Determining The Potential Economic Viability of Inter-Modal Truck-Rail Facilities in Washington State

WA-RD 605.1

Research Report
December 2004

Washington State Department of Transportation

Washington State Transportation Commission
Planning and Capital Program Management
in cooperation with:
U.S. DOT - Federal Highway Administration

Research Report

DETERMINING THE POTENTIAL ECONOMIC VIABILITY OF INTER-MODAL TRUCK-RAIL FACILITIES IN WASHINGTON STATE

By

Dr. Ken Casavant
Professor

Dr. Eric Jessup
Assistant Professor

Angelica Monet
Research Assistant

School of Economic Sciences
Washington State University
Pullman, Washington, 99164-6210

Prepared for

Washington State Transportation Commission,
Washington State Department of Transportation
in cooperation with
U.S. Department of Transportation
Federal Highway Administration
December 2004

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Transportation Commission, Washington State Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification or regulation. The authors would like to express their appreciation to Kirk Fredrickson and Doug Brodin of the Washington Department of Transportation for their helpful reviews. As usual, any errors remain the responsibility of the authors.

TABLE OF CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Problem Statement

Efficient freight mobility is the result of successfully balancing the demand for transportation capacity and service with the quantity supplied of those services and capacities. A growing number of communities and economic interests in the state of Washington recognize that efficient freight movement is directly associated with the health of their local and regional economies. As a result, state and local governments are being asked to improve freight mobility through operational improvements and new public infrastructure. Inter-modal truck-rail facilities, where goods are transferred from truck to rail or vice-versa, for shipment to domestic markets or through gateways to international markets, are offered, or sought, as a means of improving the freight movement in the area.

Proposed public investment in such inter-modal facilities raises at least two questions: Will the facility succeed in the private market place by generating a sustaining return as a commercial investment? And, is any public investment justified based on the public benefits involved? It is the combination of internal efficiencies and external competition that will affect the economic viability of the inter-modal facility itself. A great deal of information and analysis is needed to identify these necessary attributes and those operating characteristics that "would or could" produce private economic viability and, if necessary, a required rate of return on public investment.

The general purpose of this research was to investigate and develop an applied methodology for determining the potential economic viability of inter-modal truck-rail facilities in Washington State. The focus was on discerning the attributes, characteristics or market situations that are associated with successful projects, thereby suggesting a framework for economic feasibility analysis of an inter-modal truck-rail facility.

Specific objectives were to:

I. Describe the role of inter-modal truck-rail facilities in an overall transportation system context, both conceptually and from the current literature.

II. Inventory identified or potential factors, both public and private, that can contribute to, cause or guarantee economic viability of an inter-modal facility.

III. Determine which potential attributes are capable of being analyzed in a review of the literature or series of case studies.

IV. Develop a set of case studies/models that detail the application of these attributes in an applied setting.

V. Identify those attributes that are most practical and productive in each of the case studies/models.

VI. Recommend a process that incorporates those attributes into evaluation of investment alternatives.

SELECTED WORK TASKS/METHODOLODY

The overall methodology was to examine as many existing inter-modal centers, ports or trans-load centers as time and public information allowed, searching for the functions performed and the attributes of each facility or port that contribute to the competitiveness of that facility.

REPORT ORGANIZATION

This report is organized in the following fashion. A conceptual approach and general model of investigation is first developed. The conceptual approach looks at the rationale for inter-modal shipments, as well as the inherent economies and the role of the inter-modal facility in that movement. Then the conceptual relationship between volume, as an indicator of profit and therefore long-term viability, and various attributes or characteristics of inter-modal facilities of various types is presented.

A focused review of literature is used to provide perspective of varying characteristics and analysis that has been done on the subject. The review includes some general popular literature, for its information on the current issues and the policy issues currently being debated. The research available from governmental and institutional sources, written mainly for academia and industry, is then evaluated.

A presentation of various inter-modal facilities and activities is presented, with a broad review of many facilities and undertakings, varying from port activities to broader movement efforts to agricultural gathering facilities. From this review and evaluative analysis a series of case studies/models is presented that appears most relevant to the state of Washington and its surrounding states. These are chosen as examples of facilities performing differing functions in the overall supply chain for exports and imports. These are then combined with the list of attributes that are useful, even critical, to prioritize the attributes for each of the facility types and functions. These then lead to conclusions and implications of the study.

FINDINGS

Case Studies/Models of Relevance to Washington

The reviews, in this methodology, were used to inform and structure a series of case studies/models of the type of situations found particularly relevant to the state of Washington. Underlying these models was an evident need for basic infrastructure, fluid capacity and tight linkage between ports, modes and distribution/origination centers. The three models were chosen to reflect the current practices in the state, the known commodity flow and the available mode infrastructure serving the consumers and producers of the state.

These case study/models were:

- **Agricultural Gathering and Assembly**
- **Port Clearing Inland Terminal**
- **Inter-modal Distribution Center.**

The three case studies/models were then evaluated, with the use of the **Attribute Matrix** below**,** as to those attributes which are important to economic viability and how important was that attribute to the three cases, evaluated as to “critical”, “necessary”, “contributory” and “not important”. This evaluation mechanism produced the findings of the study as to a methodology to determine probability of economic viability.

Attributes	Agricultural Assembly	Port Clearing	Distribution Center
1. Adequate Land / Space	A	A	A
2. Two Class I Railroads	C	B	C
3. Major Interstate Highway	C	B	A
4. Proximity to Population Center	X	B	B
5. Available Air and Water Transportation	X	A	B
6. On Nodes or Direct Line of Railroad Service	B	A	A
7. Public/Private Partnership	A	A	A
8. Magnitude of Public Participation	B	A	C
9. Positive Working Relationship with WSDOT and other Agencies	B	B	C
10. Need for Changing, Directing and Dividing Cargo	C	C	B
11. Clearly Established Demand Opportunities	A	B	C
12. Combination of Port and Distribution Efficiencies	X	A	B
13. Labor Availability and Training	C	B	C
14. Quality of Life	X	B	A
15. Distance to/from Production Points	A	C	B
16. Distance to/from Destination Market	B	B	A
17. Degree of Facility Automation	C	A	A
18. Time to Build	C	B	B
19. Capacity	B	A	A
20. Available Volume in Local Production Area	A	C	C
21. Commodity Mix	B	X	B
22. Ratio of Transport Rate to Value of Product	A	X	B
23. Tax and Zoning Incentives	C	B	A

The evaluation scheme is A = Critical, B = Necessary, C = Contributory and X = Not Important.

Five attributes were found to be critical to the **agricultural assembly** function. The *availability of adequate land/space* was critical in all case studies. *Proximity to the* *production area* was probably the most critical in this model. Other variables that were critical to this case were found to be *clearly established demand opportunities, ratio of transportation rate to the value of the product, and public/private partnership.* The only four attributes found not important for the agricultural gathering model were *proximity to population center, quality of life, combination of port and distribution efficiencies, and available air and water transportation.*

The larger, more complex model of a **port clearing inland terminal** has more attributes that were found to be critical to its success: *the availability of adequate land/space for the inland facility, the availability of air and water, the availability of direct rail service and the construction of adequate capacity in the inland terminal. The magnitude of public investment, the amount of automation and the level of distribution efficiencies* were also found critical. The only attributes that weren't found critical or necessary were the *commodity mix* and the *ratio of transportation rate to the value of the import cargo*. The other attributes received a contributory or necessary ranking.

The **Distribution center** has the most attributes established to be critical. Attributes not mentioned above that were critical in this situation were access *to interstate highway, the capacity of the facility, the distance to the distribution market, quality of life, expansion capacity and a good taxing/zoning incentive culture*. All of the attributes were found to have value to this type of inter-modal center, at least to varying degrees.

Public participation

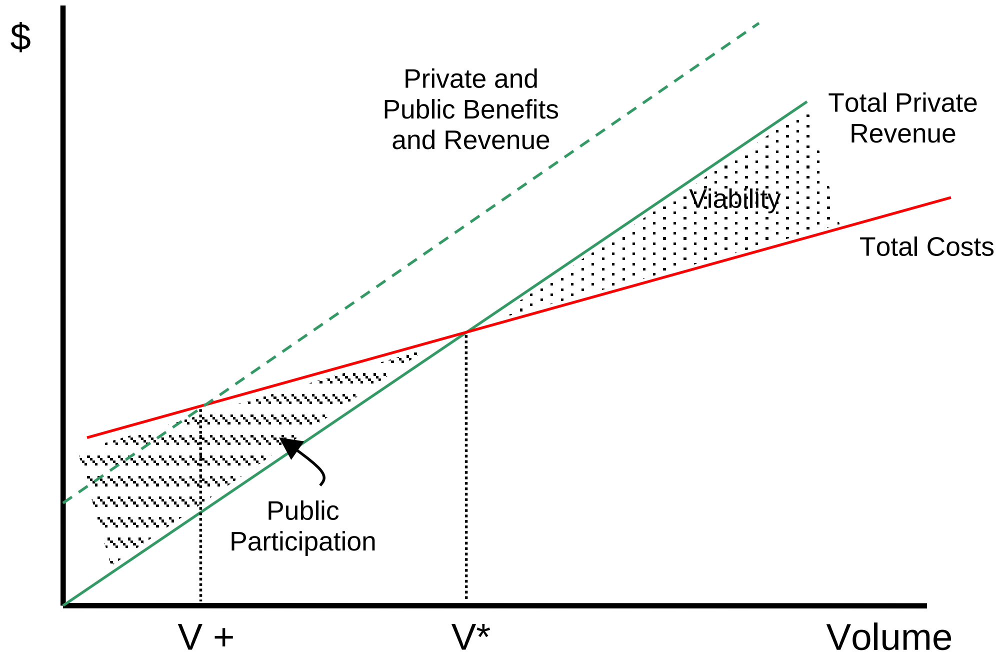
It was evident in all three of the models that some degree of public participation seems to be a positive attribute aiding economic viability. These benefits, quantified in numerous publications and studies, and in the review of inter-modal centers and ports, include the value of a reduction in highway congestion, air pollution, chances of accidents, fuel dependence, costs of maintaining and expanding the highways and a positive economic development. Figure 1 below indicates the relationship between private and public cost and benefits and how early public participation can lead to economic viability.

The availability of public investment can make these public benefits and the achievement of break even of revenues and costs for the private investment occur earlier in the time frame. The analysis revealed the efficacy of public investment when long term private investment may not be initially feasible. In some investments, the case for sustained public investment can be made because of the public benefits achieved.

