Track Length

Container Port Served

Port of Houston

Distance (mi): 10+
Connection: Dray

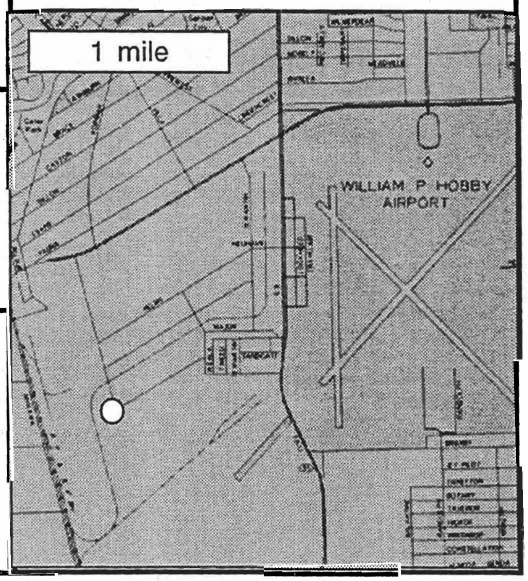
Recent Expansion

Access Route Length

3.7 miles NHS

Future Expansion

Other Notes



El Paso UP

Hours of Operation: 24/7 — 201 Dodge St., El Paso 79915

Capacity 90,000
Parking 800
Acreage 5

Year	Volume
1992	NA
1993	46,586
1994	59,189
1995	55,954
1996	74,037
1997	NA

Equipment
2 Side Lifts
0 Overhead Cranes
7 Hostling Tractors

Check Point Gates
1 Check-In Gates
1 Check-Out Gates
Total Gates
(if Reversible)

Working Track
Number of Tracks: 2
Total Length (ft): 9,000

% Trailers: 40
% Containers: 60

% Loadings: 60
% Unloadings: 40

Ave. Dwell Time: 4.2 **(Days)**

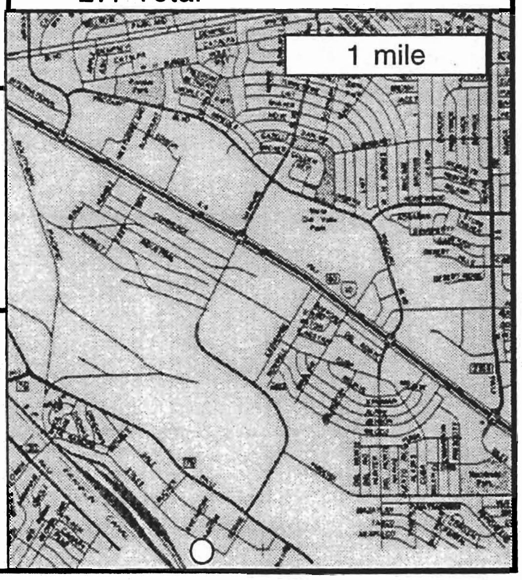
Frequency Volume Exceeds Capacity
Rarely
X Seasonally
Monthly
Weekly
Daily

Capacity Constrained By:
X Train Space
X Parking Space
Gate Operations
Equipment
Track Length

Container Port Served
None
Distance: -
Connection: -

Recent Expansion

Access Route Length
0.4 miles NHS Connector
1.7 miles NHS
2.1 Total



Future Expansion
Expansion plans on hold due to merger.

More working track is needed.

Other Notes

El Paso BNSF

Hours of Operation: M-F 7a-9p, Sat 7a-6p — 805 S. Santa Fe St, 79901

Capacity 36,000
Parking 280
Acreage 14

Year	Volume
1992	14,400
1993	16,000
1994	18,500
1995	24,000
1996	24,000
1997	NA

Equipment
- 0 Side Lifts
- 2 Overhead Cranes
- 2 Hostling Tractors

Working Track
Number of Tracks: 3
Total Length (ft): 3,000

Check Point Gates
- 1 Check-In Gates
- 1 Check-Out Gates
- Total Gates (if Reversible)

% Trailers: 100
% Containers: 0

% Loadings: 60
% Unloadings: 40

Ave. Dwell Time: 2 **(Days)**

Frequency Volume Exceeds Capacity
- Rarely
- Seasonally
- Monthly
- Weekly
- Daily

Capacity Constrained By:
- Train Space
- X Parking Space
- Gate Operations
- Equipment
- Track Length