These benefits, which are quantified in numerous publications and studies, include the value of reduced highway congestion, reduced air pollution, reduced chances of accidents, reduced fuel dependence, reduced cost of maintaining and expanding the highways and, of course, economic development. Existing budgets and proposed pro forma estimates indicate the common divergence between expected costs and revenues in the early stages of new investment projects, as illustrated below in Figure 1. Total costs, on a private basis, typically exceed total revenues up to some expected volume v* where break-even occurs and past which positive returns, again on a private basis, insure economic viability and success. However, the top dotted line indicates a magnitude of public benefits associated with the project which, when added to the private revenue, indicates that economic feasibility from society's point of view occurs far earlier, at v+. The amount of public participation to help the investment achieve long term viability is that area above the total cost line and below the revenue line, up till v*.

This simple diagram reveals the efficacy of public investment when long term private investment may be possible. In some investments, the case for sustained public investment can be made because of the public benefits achieved.   The volume of traffic achieved is the driver of private viability. If v* is not achieved, continued public participation may be necessary.

Conceptual Relationship between Private and Public Participation



Key Findings

Some policy and operational conclusions can be drawn from the reviews analyzed in this report.

- The most important element for assessing the viability of any inter-modal facility or location is the market and demand for inter-modal freight services moving through the area.

- The three models developed from the reviews reflect several of the current concerns for the state of Washington so they do serve as a useful analytical framework.

- The viability of the inter-modal centers increases when the traffic flow of the agricultural gathering model is combined with the port clearing model, generating back-hauls to each respective movement, generating a win-win-win for exporter, importer and the local community. Such facilities usually operate at an annual loss, with the expectation that, as the all-important volume grows, per unit costs will decrease while total revenue increases, bringing the enterprise to long-term viability. Development of these markets is not guaranteed and is not an easy undertaking, or the private market would have been doing so in the past.

- The list of attributes developed from the conceptual framework, the review of literature and the analytical review of inter-modal centers/facilities/ports seem to include the basic determinants of economic feasibility.

- The attributes vary by model and situation as to importance and even applicability. Each inter-modal center or project is independent in that the relevant attributes are site specific; thus the methodology developed in this report should be used carefully and with discretion.

- The availability and magnitude of public participation should be evaluated on the basis of public benefits produced by each individual project. Investment and support for infrastructure and operating environment by the recruiting communities becomes a major recruiting tool that allows attainment of the public benefits.

- The overall methodology of evaluating the appropriate attributes of each proposed facility or project to determine economic viability can inform private decision makers and the policy makers of the state of Washington.

STUDY PURPOSE AND ORGANIZATION

Problem Statement

Efficient freight mobility is the result of successfully balancing the demand for transportation capacity and service with the quantity supplied of those services and capacities. Attaining this balance requires accurate assessment of transportation demand, and the costs and productivity of transportation services supplied, in order to prioritize the provision of facilities and capacity to achieve efficient freight mobility. The need for prioritization arises particularly when funds are limited, requiring infrastructure investments be allocated to where the marginal returns of mobility are the highest. These economic truisms are as applicable to the public sector as they are to the private sector. However, public sector entities, unlike their private sector counterparts, often experience difficulty in determining the benefits that result from public investments in freight-related infrastructure and activities, in assessing the costs of providing those facilities and in determining the economic feasibility / viability of any infrastructure investment.

These facts are also important for the communities and economic interests of the state of Washington. A growing number of communities and economic interests in the state of Washington recognize that efficient freight movement is directly associated to the health of their local and regional economies. As a result, state and local governments are increasingly being asked to improve freight mobility through operational improvements and new public infrastructure. Inter-modal truck-rail facilities, where goods are transferred from truck to rail for shipment to domestic markets, or through gateways to international markets, are offered as a means of improving the efficiency of the freight movements in some marketing situations. Proposed public investment in such inter-modal facilities raises at least two questions: Will the facility succeed in the private market place by generating a sustaining return as a commercial investment? And, is any public investment justified based on the public benefits produced?

Many variables, associated with the demand for such a facility and related infrastructure costs and the functions of such a facility, are unknown and are associated with a high degree of risk and uncertainty. In the state of Washington various projects have been offered, evaluated and are on hold in the state; current evaluations of potential economic viability and the degree of public benefits reflect the level of uncertainty that exists. Numerous inter-modal centers and facilities throughout the nation and world offer indications of how best to narrow the uncertainty and evaluate market opportunities.

It is reasonable that inter-modal facilities receive some attention as loci of potential investments. Inter-modal transportation is often defined as the concept of transporting passengers and freight on two or more different modes in such a way that all parts of the transportation process are efficiently connected and coordinated. When examining freight mobility specifically, inter-modal transportation allows the inherent efficiencies of each mode to be realized, while capacity problems in differing links or segments of the system are minimized. Trucks, with low costs of assembly and collection, but relatively higher costs of long haul movement, are combined with railroads, with their high terminal costs but low volume and long distance costs. Such inter-modal movements, and achieving the potential efficiencies of such movements, are dependant on the structure, location and effectiveness of the inter-modal transfer facility. Achieving the efficiencies of inter-modal exchange is tempered heavily by the location of the transfer facility, the modes and their access to the facility, and the commodities and their flow to be handled at the facility.

The overall effectiveness and service quality of the facility in aiding the inter-modal movements in turn affects the facility's economic viability. Such effectiveness is reflected in transfers that are coordinated, seamless, flexible and continuous. An inter-modal movement requires a system of logical linkages, handled as one continuous through-shipment under the authority of a single freight bill. One challenge of inter-modality is to keep the goods moving by reducing delay when a transfer is made from one mode to another. Pundits have described this as a form of warehousing at "zero miles per hour". If the movement of goods is stalled for any length of time during transport or at modal interchange points, it is often referred to warehousing and not inter-modality. This definition continues to evolve and the terms, trans-loading, cross-dock, inventory control, just-in-time distribution, etc., suggest a more complete service function, than just physical movement that may incorporate the benefits of inter-modal movement. Most definitions of inter-modal seem to be focused on containerization solely, which may overlook the efficiencies of the warehousing/movement function, and limit the potential opportunities for the complete inter-modal concept. Just because a shipment is stored, inventoried, repackaged, etc. doesn't negate the value of the inter-modal movement. The "logistics hubs" of BNSF are one means of utilizing trans-loading as well as in-out movements, with the goal of attracting warehousing, distribution or manufacturing companies and traffic.

As the gateways to an increasingly global market, transportation corridors are the arteries through which all domestic (U.S. and the state of Washington) consumption flows. Transportation networks stimulate trillions of dollars in trade, commerce, and even tourism. In the global economy, they enable specialization in the production of goods and services, which, under the law of comparative advantage, stimulates broader economic growth. Increases in efficiency, if achieved from improved inter-modal transportation, aid in that growth.

The benefits of such movements has led to calls for unified national transport policy supporting inter-modal growth, otherwise the lack of a unified view could create a roadblock to greater efficiency and coordination that would foster even greater inter-modal growth. Railroads are working at the local level with trucking partners, 3PL's, Metropolitan Planning Organizations (MPO) to increase the overall expertise in freight planning, strategic activities that recognize the inherent efficiencies of inter-modal movements. Recent inter-modal records in revenues have led to expected record profits as well. Such economic returns are expected to generate interest in development of more facilities and more economically successful facilities.

Dependence on the new inter-modal efficiencies means that the system then becomes vulnerable when one part of the supply chain is impeded or breaks down. Recent drayage truck driver strikes reveal the benefits of having alternative choices in the supply chain. Inter-modal facilities with multi-modes available offer some of that flexibility and reliability.

Related is a specific form of inter-modal shipment, the advent of large distribution centers that are operated by private firms for themselves and their own product lines as a means of controlling their supply chain cost and performance. Location, location, and location seem to drive the operational profitability of these centers. Choosing a site depends in large measure on the service and function that the warehouse or distribution center will provide. Traffic patterns, an available labor pool and a solid transportation network are keys in site selection. Although having a distribution center or warehouse near major markets is an advantage, the associated traffic and congestion is not. The trend is to have a major facility that can handle everything, with smaller, regional facilities for quick turn products, resulting in fewer but larger centers, like Ford Motor Co. Many companies prefer sites with easy truck and interstate access, especially for just-in-time operations.

From the public point of view, selected use of the rail movement has the possibilities of decreasing highway congestion, road damage and maintenance and increasing air quality, safety and energy efficiency. Congestion in urban areas and intercity corridors is a growing concern. Truck traffic has become a significant contributor to road congestion. Further the issue of security is addressed when flow is enhanced, since when it is stopped, it is vulnerable to security breaches, and the populations surrounding the movements are affected. These public benefits are now being added to the private efficiencies acknowledged by most evaluators.

Again, such achieved efficiencies are, first, the means to providing desired service, but as importantly, are the means for the inter-modal transportation system to be able to compete against single modes. It is this combination of internal efficiencies and external competition that will affect the economic viability of the inter-modal transfer facility itself. A great deal of information and analysis is needed to identify these necessary attributes and those operating characteristics that “would or could” produce private economic viability and, if necessary, a required rate of return on public investment.

Project Purpose and Objectives

The general purpose of this research effort is to investigate and develop an applied methodology for determining the potential economic viability of inter-modal truck-rail facilities in Washington State. The focus will be on discerning the attributes, characteristics or market situations that are associated with successful projects, thereby suggesting a framework for economic feasibility of an inter-modal truck-rail facility. Underlying themes are to determine:

- *Current activities being produced by existing centers and facilities*
- *The economic and physical characteristics associated with these centers*
- *Attributes that determine or contribute to the economic feasibility and long-term economic viability*
- *Enumerate the public benefits associated with the inter-modal center activities*
- *The combination of private and public interests that support inter-modal center feasibility*

Specific objectives are to:

I. Describe the role of inter-modal truck-rail facilities in an overall transportation system context, both conceptually and from the current literature.

II. Inventory identified or potential factors, both public and private, that can contribute to, cause or guarantee economic viability of an inter-modal facility.

III. Determine which potential attributes are capable of being analyzed in a review of the literature or series of case studies.

IV. Develop a set of case studies/models that detail the application of these attributes in an applied setting.

V. Identify those attributes that are most practical and productive in each of the case studies/models.

VI. Recommend a process that incorporates those attributes into evaluation of investment alternatives.

Selected Work Tasks / Methodology

The overall methodology was to examine and inventory as many existing inter-modal centers, ports or trans-load centers as time and public information allowed, searching for the functions performed and the attributes of each facility or port that contribute to the competitiveness of that facility. Work tasks sequentially included:

I. Review state and national studies and academic literature on the conceptual role of inter-modal truck-rail facilities.

II. Develop a conceptual model detailing a list of attributes or operational characteristics that appear to be connected to economic feasibility of the facility.

III. Review the literature of published studies and analysis on inter-modal facilities.

IV. Review and summarize various current and past inter-modal facilities development and operation in the United States. Compare and contrast the functions and performance of the various centers, looking at size of facility and services provided.

V. Develop case studies/models that summarize the relevant types of possible facilities to be developed in the State of Washington.