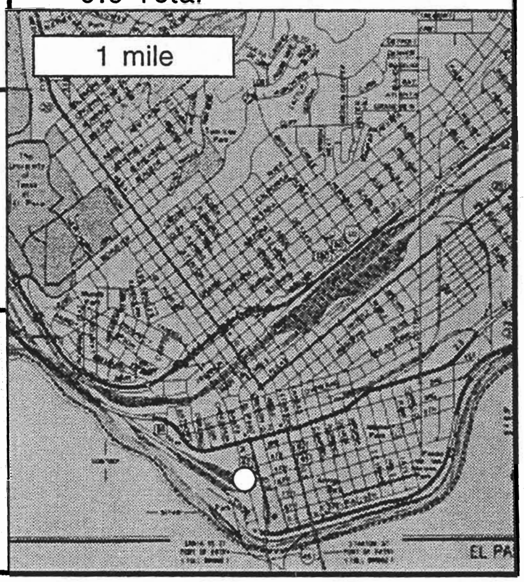
Container Port Served
None
Distance: -
Connection: -

Recent Expansion

Future Expansion

Other Notes

Access Route Length
- 0.3 miles NHS
- 0.6 miles NHS Connector
- 0.9 Total



San Antonio UP (Sherman)

Hours of Operation: 24/7 — 1201 Sherman St., San Antonio 78202

Capacity 70,000
Parking 600
Acreage 22

Year	Volume
1992	NA
1993	NA
1994	NA
1995	70,000
1996	60,000
1997	50,000

Equipment
1 Side Lifts
0 Overhead Cranes
3 Hostling Tractors

Working Track
Number of Tracks: 1
Total Length (ft): 2,800

Check Point Gates
Check-In Gates
Check-Out Gates
1 Total Gates
(if Reversible)

% Trailers: 40
% Containers: 60

% Loadings: 50
% Unloadings: 50

Ave. Dwell Time: 1.2 **(Days)**

Frequency Volume Exceeds Capacity
Rarely
Seasonally
Monthly
Weekly
Daily

Capacity Constrained By:
Train Space
Parking Space
Gate Operations
Equipment
Track Length

Container Port Served
None

Distance: -
Connection: -

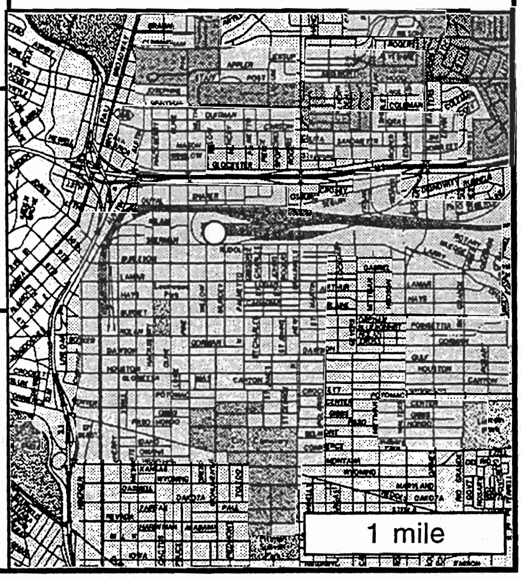
Recent Expansion

Access Route Length

0.7 miles NHS Connector

Future Expansion

Other Notes
Likely to move operations to Quintana Ave. facility.



San Antonio SP (Quintana St.)

Hours of Operation: 24/7 | 1711 Quintana Rd, San Antonio 78211

Capacity 7,000
Parking 200
Acreage 26

Year	Volume
1992	-
1993	-
1994	6,875
1995	6,900
1996	7,000
1997	NA

Equipment
1 Side Lifts
0 Overhead Cranes
2 Hostling Tractors

Working Track
Number of Tracks: 2
Total Length (ft): 3,700

Check Point Gates
1 Check-In Gates
1 Check-Out Gates
Total Gates (if Reversible)

% Trailers: 90
% Containers: 10

% Loadings: 50
% Unloadings: 50

Ave. Dwell Time: 1.85 **(Days)**

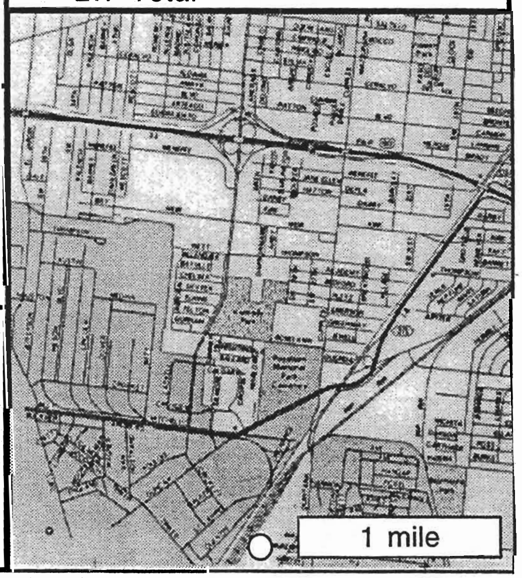
Frequency Volume Exceeds Capacity
X Rarely
Seasonally
Monthly
Weekly
Daily

Capacity Constrained By:
Train Space
X Parking Space
Gate Operations
X Equipment
Track Length

Container Port Served
None
Distance: -
Connection: -

Recent Expansion

Access Route Length
1.2 miles NHS
1.5 miles non-NHS
2.7 Total



Future Expansion

Other Notes
No Traffic Signal at the entrance.
Consolidation likely to happen here.

BNSF Amarillo

Hours of Operation: 24/7 — 1801 Farmers Ave, 79110

Capacity 20,000
Parking 200
Acreage 3

Year	Volume
1992	6,000
1993	6,000
1994	6,000
1995	6,000
1996	12,000
1997	NA

Equipment
- 0 Side Lifts
- 1 Overhead Cranes
- 2 Hostling Tractors

Working Track
Number of Tracks: 1
Total Length (ft): 2,900

Check Point Gates
- Check-In Gates
- Check-Out Gates
- 1 Total Gates
- (if Reversible)

% Trailers: 10
% Containers: 90

% Loadings: 90
% Unloadings: 10

Ave. Dwell Time: 1.25 **(Days)**

Frequency Volume Exceeds Capacity
- X Rarely
- Seasonally
- Monthly
- Weekly
- Daily

Capacity Constrained By:
- X Train Space
- X Parking Space
- Gate Operations
- X Equipment
- Track Length

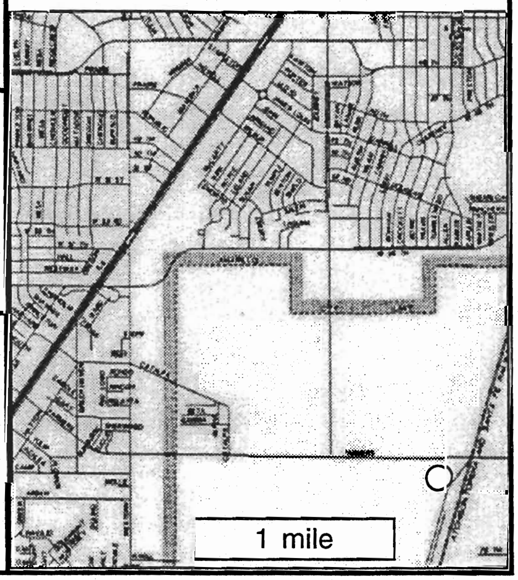
Container Port Served
None

Distance: -
Connection: -

Recent Expansion

Access Route Length

3.3 miles non-NHS



Future Expansion
Entrance to be relocated and lot to be resurfaced.

Other Notes
Train Space is limited for outbound loads.

APPENDIX D. CONTAINER PORT PROFILES

Figure D.1 Summary of Texas Container Ports

	Houston	Freeport	Galveston	Corpus Christi
Volume (TEU)				
1993	320,000	21,860	NA	-
1994	350,000	34,062	NA	-
1995	590,000	30,516	NA	-
1996	681,000	35,980	NA	-
1997*	800,000	46,200	10,000	500
1997 Volume (Containers)	496,894	23,100	5,714	333
Berths	6	3	1	1
Sailing Time to Gulf (hr)	3.5	0.5	1.0	2.0
Channel Depth (ft)	42	36	42	45
Parking Area				
TEU	22,000	500	NA	NA
Acres	197	3	30	22.5
Cranes	12	1	3	1
Rail Connection	Near Dock	On-Dock (not used)	On-Dock (not used)	On-Dock (not used)

Source: Completed Surveys

Note: The port of Brownsville was constructing a container facility during the study.