VI. Draw from the attributes those that are applicable to each of the marketing situations/scenarios of the case study/models.

VII. Recommend applied methodology and attributes framework.

VIII. Prepare and write draft and final reports.

Report Organization

To achieve the objectives identified above, and using the sequential work task output, this report is organized in the following fashion. A conceptual approach and general model of investigation is first developed. The conceptual approach first looks at the rationale for inter-modal shipments, the inherent economies and the role of the inter-modal facility in that movement. Then the conceptual relationship between volume, as an indicator of long-term viability, and various attributes or characteristics of inter-modal facilities of various types is presented.

A focused review of literature is used to provide perspective of varying characteristics and analysis that has been done on the subject. The review includes some general popular literature, for its information on the current issues and the policy issues currently being debated. The research available from governmental and institutional sources, written mainly for academia and industry, are then evaluated. The review of literature also includes some case studies that have been developed in the academic literature, including some cases from the governmental research.

A presentation of various inter-modal facilities and activities is then presented, with a broad review of many facilities and undertakings, varying from port activities to broader movement efforts to agricultural gathering facilities. This includes in-depth review of operating characteristics, functions and performance of several of the most interesting and informative projects.

From this review and evaluative analysis a series of case studies/models is presented that appear most relevant to the state of Washington and its surrounding states. These are chosen as examples of facilities performing differing functions in the overall supply chain for exports and imports. These are then combined with the list of attributes that are useful, even critical, to prioritize the attributes for each of the facility types and functions. These then lead to conclusions and implications of the study.

CONCEPTUAL APPROACH

Any examination of the efficiency and performance of inter-modal movements primarily emphasizes the cost characteristics of the modes involved in that movement. That is appropriate because without judicious use of the alternative efficiencies, the entire concept of inter-modal movement breaks down. But, not as much attention has been paid to the transfer point between those modes, the inter-modal center. This center may include a small loading or unloading ramp in the country, a more substantial building and billing facility in the area or as elaborate as the multi-modal and high capacity ports in the United State or the world. Some one or entity has to provide the critical linkage between water and rail, rail and truck, truck and water, air and other modes, etc. for the inter-modal movements to be a sustaining real world success.

The growth in volume of inter-modal transportation traffic is by now conventional wisdom. Focused in recent years on the benefits of containerization and double stacking of such containers, the early life saw water movements met by rail and by truck in a freight-staging role. Shipments through the transfer facility weren't the seamless movement envisioned in today's transportation but did offer the basic functions. Now, with just-in-time and off-the-shelf inventory control by firms the use of containers and inter-modal movements has proven critical. But, the availability or lack of availability of the transfer or inter-modal facilities could be an effective chokepoint, increasing costs to existing markets and constraining access to new potential markets. It may be that for international trade to continue to be a current and growing success story, a similar inter-modal success story has to be seen.

The feasibility and viability of an inter-modal facility relies on the ability of that facility to provide a service at a price that generates a Return on Investment (ROI) or Internal Rate of Return (IRR) that will maintain business activities and warrant continued renovation and reinvestment. Corporate commercial firms demand an IRR that compete both with cost of capital and the alternative returns on that capital. The "bottom line", or net profit every accounting period is directly dependent on the ratio of revenue to costs.
Costs often necessarily considered involve development, design, construction, maintenance, rehabilitation, marketing and service programs, among others. Notable is the large economies of utilization available in such facilities, almost irrespective of the size of the project. The larger volume put into and through the facility, the lower per unit costs of handling.

Similarly, revenue, the other half of the ratio determining net profits, is directly related to the per unit rate (handling, storage, etc.) charged for the service. The greater the volume of the throughput, the greater the total revenue for the accounting period for any chosen rate level. These two points are so important. They need to be put in the executive summary and they get at our comments regarding competitive rates.

But, the simple accounting equation that determines feasibility and viability can also vary depending on whether it is examined on a private commercial basis or a private/public partnership basis. Associated with the private decision of decreased shipping costs by shippers using inter-modal transportation are public benefits, benefits that occur outside of the private commercial perspective but are real benefits in any case. These benefits, mentioned earlier in this report include reduction in congestion, decrease in road deterioration and consumption, decrease in pollutant emissions, decrease in traffic fatalities and incidents, decrease in energy consumption, etc. These benefits bring forth the possibility and rationale for public participation in provision of inter-modal facilities.

Such public investments condition both the costs and revenue of the facility operator. Development and construction costs can be lessened, rates then decreased, and then, in response to the lower rates, increased volume may be realized. Volume, as indicated earlier, affects both sides of the profit equation, costs and revenues. As such, volume through a facility is one indicator of past and potential success and competitiveness.

Thus, it is important to examine the relationship of volume through a facility to the attributes that characterize that facility. These attributes condition the ability of that facility to offer a price-product combination for competitive edge and marketing niche success. It is these attributes that affect the supply costs for the facility, the nature and magnitude of demand for the product being offered and ultimately, feasibility as determined by the ROI and IRR. The importance of each of the many attributes can vary by the situational position and structure of the inter-modal center or facility.

In those attributes are characteristics revealing the degree of public participation in the cost or revenue side of the equation. Marginal or negative returns can be enhanced and significantly changed by public participation as a result of the provision of public benefits. These private/public partnerships may well be the staircase leading to long-term viability. However, even in a public/private partnership certain attributes serve to distinguish the probability of success among alternative investments, by either private or public entities

Conceptually, the following approach is used in this study to evaluate variables (attributes) that are related to the economic viability of inter-modal facilities (which has been shown above to affect both cost and revenue). Essentially, the process is to determine the functional relationship, as information allows, between the dependent variable of economic viability (or such surrogates as profit, cost or revenue per shipment, overall efficiency, etc.), and other relevant variables.

Generally, this relationship can be stated as:

$$Economic\ Viability = f\ (x_i\ )$$

Where economic viability is some function *f*, which is influenced by a vector of attributes or variables denoted (x_i). Each of these attributes, many of which are correlated or a function of other variables, has some measurable impact on the operational success and economic viability of the inter-modal facility. These variables are provided below in Table 1.

Table 1: Conceptual Model and Variable Selection

Dependent Variable EV	**Independent Variables** x_i	**Marginal Change in Economic Viability** $\frac{\partial EV}{\partial x_i}$
Economic Viability • Profit Per Unit • Operational Efficiency - Cost	Ownership Type	+
	Access to Modes	+
	Capacity	+
	Distance to/from Supply Markets	+/-
	Distance to/from Destination Markets	+/-
	Commodity Mix	+/-
	Ratio of Transportation Rate to Commodity Value	+/-
	Time to Build	-
	Degree of Automation	+
	Labor Availability	+
	Labor Cost	-
	Tax / Zoning Incentives	+
	Available Land / Space	+

The evaluation scheme is A = Critical, B = Necessary, C = Contributory and X = Not Important.

Dependent Variables

As a surrogate for, or in conjunction with, economic viability, the variables of *profit, cost per shipment and an efficiency measure* are all possible choices for the dependent variable in the conceptual model. The primary obstacle with these choices is in obtaining adequate data and informational observation. Also, cost per shipment and efficiency may bias the model toward large-scale operations that focus primarily on low-cost/high volume commodity goods such as agricultural produce, to the exclusion of higher-cost/lower volume consumer goods such as automobiles and consumer electronics.

Independent Variables (Attributes)

Ownership Type

The type of ownership certainly influences success and economic viability of any proposed inter-modal facility and accounts for the ownership/operational structure of the proposed facility, such as a public entity, private/public partnerships, separate private company, or a joint venture between various private entities such as railroads, shippers, logistics companies, etc. The impact on the dependent variable may not be clear and may be more of a qualitative relationship, as is presented in this study. However, one would generally expect that the marginal relationship between ownership type and performance of the inter-modal facility would be positively related, especially with respect to increased participation from public and private agencies as greater diversification of risk/reward with public/private partnerships. Depending on the decision of which dependent variable is used, and an examination of other inter-modal facilities, the analysis may provide an estimation of the performance characteristics of different ownership structures that would be valuable in examining attributes.

Access to Modes

Access to other modes is actually a series of variables related to measures of time, distance and flow capacity on different transportation modes that would be in near proximity or on-site. Examples would include: distance to the highway (and highway type), railroad spur, navigable river, air terminal, the transit time(s) to such destinations and the flow capacity of such modes. Also, the availability of rolling stock on each of the modes influences access and economic viability. Generally, as access to alternative modes increases, operational efficiency improves and the likelihood of economic viability becomes greater. Thus the marginal relationship between modal access and economic viability is positive.

Capacity

A somewhat related measure of access to modes, this variable directly measures the volume capacity and size of the facility. Measures may include length of track, number of loading docks, railcar loads that could be processed, tons shipped, containers lifted, or some other physical category of throughput potential. Economies of size would suggest that the marginal relationship between capacity and economic viability is positively related, as long as the capacity is utilized. Costs per unit moved declines as facility size (throughput volume) increases.

Distance to/from Supply (production) / Destination (consumption) Market

These two variables measure the distance to markets for products and commodities that are handled by the facility. It is not intuitively clear whether the marginal relationship between distance (production and consumption) and economic viability is positive or inversely related. As the absolute distance between supply markets and consumption markets decreases, the need for inter-modal transportation declines, ceteris paribus. The type of function (collection/assembly or distribution) being served at the inter-modal facility will influence the relationship between distance to/from markets and economic viability. Regardless, this requires some knowledge of the commodity mix, in order to ascertain the supply and consumer markets.

Commodity Mix

This would account for the mix of commodities and products that would most likely be serviced by the inter-modal facility. Associated market channels would have to be determined to ascertain competitive market structure. Again, the marginal relationship between number of commodities handled at the facility and economic viability is not certain. A facility that specializes in one or two commodities may gain considerable efficiencies per unit handled, especially for bulk agricultural products but the risk of being directly linked to only one or two product markets may be quite high as supply/demand conditions for those products change. A more diversified flow of products may involve higher transfer or handling costs but lower economic risk.

Relationship of Transport Rate to Product Price

This variable captures the transport cost associated with commodities or products moving through the facility in relation to the final product price or value. Obtaining data related to transport costs and final product prices would be necessary for this variable and may prove difficult. Specifying the expected marginal relationship between this variable and economic viability is difficult due to the variety of factors that influence the product price and the transportation rate. In certain cases, higher valued products rely less on the gained efficiencies from inter-modal transport as opposed to lower valued bulk commodities but not in all cases.

Time to Build

This is the time and complexity in building and constructing the facility. This may be necessarily coupled with a discount rate, time preference, IRR or ROI or some other choice variable in the model. In general, one would expect this variable to be inversely related to economic viability.

Degree of Automation / Labor Availability and Cost

These variables measure the labor/capital mix needed to operate the facility at capacity by determining the local labor force availability (and cost) and the capital/technology requirements of the facility. One would expect that the degree of automation and labor availability are positively related to economic viability. However, labor cost (which is related to labor availability) is inversely related to economic viability.