Port of Houston

Facility Type
Dedicated Container Terminal

Sailing Time To Gulf (hr): 3.5
Channel Depth (ft): 42

Capacity: NA
Berths: 6

Year	Volume (TEU)
1993	320,000
1994	350,000
1995	590,000
1996	681,000
1997*	800,000

* Projected from 11/97

Rail Connection

Type of Connection:	Near Dock
Drayage Distance:	3 mi
% of Containers go by Rail	15 %

Railroad: Union Pacific

Container Size Mix

20 footers:	39 %
40 footers:	60 %
45 footers:	1 %

TEU to Container Factor: 1.61

Equipment
12 Container Cranes
120 ft Reach

24 Yard Tractors

Dwell Time Distribution
(percent picked up in time interval)

Day	Percent
Same	1.0
2nd Day	2.8
3rd-14th Day	31.3
14th+ Day	64.6

Average Dwell Time: 6.0 days

Parking
Capacity: 22,000 TEU
Area: 197 Acres
Stacking Height: 3-4

Gate Operations

Average Gate Wait During Peak:	65 minutes	7 Check-In Gates
Average Peak Turnaround Time:	60 minutes	3 Check-Out Gates
Ave. Off-Peak Turnaround Time:	60 minutes	22 Total Gates

Trade Balance

Import	50%
Export	50%

Access Roads
1.8 miles NHS

Port Notes

Advantages are:
Facilties, expanding.

Concerns are:
Space

Map is unavailable.

Port of Freeport

Facility Type
Emphasis is Containers Traffic

Sailing Time To Gulf (hr): 0.5
Channel Depth (ft): 36

Capacity: NA
Berths: 3

Year	Volume (TEU)
1993	21,860
1994	34,062
1995	30,516
1996	35,980
1997*	46,200

* Projected from 11/97

Rail Connection
Type of Connection: On-Dock
Drayage Distance: - mi
% of Containers go by Rail 0 %

Railroad:

Container Size Mix
20 footers: 0 %
40 footers: 100 %
45 footers: 0 %
TEU to Container Factor: 2.00

Equipment
1 Container Cranes
110 ft Reach

7 Yard Tractors

Dwell Time Distribution
(percent picked up in time interval)

Day	Percent
Same	25.0
2nd Day	25.0
3rd-14th Day	25.0
14th+ Day	25.0

Average Dwell Time: 2.0 days

Parking
Capacity: 500 TEU
Area: 3 Acres
Stacking Height: 3

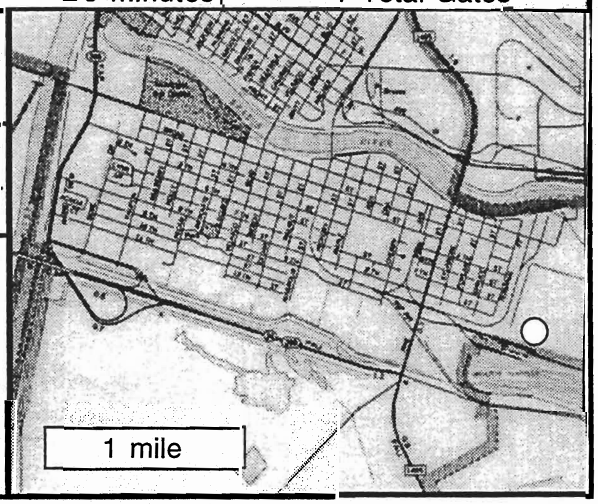
Gate Operations
Average Gate Wait During Peak: 10 minutes
Average Peak Turnaround Time: 20 minutes
Ave. Off-Peak Turnaround Time: 20 minutes

2 Check-In Gates
2 Check-Out Gates
4 Total Gates

Trade Balance
Import 50%
Export 50%

Access Roads 1 mile total
0.2 mi NHS Connect.
0.8 mi, NHS

Port Notes
Advantages are:
Quick turnaround times.
Reefer handling specialty.
Concerns are:
Adaquate paving on access roads.
More gates and dock space.



Port of Galveston

Facility Type
Dedicated Container Terminal

Sailing Time To Gulf (hr): 1
Channel Depth (ft): 42

Capacity: 50,000
Berths: 1

Year	Volume (TEU)
1993	NA
1994	NA
1995	NA
1996	NA
1997*	10,000

* Projected from 11/97

Rail Connection
Type of Connection: On-Dock
Drayage Distance: - mi
% of Containers go by Rail 0 %

Railroad:

Container Size Mix
20 footers: 25 %
40 footers: 75 %
45 footers: 0 %
TEU to Container Factor: 1.75

Equipment
4 Container Cranes
110 ft Reach

NA Yard Tractors

Dwell Time Distribution
(percent picked up in time interval)

Day	Percent
Same	NA
2nd Day	NA
3rd-14th Day	NA
14th+ Day	NA

Average Dwell Time: NA days

Parking
Capacity: NA
Area: 30 Acres
Stacking Height: 3

Gate Operations
Average Gate Wait During Peak: NA minutes
Average Peak Turnaround Time: NA minutes
Ave. Off-Peak Turnaround Time: NA minutes

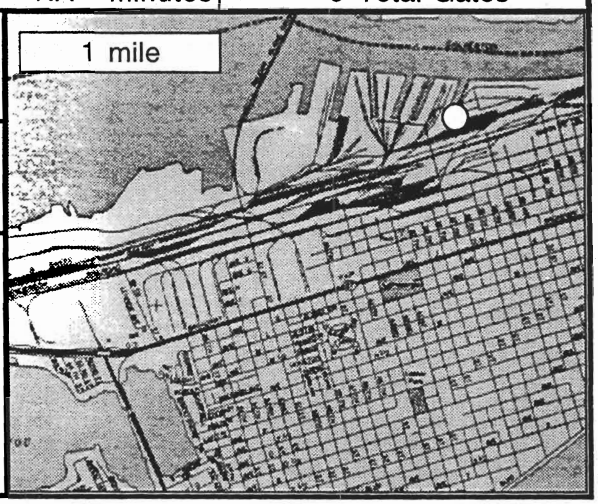
3 Check-In Gates
3 Check-Out Gates
6 Total Gates

Trade Balance
Import 50%
Export 50%

Access Roads
2.5 miles NHS

Port Notes
POH leases the terminal.

Advantages are:
Accessibility, Turnaround time, fewer channel restrictions, closer to the gulf.



Port of Corpus Christi

Facility Type
Emphasis is Other Traffic

Sailing Time To Gulf (hr): 2
Channel Depth (ft): 45

Capacity: NA
Berths: 1

Year	Volume (TEU)
1993	-
1994	-
1995	-
1996	-
1997*	500

* Projected from 11/97

Rail Connection
Type of Connection: On-Dock
Drayage Distance: - mi
% of Containers go by Rail 0 %

Railroad:

Container Size Mix
20 footers: 50 %
40 footers: 50 %
45 footers: 0 %
TEU to Container Factor: 1.50

Equipment
1 Container Cranes
110 ft Reach

0 Yard Tractors

Dwell Time Distribution
(percent picked up in time interval)

Day	Percent
Same	NA
2nd Day	NA
3rd-14th Day	NA
14th+ Day	NA

Average Dwell Time: NA days

Parking
Capacity: NA
Area: 22.5 Acres
Stacking Height: 3

Gate Operations
Average Gate Wait During Peak: NA minutes
Average Peak Turnaround Time: NA minutes
Ave. Off-Peak Turnaround Time: NA minutes

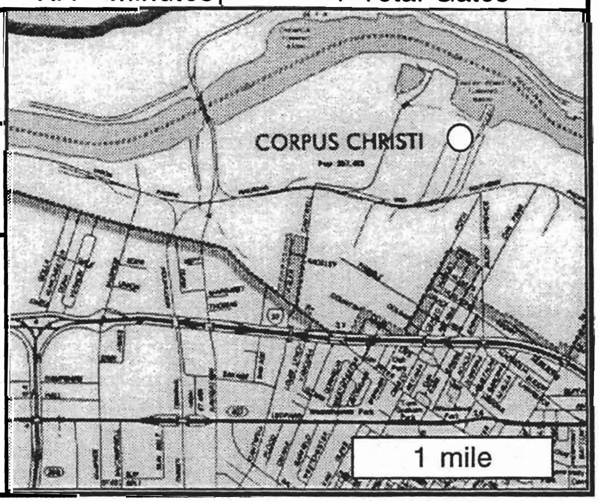
2 Check-In Gates
2 Check-Out Gates
4 Total Gates

Trade Balance
Import 0%
Export 100%

Access Roads
Not determined, but NHS Connectors exist.

Port Notes
New in the container business. (10/97)

Advantages are:
Good Surrounding Highways, low rates, proximity to Mexico



GLOSSARY

Backhaul- The return trip for a truck operator with a load.

Break-even Distance- Refers to the minimum shipment distance which the cost of intermodalism is less than or equal to trucking.

Deadhaul- A tractor returning without a trailer.

Class I Railroad- A railroad with revenue greater than $256 million.

Class III Railroad- A railroad with revenue greater than $20.4 million.

Drayage- The trucking segments of an intermodal shipment.

Long Haul- A haul over 1500 miles.

Megaship- The next generation container ship requiring 50' channels.

Medium Haul- A haul between 500 and 1500 miles.

Panamax- Refers to the maximum ship size in the locks of the Panama Canal.

Reefer- Refrigerated Containers or Trailers.

Rubber Tire Interchange- The practice of draying containers and trailers from one railroad's terminal to another's for shipments requiring two railroad line-hauls.

Short Haul- A haul less than 500 miles.

Steel Wheel Interchange- The practice of interchanging trailers and containers over the rails between railroads.

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