Tax / Zoning Incentives / Land Availability

This is another array of measures relating to public participation through changes in zoning requirements or tax incentives to facilitate construction of the inter-modal facility. Each of these variables is positively related to economic viability.

The above examples of attributes, presented in functional relationships as explanatory variables, are a general presentation of the conceptual approach used in this study. Volume affects both the revenue and cost sides of the profit equation and the degree of public and private benefits and costs, and attendant participation/investment. The following review of the literature and the numerous case studies presented in varying detail will develop other and, in some cases, more relevant attributes. Then, these will be applied to the case studies/models developed from that same review of literature and empirical case studies.

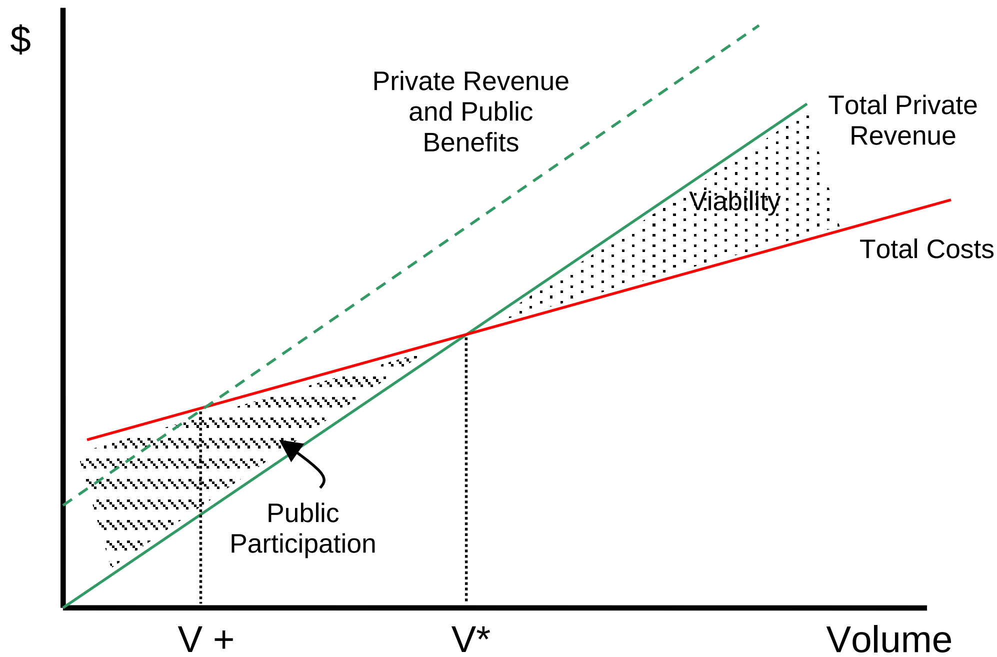
Public Funding Participation

As will be evident in all three of the subsequent case study/models, some degree of public funding participation appears to be a positive attribute aiding economic viability. This activity reflects the desire of development agencies, cities, and ports for economic growth and an understanding of the importance of inter-modal transportation in that growth. Specifically, public benefits arise outside of the private investment decisions associated with development of an inter-modal facility. Removal of some traffic from road to rail offers a series of benefits that can be summarized here.

These benefits, which are quantified in numerous publications and studies, include the value of reduced highway congestion, reduced air pollution, reduced chances of accidents, reduced fuel dependence, reduced cost of maintaining and expanding the highways and, of course, economic development. Existing budgets and proposed pro forma estimates indicate the common divergence between expected costs and revenues in the early stages of new investment projects, as illustrated below in Figure 1. Total costs, on a private basis, typically exceed total revenues up to some expected volume v* where break-even occurs and past which positive returns, again on a private basis, insure economic viability and success. However, the top dotted line indicates a magnitude of public benefits associated with the project which, when added to the private revenue, indicates that economic feasibility from societies point of view occurs far earlier, at v+. The amount of public participation to help the investment achieve long term viability is that area above the total cost line and below the revenue line, up till v*. If the traffic level of v* isn't reached, public participation may need to be continued.

This simple diagram reveals the efficacy of public investment when long term private investment may be possible. In some investments, the case for sustained public investment can be made because of the public benefits achieved.

Figure 1: Conceptual Relationship between Private and Public Participation



LITERATURE REVIEW OF ACADEMIC AND PUBLIC INFORMATION

This literature review comprises four components, as outlined below:

- A description of the type of literature reviewed;
- An overview of literature related to defining inter-modal shipments;
- An overview and evaluation of literature related to inter-modal benefits and feasibility characteristics. A summary of findings uses key themes in potential economic viability of inter-modal facilities;
- Previous study methodologies and commentary on these methods; commentary on existing methods that have been used in research studies, with their corresponding recommendations for future enhancement;

Literature Reviewed:

There is a continual challenge for inter-modal operators/owners to be efficient while meeting shipper/receiver demands and maintaining an adequate return on investment. Determining these precise operational and investment needs is not often easy, and varies by facility, location and commodities moving through the inter-modal facility. Even though different types of organizations, facilities or locations have different functions or services provided, many common or shared characteristics influence economic viability. This report specifically addresses inter-modal facilities and locations. However, given the considerable breadth of literature and data, many types of literature were reviewed for this study but a focused core is presented here. Most literature is recent, but some older literature was reviewed for currently relevant material. The general sources of literature and information for this review include the following:

- magazine articles
- newspaper articles
- government research
- institutional research (e.g. non-governmental agencies)
- academic research
- industry conference topics
- improvement studies
- feasibility studies

- case studies
- transportation planning reports

Defining Inter-Modal:

The purpose of this study is to develop a methodology for determining the potential economic viability of inter-modal truck-rail facilities in Washington State. An initial review of how “inter-modal” is defined was necessary for guiding the focus of this literature review and its ultimate result.

Inter-modal transportation is defined as the combination of two or more modes of transportation to move a shipment from its origin to its destination, while combining the advantages of each mode used (Ozment). Additionally, some authors define inter-modal within narrower bounds upon which specific studies may be tailored. For example, the “Louisiana Statewide Inter-modal Plan: Working Paper on Water, Rail and Inter-modal Freight Transportation”, by the National Ports and Waterways Institute and Louisiana State University, narrows their scope specifically to “inter-modal connections” between marine and rail transportation, which emphasizes transshipment facilities where inter-modal transfers occur, which mostly take place at ports and rail-highway terminals.

This usage is also similar to the Oregon Department of Transportation’s Planning Section of the Transportation Development Branch in their “Inter-modal Connector Needs on the National Highway System: Procedure for Estimating Needs”. Their definition includes public passenger transportation, but limit inter-modal connectors to local roads, not state highway, which falls under the Highway Plan for modernization, preservation, bridge, and safety needs. Since the focus of this study is mostly rail-highway inter-modal facilities, the report focuses on highways, and not passenger transportation. From the above, “Inter-modal” is addressed in specific terms, yet, in some definitions, are general enough for additional specificity. For instance, by combining the advantages of each mode use, defining, limiting, or addressing “advantages” is useful for the purpose of this study in determining the potential economic viability of inter-modal facilities. These advantages are explored in the following sections.

It is useful to add another dimension to the definition of inter-modal freight. Not only is defining inter-modal important, but more accurately defining “inter-modal feasibility” is equally important. In addition to the “two or more modes” definition, for purposes of our research and literature review, it is also critical to add that “inter-modal feasibility” includes encouraging and continuing to support industries to use the facility for a long period of time. This added dimension will not occur unless the companies that use the inter-modal facilities find the facilities to be efficient &/or effective for their operations, the focus of the following section.

Related Academic Research

A rich and varied literature has evolved addressing freight inter-modal issues related to infrastructure investment, site location, system-wide operational efficiency and economic viability. The combination of the recent growth in inter-modal freight traffic and the complexity of economic and efficiency issues related to functions performed, services offered and the demand for transportation join to cultivate a plethora of academic research paths and foci. A wide body of the technical literature is devoted to the development of network models for use in estimating transportation freight systems that shed light on the interactions between different variables throughout the network and the overall network performance. While the focus of this research effort is not on developing improved estimation and modeling techniques per se, valuable information may be gained from evaluating different freight modeling and estimation approaches and the types of variables, which have been utilized toward these efforts.

Recent efforts and contributions for modeling intercity freight movements have incorporated system-wide equilibrium models, most notably the freight network equilibrium model (FNEM) (Friesz et al.,1986). This modeling approach incorporated the decisions and interactions between shippers and carriers in the determination of how, where and when cargo is moved, utilizing a two-stage sequential model formulation. Improvements upon FNEM have allowed for simultaneous solutions over the two-stage sequential approach, including the multi-mode multi-product network assignment model for strategic planning of freight flows (STAN) (Guelat, et al. 1990). Whereas the STAN network model only captures carrier decisions, the variational inequality network equilibrium (VINE) approach incorporates both shipper and carrier interactions in a full multi-modal supply-demand freight equilibrium model (Fernadez, et al. 2003). Each of these successive modeling advances have contributed to the empirical understanding of strategic assignment models, but more importantly help specify the importance and contribution between interacting forces, namely shipper and carrier.

The importance of location decisions and incorporation of multi-objective optimization functions for identifying optimum network configuration. The VINE model defines movements by optimizing over mode, carrier, transfer (inter-modal) points and travel time. Thus, the simultaneity and interdependent relationship between shipper (demand for transportation service) and the carrier (supply of transportation service) are mathematically formulated and empirically estimated. The “chicken and egg” paradox exemplified from these modeling efforts highlights how the demand for an inter-modal facility at a given point or location is largely dependent upon the demand for inter-modal shipments expressed by shippers as they seek to maximize their individual service (or minimize cost) optimization problem. The level of service that may be provided at a given inter-modal facility is largely dependent upon the inter-modal demand or volume moving through the facility as expressed by shippers and the attainment of economies of size.

Other research efforts have focused on the attributes or characteristics which influence operational or logistical efficiency for inter-modal facilities and alternative inter-modal terminal designs which improve transportation efficiencies. Site specific characteristics such as the spatial relationship between inter-modal terminal and production / consumption centers, the existence and proximity of competing terminals, and access to existing transportation infrastructure have been empirically considered (Ballis and Golias, 2002). By identifying site specific characteristics of inter-modal terminals and incorporating a combined simulation and cost-calculation module, Ballis and Golias develop a series of cost-versus-volume relationships that detail the importance of terminal layout, length of rail sidings, amount of storage, loading and driving lanes for trucks, stacking capacity and personnel requirements at different expected cargo volumes. The incorporation of expected investment dollars with facility volume expectations advances the thought of some minimum volume threshold for inter-modal facilities below which investment would not occur.

The role and influence of different ownership structures for large container terminals and how these different types of ownership impact efficiency have also been assessed (Cullinane et al. 2002). This analysis evaluates a spectrum of container terminal ports and their ownership structure ranging from entirely public to completely private by categorizing different port functions and the type of ownership performing these functions. A combination of cross-sectional and panel data is used to evaluate relative efficiency for different ownership structures. The data is collected from container terminal ports in Asia and therefore not exactly comparable to conditions in Washington State given the preponderance of state owned and operated terminals in Asia. But the results of their analyses do shed some light on the impact of terminal ownership and the importance of facility size. Variables captured in the model include site and facility attributes in addition to cargo handling equipment such as gantry cranes. It is interesting to note Cullinane et al. indicated that 42% of port terminal expenditures are for capital (buildings and equipment) while 43% is attributed to labor. Their research concluded that, as port terminal facilities become more privatized, the operational efficiency of the facility improves. Likewise, as the size of the port terminal increases, productivity and efficiency improves. The existence of first-mover advantage also seems important in influencing operational efficiency. Large terminal ports which are established first are better able to develop stronger market positions leading to dominant market behavior that limits subsequent entry from competitors.

The mix of commodity types and the value of inter-modal cargo play an important role in the demand for inter-modal movements and the facilities that support these movements (Oum, 1979). This has lead to several studies focusing on inter-modal and multi-modal freight transportation demand which account for cargo commodities separately in the demand model by assigning cargo into unique commodity categories (Buethe et al. 2001). Shippers of high-value commodities are more likely to incorporate speed and reliability into the transportation decision as opposed to shippers of low-value commodities and the interaction of commodity value and shipping distance combine to influence the demand for inter-modal loading / transloading facilities. The incentive to utilize rail for the long-range efficiencies associated with this mode increase with distance while the demand for truck movements decline.

The location decision associated with where to develop inter-modal infrastructure and facilities has also been a focus of academic literature, primarily modeled from the firm's perspective of minimizing capital outlay in terms construction cost while maximizing expected inter-modal demand or throughput volume. The location decision is considered to be a simultaneous systems process involving among other variables, distance, access, transshipment costs, efficiency, flow volumes and pricing (Pierre et al. 2004). One common difficulty with this type of network analysis and application of location theory is the enormous number of decision variables and potentially limitless number of origin-destination pairings for freight flows into and out of the facility. Pierre et al. present a means for placing realistic bounds on these decision variables and origin-destination pairings. The objective function to be minimized in these studies is total collection and assembly costs throughout the inter-modal network, including both fixed and variable transport costs (Nierat, 1997)(Melkote and Daskin 2001)(O'Kelly and Bryan 1998).

Other local and national studies have taken a broader perspective of the characteristics which lead to the operational success for an inter-modal facility and have evaluated a multitude of case studies involving different types of facilities providing inter-modal transportation service functions (Casgar et al. 2003). The "Rail Short Haul Inter-modal Corridor Case Studies: Industry Context and Issues" report conducted by the Foundation for Inter-modal Research and Education provided an evaluation of several short haul rail case studies. This study describes the growing need and demand for inter-modal movements as a result of the expanding global economy and growing congestion. The primary focus of the article is on inter-modal corridors, but provides suggested planning and financing models that are based largely on public / private partnerships. This evaluation and analysis also incorporates U.S. Department of Transportation and Federal Highway Administration Freight Analysis Framework Data for investigating private sector cost factors and public benefits.

The State of Washington/Port of Benton Hanford Investment study is one recent study investigating the possibility and feasibility of developing land transferred from the

Hanford Nuclear Reservation (HDR Engineering, 1999). Given the location and available rail tracks on the property, development of an inland port or inter-modal center was the basis for evaluation. Eight different U.S. inter-modal centers or inland ports were evaluated and analyzed to determine key drivers for success.

The combined review of literature reveals the complexity and interrelated issues associated with determining successful or economically viable inter-modal facility locations. The simultaneous relationship between inter-modal freight services offered, the rate for such services and the demand for inter-modal movements has been difficult to separate and evaluate. Also related is the type of commodities moving through the inter-modal facility, ownership structure (level of public participation) and the degree of competition for inter-modal services as illustrated by the first-mover advantage for inter-modal facilities initially developed and the degree of market power for being the first inter-modal facility.

Each of these factors will influence the success of the inter-modal facility, depending on the types of functions performed at the facility. These factors, identified as key drivers, are identified below in Figure 2, illustrating those attributes or aspects that are primary determinants of the inter-modal facility's success (NSW Sea Freight Council). The functions performed by the inter-modal facility may include:

- Place in Market
- Sustainable Business Entity
- Elements of the Supply Chain

The interaction between inter-modal services provided (supply) and the volume (demand) of inter-modal freight traffic are graphically illustrated in Figure 3. The needs and goals of the transportation company influence those advantages for using inter-modal services through such factors as costs, timeliness, reliability, etc., which in turn impact the demand for inter-modal service. The volume of demand then largely determines the appropriate investment size of the facility.

Figure 2: Key Drivers of a Sustainable Inter-Modal Facility

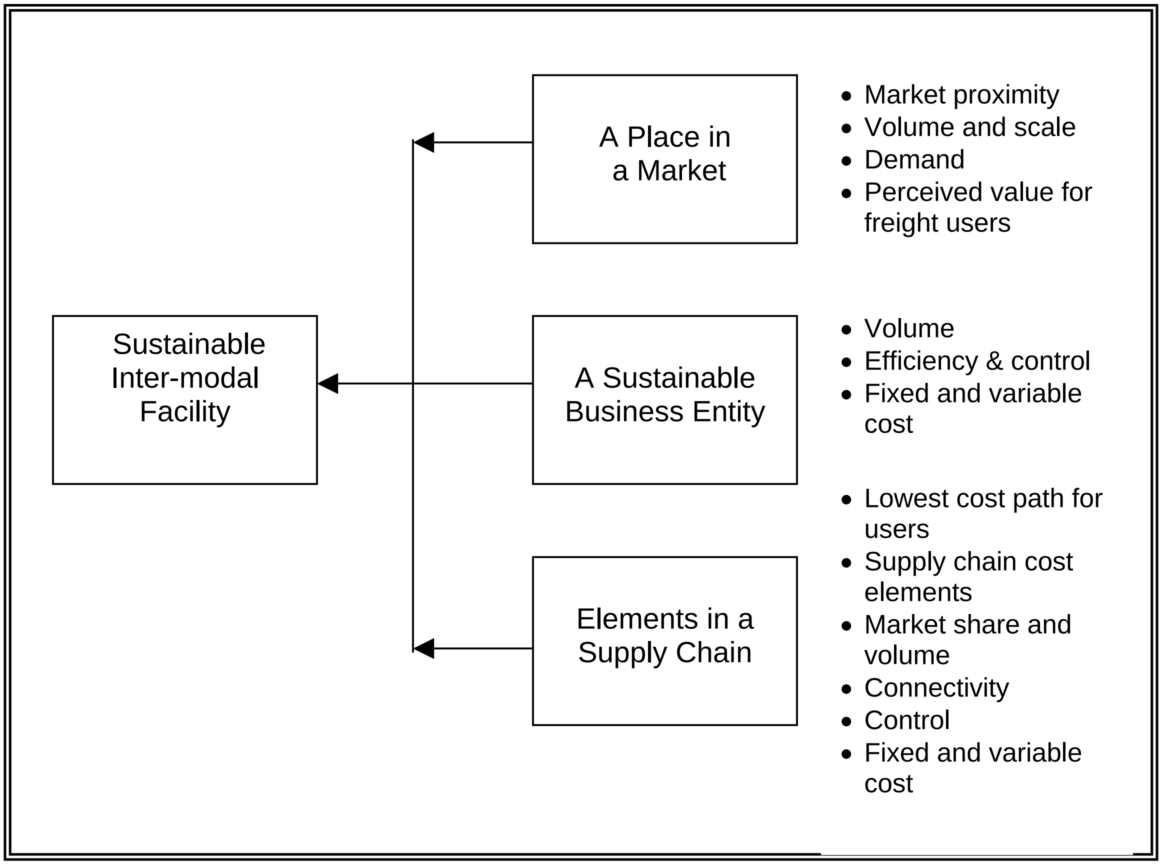
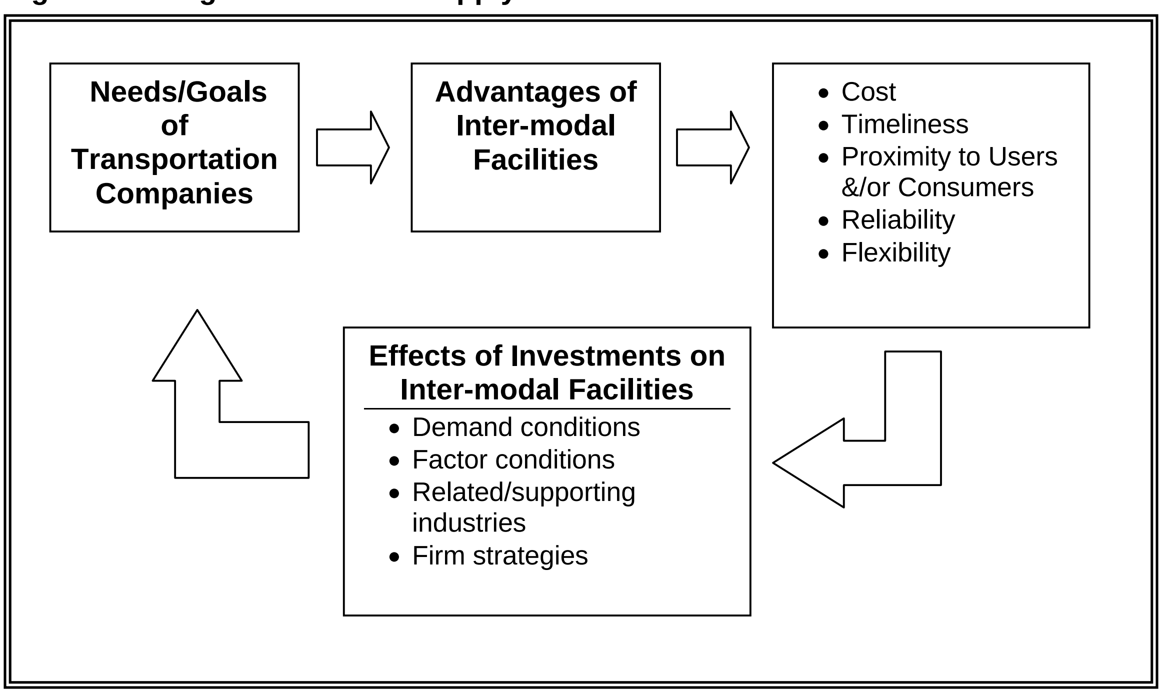


Figure 3: Freight Inter-Modal Supply / Demand Interaction



SELECTED INTER-MODAL PROJECT REVIEWS

The following selection of inter-modal centers, corridors and ports offer varying attributes and functions that have implications for feasibility and long term viability. Characteristics from the many other centers and ports reviewed in the course of this study, but not discussed below due to space limitations, are similar to those in this following review of projects, and in the list of attributes and case studies discussed later in this report. The reader is referred to the bibliography for specific sources on these and other port reviews.

Detailed information is presented on four of the larger inter-modal centers/ports to indicate the structure of such projects, the characteristics of large sites and the attributes that seem to suggest success. Various other smaller inter-modal centers, with varying degrees of development success, are presented in enough detail for the reader to identify the attributes available from each project.

Midway Hub Center (MHC), Minneapolis/ St. Paul

The earlier literature review indicated the importance of modal access. Within five miles of the MHC are two railroads (Burlington National Santa Fe and Canadian Pacific Railroad Service) and at least 7 main highway arteries, Interstates 394, 94, and 35, and Highways 65, 122, 280, and 36. Midway Hub Center is surrounded on four sides by four of these main arteries. To the north and south are Highway 36 and Interstate 94, respectively. To the east and west are Interstate 35 and Highway 280, respectively. Within this boxed region, the facility is in the southwest corner, near the Mississippi River waterway.

MHC is on the heavy marketing link between Chicago and the Pacific Northwest. Ninety percent of Burlington Northern Santa Fe's two million tons of inter-modal tonnage went through MHC, while the remaining 10% moved by truck. The mix of trailers and containers through MHC was 48% and 52%, respectively, reflecting the need to have capacity for both box types.

The facility has 52 acres of terminal working area, is open 24 hours per day on weekdays, and 18 hours over the weekend. It has 4 tracks inside the yard totaling

11,650 feet, as well as 2,600 feet of track on 4 storage tracks outside the yard. There are 45 weekly trains to be de-ramped and 55 trains to be ramped, of which 42% and 58% occur during noon and 6:00pm, respectively. The average length of train is 68 cars inbound from the west and 33 cars from the east, implying that there are about 100% more cars coming from the west than from the eastern area. The average length on outbound trains is 62 and 22 to the east and west, respectively. The higher number of trains from to the east reflects the apparent flow of goods as inbound from the west, to MHC, outbound to the east.

Based on the number of hours open, the throughput of rail goods, and the geographic area, the Midway Hub Center's most advantageous characteristics appears to be location to a significant portion of U.S. consumers and manufacturers, sufficient terminal access through available terminal hours, a sufficient number of ramp/de-ramp tracks with which to decrease dwell time, and a sufficient number of storage tracks which to have a relatively satisfactory amount of loaded cargo ready to be formed into a road train for departure.

Assuming a combination of double stack and standard equipment, daily loading volumes can exceed 1,000 units per day. This is based on three tracks for loading, an average turnover rate of two switches per day, and the availability of using tracks in each of two directions. If the tracks were switched a third time, track capacity can be increased.

The Midway Hub Center has 4 side-loading lift machines and eight hostling tractors to support its 100% non-grounded load/unload system mix, which are operated via wheeled chassis support. The facility relies exclusively on side-loaders, which are expected to handle 30 to 50 trailers per hour per side-loader. Based on these expected performance levels, in a scenario where 1,000 trailers/containers are handled in one 6-hour period during the peak time of 12 noon to 6pm, four side-loaders are necessary. This peak time handles 42% and 58% of the daily inbound and outbound volume, respectively. MHC handles over 200,000 loaded units per year, which may create a potential storage, track, and lift capacity issue during these peak hours of operation.

MHC is a 100% non-grounded, wheeled-chassis operation, in combination with its track and lift capacities, allowing the facility to have low dwell time and staging time during non-peak hours. Additionally, there appears to be more of an advanced staging or live lifting operations, and even cross-docking, thereby decreasing storage needs, during these non-peak times

The success and feasibility of this facility has been a cooperative and coordinated task between private and public sector organizations. Their goal is to give the region access to a network of efficient rail-highway container/trailer transportation, which will provide businesses with competitive charges and service arrangements for shipping and receiving through a rail-highway inter-modal facility. This network benefits consumers with competitive prices on most goods. To the extent that freight moves on rail rather than over the highway, all citizens benefit from improved environmental and highway safety conditions and taxpayers incur lower highway repair costs. Opportunities for public investment in rail inter-modal infrastructure provide a mechanism which may assure that the railroads will provide efficient services and competitive rates.

As mentioned above, MHC can easily handle off-peak volume. However, depending on peak-hour volume, capacity issues can arise. When volume increases, capacity will inevitably need to be addressed. In resolving future capacity constraints, MHC does not have the land in which to increase track capacity, in part because it is in a heavily populated, high cost, metropolitan area.

However, overhead gantry cranes can increase capacity by increasing trackside parking space, other parking space, and storage space. Also, the overhead cranes would allow a two-lane staging area of the chassis containers adjacent to the railcars for quick loading/unloading cycles without the subsequent use of hostling vehicles.

The Midway Hub Center is a rail-highway inter-modal center that focuses on transshipment functions. Its lack of land in which to expand is a constraint in the future. However, its apparent points of successful viability are its direct access to Class I railroads, its close access to many major arteries, the number of public and private organizations working together, and proximity to destination markets.

Shoreham Inter-modal Facility, Minneapolis, Minnesota

The Shoreham Inter-modal Facility (SIF) is in northeast Minneapolis, Minnesota. Because this facility is near the Midway Hub Center, its arteries and railroads are similar. Within five miles of the SIF are two railroads (Burlington Northern and Santa Fe Railway and Canadian Pacific Railroad Service) and at least 8 main highway arteries, Interstates 394, 694, 94, and 35, and State Highways 65, 122, 280, and 36. Shoreham is surrounded on four sides by four of these main arteries. To the north and south are Interstates 694 and 35, respectively. To the east and west are Interstates 35 and 94, respectively. Within this boxed region, the facility is west of the center, near the Mississippi River waterway.

SIF is on the main link between the areas of Chicago, Kansas City, northeast U.S. and Canada and the Twin Cities area of St. Paul and Minneapolis, Minnesota, including port facilities in Montreal. The facility has two areas that consist of the primary inter-modal operations area, but also has an adjacent container storage yard that is not reviewed in this report.

The facility has 36 acres of terminal working area, is open 18 hours per day on weekday, and 12 hours over the weekend. It has 2 tracks inside the yard totaling 3,830 feet, as well as 1,361 feet of track on 9 storage tracks outside the yard. There are 21 weekly trains to be de-ramped and 17 trains to be ramped, of which 67% occur during noon and 6:00pm for de-ramping. Of the three 6-hour time intervals that the facility is open during the week, the departing trains leave almost equally among those three intervals. The average length of train is 11 cars inbound from the west and 30 cars from the east. The average length on outbound trains is 37 to east. There are no outbound trains to the west, implying that there is a flow of goods from the east and being sent back towards the east. Additionally, the flow of goods indicates that there are local manufacturers that are using the SIF as either a distribution center or an initial inter-modal facility.

Based on the number of hours open, the direction of the flow of goods, and the geographic area, the Shoreham Inter-modal Facility's most advantageous characteristics appears to be location to a significant portion of U.S. consumers and manufacturers and a sufficient number of storage tracks allowing a relatively satisfactory amount of loaded cargo ready to be formed into a road train for departure.

Because there are only two tracks, the facility operates on a “one track/one staging area”. This allows one track to de-ramp an inbound train and then be ramped for the outbound trip. Unfortunately, because the train-sequencing schedule and the “short” track length, the loading/unloading and dwell times are significant. The timing is extremely tight between inbound unloading and outbound loading, especially when taking into account the one-track/one-staging area. The first inbound/outbound sequence has a sufficient 7 hour time availability before the second train arrives, after which there is 2 ½ hours to load and unload the second train. This small time interval with which to load and unload an average of 30 inbound cars per train and 37 outbound cars per train creates a holdup for the third incoming train. The third train has 4 ½ hours in which to be unloaded and loaded. Based on the two tracks, the number of trains, the number of cars per train, and the time sequencing, the facility has 8 to 10 switches per day.

The Shoreham Inter-modal Facility has three lifts and five hostling tractors to support its combination of grounded and non-grounded load/unload system mix. Given the same 30 to 50 cars per side-loader per hour performance level mentioned above in the Midway Hub Center review and analysis, the average length of cars per train of 30 inbound and 37 outbound from and to the east, suggest that the lift equipment is sufficient to handle current volume. SIF handles over 70,000 units per year, which may create an increased storage and track capacity issue, especially during the unload/loading of the second train. The dwell time ranges from 2 days for loaded trailers and 6 days for loaded containers.

Shoreham Inter-modal Facility has no reasonable way to operate an advanced staging area because of track and sequencing constraints. Additionally, this also creates significant dwell time and staging time issues. If these constrains can be addressed, the result could be a cost decrease or volume growth for the facility.
Cooperating private and public sector organizations simultaneously analyzed both the Midway Hub Center and the Shoreham Inter-modal Facility. Similar to the Midway Hub Center mentioned above, their goal is to give the region access to a network of efficient rail-highway container/trailer transportation, which will provide businesses with

competitive charges and service arrangements for shipping and receiving through a rail-highway inter-modal facility. This network benefits consumers with competitive prices on most goods. To the extent that freight moves on rail rather than over the highway, all citizens benefit from improved environmental and highway safety conditions and taxpayers incur lower highway repair costs. Opportunities for public investment in rail inter-modal infrastructure provide a mechanism for which to assure that the railroads will provide efficient services and competitive rates.

The dedicated schedules and rail sequencing is both helpful and constraining. It is helpful because the facility may have more incoming trains if they were not specifically scheduled, which could increase the capacity issues at the facility. However, the timing of the trains, especially the second one, holds up the third incoming train. Track length additionally limits the capacity of unload/load activities. Lastly, the number of tracks limits the possibility of trackside staging or pre-positioning empty containers for inbound unloading, all of which results in an increased amount of switching. In resolving future capacity constraints, SIF does not have the land in which to increase track capacity, in part and similar to Midway, because it is in a heavily populated, high cost, metropolitan area. However, adding a track would alleviate train loading/unloading operations. Additionally, increasing the distance between the two existing tracks, which are currently only four feet, would allow additional "temporary storage" space on which to work on trailers/containers before loading/unloading the trains. This would decrease the time needed for trains to be in the facility.

Port Inland Distribution Network (PIDN), New Jersey/New York

The Port of New York/New Jersey is the hub of an extensive inland transportation network connecting its marine terminals, via road and rail, to markets throughout the United States and Canada. It is an historical port but one that has developed active plans and action elements both in the port proper and in its hinterland. It is a good example of forward planning, technology improvements, massive investments and substantial private/public partnerships.

Its basic facilities are broad and extensive. Hundreds of trucking companies serve the port and it has multiple accesses to the Interstate System. Its development of SEALINK, a uniform truck driver identification system serves to speed trucks through the marine terminal gates, increasing the efficiency of moving thousands of containers each day to and from inland markets.

It is also served by more than a dozen rail terminals, and by three Class I railroads (the Canadian Pacific Railway, CSX and Norfolk Southern). ExpressRail, the Port Authority's on dock inter-modal rail terminal, provides daily double stack rail service to the markets in eastern U.S. and Canada. The initial service was on an ad hoc basis. But a new facility at the Howland Hook Marine Terminal and/or the Maher and APM terminals will essentially be ExpressRail II, providing permanent on dock movement and replacing thousands of truck movements through the dense New York traffic to markets.

The new entrance to this facility, for ExpressRail II, will allow uninterrupted rail access to the terminal and remove conflicts with truck traffic, improving drayage efficiency and easing traffic congestion throughout the Port Newark/Elizabeth marine Terminal complex. The terminal, to be located on a 70-acre site, will have the capacity to handle up to 1 million containers annually.

A new $ 72 million rail facility will be located on a 338 acre parcel of land, now owned by the Port Authority. Currently truck movements on the dock predominate. The Staten Island Railroad will also receive funding, restoring freight service between Staten Island and the national freight network in New Jersey.

Over $1 billion will be invested in enhancements to the port transportation system over the next five years. It is part of the investment strategy and port redevelopment program to deepen the harbor channels, expand marine terminal capacity and improve landside transportation connections, including rail investments like Staten Island. When completed next year, the Howland Hook rail facility will be able to handle approximately 250,000 containers a year.

The interesting part of this active port and inter-modal development is the breadth of the actors in the progress. For example, Port Elizabeth Terminal & Warehouse Corp has been providing public warehousing and transfer facilities for over 25 years. It offers access to over 80 steamship lines, immediate access to rail, road and air transportation but, quite notable, it offers the locational advantage of being able to legally transport heavyweight loads and containers to its facilities and trans-load them to legal weights for over the road deliveries, resulting in significant savings in marine freight costs. Such innovation builds the reputation of the port and its activities.

But, for this study, it is the innovative way the Port of New York/New Jersey had gone inland with their service in their attempt to serve more and more markets and customers. The Port Inland Distribution Network is a new system for distributing containers moving through the tidewater port by barge and rail as well as trucks. A hub and spoke system is designed to move containers by barge to water accessible points such as Albany, NY, Camden, NJ, Bridgeport, CT and Providence, RI. Rail connections could be used for traditional and new destinations in New York, New Jersey and Pennsylvania

The inland terminals are located at or near centers of marine customer service and distribution activities or cluster points of demand. The port points out that 82% of the container markets within this 13 state area are found within a 50-mile radius of these points. The PIDN program aims to lower inland distribution costs, reduce truck trips, improve air quality, save energy, increase port throughput capacity, and spur economic development at feeder ports and the hinterland.

The PIDN is a public/private partnership including the Port authority of New York and New Jersey, prospective feeder port operators and state and local government agencies that support PIDN development. PIDN, and the new barge service, Albany ExpressBarge, began operating between the Port of New York and New Jersey and the Port of Albany, NY, in April, 2003.

It is evident that the Port of NY/NJ understands and utilizes the differing efficiencies of the various modes in differing circumstances. It operates its transportation system as a system of the whole, taking advantage of those inherent efficiencies from each mode and the inter-modal interchange when appropriate.

Stark Inter-modal Facility, Navarre, Ohio

The Neomodal Freight Terminal (NFT), also known as the Stark Inter-modal Facility is in Navarre, the northeast area of Ohio. The facility is within Stark County, which surrounds the City of Canton. Within five miles of Stark are two Class I railroads (Canadian National and Norfolk Southern), one regional railroad, and at least 3 main arteries, which are Interstates 30, and 62, and Highway 77, not including state highways. At the intersection of these three arteries is the NFT. Interstate 62 runs northeast southwest; Interstate 30 runs mostly east west; Highway 77 runs north south.

The Stark-Neomodal facility is centralized on a tie, from a regional railroad, that runs to a long inter-modal network that links Mexico and southern U.S. northward through New York and western Canada. An additional rail line links Chicago and Buffalo to Midwest U.S. and southern Canada. The local trucking companies have overnight services to many of the closer major cities that include Chicago, Cincinnati, Cleveland, Columbus, Dayton, Detroit, Erie, Indianapolis, Louisville and Philadelphia. The facility is on 28 acres, is open 24 hours per day, and has Electronic Data Interchange and computerized inventory control.

Based on the number of hours open, the geographic area, and the extent of the rail and highway network, NTF’s most advantageous characteristics appears to be location to a significant portion of mid-west and U.S. consumers and manufacturers, as well as Canadian and Mexican markets, and sufficient terminal hours in which to accommodate users and reduce potential congestion issues.

The Stark Inter-modal Facility relies on three MI-jack overhead cranes, meaning that the existing and future capacity could be large. This is based on the fact that three side-loading cranes can operate 1,000 containers per eight-hour period and because overhead cranes use less space which increases storage and unload/load capacity.

The development of the facility sprang from am effort made by Stark County who created a Stark Development Board, a non-profit organization, to address the economic development of Stark County. Their goal is to serve trailer or container transfers to and from rail within a 120-mile radius of Stark County. This network expected to offer benefits to consumers and manufacturers with competitive prices on most goods because of the facility's proximity to major markets via extensive rail lines and highways.

Anticipated volume has not developed, as projected by the railroad. Recently, there were a peak number of only 500 lifts, which equates to an annualized rate of 6,000. The facility's capacity is designed for 150,000 lifts. Also, there have been financial difficulties, which are not limited to one of the original Class I Railroads, CSX, deciding to depart the facilities. Fortunately, Canadian National appears to be servicing the facility through the regional railroad.

Part of the situation seems to stem from two sources. First, the underlying impetus was to accommodate and support a major business entity and, thus, encourage it to either stay or expand. The second circumstance is that during the development, feasibility studies, and siting, there does not appear to have been coordination or communication with the railroad. This results with the railroad not being supportive and not producing volume through the facility. With Canadian National now at the site, there may be a dedicated relationship that will effectually increase services and volume through the facility.

The Neomodal Terminal Facility is a rail-highway center that appears to focus on trans-shipment functions, due to its geographic location to consumer and manufacturing markets. Its lack of anticipated volume appears to be because of its lack of relationship with a major provider of inter-modal services, specifically a railroad company. However, its apparent points of future successful viability appear to be: adequate land/space, a Class I railroad, major interstate highways, proximity to major markets, and adequate capacity.

Clark Maritime Centre, Jefferson, Indiana

An inter-modal center that has received some attention is the Clark Maritime Centre in Jefferson, Indiana, directly across the river from Louisville. It is situated in Madison County, a county that has no maritime freight facilities. For the state of Indiana only eight ports are identified and only three of them are available to the public. Burns

Harbor and Southwind Maritime Centre are the sister ports to the Clark facility, giving access to and opportunities for international trade.

Clark Maritime Centre is located on the northern bank of the Ohio River, offering 12-month ocean access to world markets through its connections to the Inland Waterway System and the Gulf of Mexico. Most of the commodities are bulk in nature and most of them go to the manufacturing and agricultural markets in surrounding states, either by rail or by barge. Bulk commodities include corn, soybeans, fertilizers, iron and steel. Some containerized cargo includes paper and plastics and associated products.

The other two ports in the triad deal mainly with bulk materials related to agriculture, both products such as grain and agricultural inputs such as fertilizers and chemicals. It appears only Clark Maritime Centre deals both with general cargo that can be containerized and the typical bulk commodities in one facility and seems to be successful at providing such a service. Its main role appears to be assembly of grain and then to provide access to international ports and domestic markets. Its relative success is based on assessing the demand for services and providing that demand, in this case movement of bulk commodities.

Port of Anchorage, Anchorage, Alaska

An interesting port and inter-modal center is the Port of Anchorage, both because of its location and the functions offered to the shipping public. A port that has only been in operation since 1961, it has increased its tonnage across its facilities from 38,000 in that year to more than 4 million tons in 2003, mainly by increasing its capacity from one berth to offering a five-berth terminal. Products moved include containerized freight, iron and steel products, wood products and cement.

The port is not a typical inter-modal center in that it has ocean access, rail, trucking and barge capability. Three major carriers serve it weekly from the Pacific Northwest and one from Asia. Petroleum tankers supply jet fuel for airport operations, barges on-load petroleum products for western Alaska and ships from Japan and Korea bring construction material and automobiles. Container movements are on the increase as population grows, income increases and population disperses in the hinterland of the port.

The current facilities include a 129-acre industrial port, with slightly over 80 acres leased to port tenants. Thirty-one acres are available for staging of marine containerized and general cargo in transit. Current efforts are underway to reduce traffic conflicts in the city and county and to improve general cargo flow. Internal port management activities are designed to improve coordination between barge and container ship traffic and to use more truck-rail combination movements. Improvements in handling container ships via bigger and more efficient cranes are also planned, along with dock expansion for the same purpose. This port is another good example of providing increased services as demand in the area is identified and responded to, both in physical capacity and services offered.

Port of Lewiston, Lewiston, Idaho

This center of economic activity offers transshipment, storage and handling services. It is located on the confluence of the Snake and Clearwater Rivers and is the farthest inland port on the west coast, 465 miles upriver from the Pacific Ocean.

The Port is richer in facilities and transportation modes than it is in total traffic. The Port is serviced by four-five tug and barge lines, two U.S. highways, up to ten truck lines and a short line railroad that has reasonable connections to the Union Pacific and the Burlington Northern/Santa Fe railroads. Eleven substantial container companies are available at the Port.

The Port arose in 1958 when created by the residents of Nez Perce County, becoming a working maritime port in 1975 when the Lower Granite Dam was completed on the Snake River. This inter-modal port significantly reduces rail and highway shipping costs, takes trucks off of the highway and aids environmental conditions. It takes about 50 hours to get to the Port of Portland for whom the Port of Lewiston serves as a truck-barge inter-modal inland port.

The Port continues to be successful in the market available to them, moving some 1 million tons of wheat and barley and an additional million tons of containerized cargo. Major shippers and users of the inter-modal movement are Lewis and Clark Terminal and Cargill, Inc at the port (grain) and Potlatch Corporation (pulp, paper and wood products, etc.). Other commodities moving in inter-modal movement include potato products from southern Idaho, bentonite from Wyoming, talc from Montana, grain from the Dakotas, and lumber from Canada.

The efficiency of the inter-modal movement has been aided by the construction of a 150,000 square foot warehouse and containerized freight-shipping center, Island 465. This facility, completed in 1992, accommodates rail, barge and truck traffic and is aided by two industrial sites that are under completion by the Port. These containers moving through this facility enable the Port to ship to some 40 foreign countries in eight major regions of the world.

Peas, lentils, paper and paper products have been the principal containerized commodities but the recent rates for steamships have made new movements of wheat and barley economically viable. How well these are sustained into the future will be seen.

It is evident that the inter-modal activities of this center required initial investment by a government body and the resulting private/public partnership seems to be working well. Partnerships with the international steamship lines appears critical to this port’s future.

Auburn Inter-modal Facility, Auburn Maine

This is a $5 million inter-modal transportation facility, based on an existing rail-truck system. The site utilizes a two-track rail-truck facility with container and trailer storage areas serving the transfer function. It is a joint effort of the St Lawrence and Atlantic Railroad, the Auburn/Lewiston Metropolitan Planning Organization and the State of Maine.

New site improvements are a 1,600 square foot maintenance building, a 700 square foot office building, a new 75-foot truck scale and parking for almost 550 trailer units. A new 6,000-foot siding track is combined with the rehabilitation of over 11,000 feet of existing mainline track.

The overall purpose of this center is, by providing inter-modal connections and transfer, to redirect truck traffic to rail, providing an alternative route for rail and truck traffic originating in the Midwest and the New England regions. Its first mission, and a successful one thus far, was to retain and build business for the local paper industry.

The continued new development is jointly funded by the City of Auburn and the Maine Department of Transportation utilizing TEA-21 funds that were available. These new funds add on to the public/private partnership originally existing among the railroad, the MPO and the State of Maine. A stable volume from the local paper industry serves as a base for other demand conditions in the area.

Virginia Inland Port (VIP), Washington , DC

The Port of Virginia offers access to more than 100 countries and is one of the most successful ports on the east coast. The benefits of the Port of Virginia are brought 220 miles closer to U.S. markets by the Virginia Inland Port, located just west of Washington, D. C. in Warren County, Virginia. This inland port serves as the extension of the Port of Virginia, in an established version of an “agile port”, offering reduced congestion time losses, increased safety and overall efficiency improvements.

Historically, five day a week rail service between the VIP and the marine terminal in Hampton Roads allowed direct access from the interior to the trade routes of 75 international shipping lines overseas. This rail service is now seven days a week both ways from the inland port to the marine terminals, in order to service the growing demand.

The facility contains 17,820 feet of on-site rail services by one of the largest railroads in the U.S., Norfolk Southern. The site is within one mile of Interstate 66 and within miles of Interstate 81. The Inland Port Terminal has a three-door cross-dock warehouse facility for transferring cargo and a maintenance building for making car repairs. Other services that attract cargo to the inland facility are USDA inspections, SGS inspections and U.S. Customs houses. The facility also provides pooled-chassis, refer-gensets (electric generator sets that provide power for refrigerated shipping containers) and shore-side electrical power as needed.

The Cargo Division of the inland terminal is responsible for loading and unloading of trucks and railcars of break-bulk cargo and the stuffing and stripping of containers at the Container Freight Station. The division also coordinates warehouse storage and cargo fumigation as needed. The Container and Yard Divisions serve to document containers leaving and entering the terminal by ship, rail or truck as well as allocating yard stowage space, mounting and stacking containers and overall coordination of the inter-modal switch.

This facility serves as a good example of a major port reaching out to the hinterlands via an inland port to reach customers while increasing the quality of service in the main port. Congestion decreases are a benefit, along with services now being available competitively further inland.

North Carolina's Inland Terminal Network, Wilmington, North Carolina

The State of North Carolina also has the benefit of an inland terminal, referred to by them as their Inter-modal Terminal Network. It advertises itself as the first of its kind in the nation, providing better, less expensive and more convenient land transportation services than other alternatives. Basically, it substitutes short haul rail for truck movements through the congested parts of Wilmington to get access to the Port of Wilmington. Two inland inter-modal terminals offer this service, the Charlotte facility, established in 1984, and the Greensboro terminal, developed and constructed in 1987.

The function of the inland inter-modal centers is to link the largest manufacturing centers, Charlotte and Greensboro, to the Port of Wilmington. Both terminals serve as consolidation points for import and export cargo. The port advertises and feels they have accomplished substantial cost savings for the shippers, resulting from the direct, high volume truck and rail transport of combined product shipments to and from the port.

The Greensboro inland terminal offer shippers free match-loading assistance to avoid empty rail hauls, and reducing costs by load consolidation. Charlotte has the ability to offer one day, non-stop rail service through a historical Seaboard System SPRINT train, now operated by CSX Transportation.   Both terminals offer fast delivery of empty containers to shipper for transport to the Port. The consolidation and assembly functions of this port structure offer benefits that may be useful in the state of Washington.

ExpressWay - Canadian Pacific Railway, Toronto and Montreal, Canada

An excellent and extremely successful short haul container rail movement is the ExpressWay service provided by the Canadian Pacific Railway. This is an example of how providing solid and efficient line-haul movement with adequate and appropriate rolling stock to match the need can be feasible and viable in the long run.

Canadian Pacific Railway has a history and experience that set the stage for the current successful endeavor. Fifty-one years ago it introduced the inter-modal freight train, probably the first in North America, by carrying truck trailers on railway flat cars between Toronto and Montreal. Since then CPR Inter-modal has become the largest segment of the railroad’s business, serving long, medium and short- haul corridors.

It is the ExpressWay movement that has special interest for inter-modal transportation for this study. Launched in 2002 by the CPR after several trial efforts it provides service between Toronto to Montreal to Windsor to Detroit Michigan. The original concept had been tested under the name “Iron Highway” for about five years and because the Port of Montreal is 1,000 miles inland, along the St. Lawrence River in Canada, more goods to and from mid-west US travel this way than via east coast U.S. ports such as New York/New Jersey. Montreal now handles more than 1 million containers per year, half of them coming from or going to the U.S.

ExpressWay offers trailer on train service that partners with trucking companies and fleet owners to get their loaded trailers form one terminal to another, saving on tractor investments, drive, fuel and maintenance expenses spent trying to get across the US/Canadian border, offering a transit time that is comparable to that offered by truck. The service offers two departures daily, six days a week, with each train capable of carrying up to 90 non-reinforced (meaning light highway equipment can be used) trailers. The specialized ExpressWay trains are made up of articulated, five-platform cars, of which CPR has 260, joined together to form a continuous surface for fast, roll-on/roll-off loading and unloading of trailers. User friendly "e-commerce" reservation systems, offering freight shippers the opportunity to reserve places aboard the trains by internet or fax and which uses hand-held portable computers by terminal personnel to control operations form the time a highway trailer arrives at the terminal to time of train departure are available and appear to be heavily used.

These services carry anything from high-priority auto parts, an extremely valuable and time sensitive movement (moving at a high tariff rate with attendant revenue considerations) to perishable food products and resource-based traffic. Less than truckload carriers have been using the service since its inception, mainly because of its high performance on time and safety. Freight forwarders and shippers such as Sears Canada and Canadian Tire have partnered with the CPR by building their regional distribution facilities next to CPR inter-modal terminals in major Canadian centers. Under this partnership, the shippers have their own private access to CPR's terminal, with containers and trailers being delivered and picked up within minutes of the arrival or departure of the high-speed inter-modal trains without truck movements on public roads.

The all important demand and volume attributes are driven, in this center, by providing better and enhanced services. Competition among modes of transportation also seems to spur development and competitive advantage. Also, it appears that the larger facilities, the more likely they are to be able to develop partnerships and rate contracts with transportation firms.

Bethlehem Commerce Center, Bethlehem, Pennsylvania

This facility is under continuing construction and design, being originally established in 1988 to create business opportunities for the Subsidiary (short and regional lines) Railroads located in Pennsylvania, Maryland and Indiana. The Bethlehem Commerce

Center consists of 1,600 acres of industrial-zoned property in the Lehigh Valley. It lies mainly within the city limits of the City of Bethlehem, with about 90 acres in Lower Saucon Township. It is about 90 miles due west of New York City, about 69 miles north of Philadelphia and about 90 miles east of Harrisburg, Pa.

When constructed in its final design, the Center will be one of the largest rail served industrial parks in the region, offering rail connections to two Class I railroads and having close access to adjacent interstate highway systems that also have access to the Class I railroads.

A critical part of the overall Bethlehem Commerce Center is the BethIntermodal Terminal which markets rail switching, distribution, warehousing, transloading, inter-modal and other rail related services to potential customers. It has connections to the Norfolk Southern and Canadian Pacific railroads with rail connections coast to coast. It offers bulk transfer, trans-loading, storage and warehousing in its inter-modal operations.

The overall design of the facility has aspects of inter-modal loading, transshipping and basic warehousing/storage functions. There is a trans-load facility of 100,000 square feet, for lumber, paper and other products, and an inter-modal yard 200 acres in size, with two trains per day, 6 days per week and less than 1 mile to Interstate 78. The combination of public and some private investment is a strong aspect of the project and Center, though not unique to this facility.

The Bethlehem Commerce Center has plans for extensive development of the overall site. The corporate commercial campus will be accompanied by a state of the art industrial part with the primary focus on transportation efficiency through the BethIntermodal Terminal and interstate highway access.

This facility supports the earlier discussion about just what an inter-modal facility can encompass. It is a conglomerate of functions, facilities and demand nodes, within which an inter-modal center operates successfully.

Big Pasco, Pasco, Washington

The Port of Pasco is located in Pasco, Washington, in the southeast corner of Washington. Its location appears useful as a transportation hub, 136 miles south of Spokane, 46 miles west of Walla Walla, 229 miles east of Seattle and 216 miles east of Portland, Oregon.

The Port of Pasco was established by Franklin County voters as a local municipal corporation in 1940. The Port was originally formed to provide facilities for barge shipments of grain from the area of eastern Washington serving as the grain shed for the Pasco area. Over the years the Port has become a full developmental and transportation port.

In 1959 the Port purchased a World War II Army Depot, named it the Big Pasco Industrial Center, with over 600 acres of land with several miles of railroad tracks and over 1.7 million square feet of buildings. The Port installed the first container crane facility on the upper Columbia for barging products to and from Pasco. The container barge terminal averages over 2,700 containers each year, mostly local products going into the international market. It also operates the Tri-Cities Airport as a service to the area. In sum, the Port of Pasco now provides services from facilities at the Tri-Cities Airport, the Big Pasco Industrial Center, the Pasco Processing Center and the Container Barge Terminal, totaling assets work in excess of $130 million.

The role of the port as a transportation center is aided by the availability of a major switchyard of the mainline Burlington Northern Santa Fe, highway access to Interstate 182, U.S. 395 and U.S. 12 and barge shipment, both bulk and containerized on the largest public marine terminal on the upper Columbia River.

Current commodities using containers are hay cubes, onions, peas, beans, soil fumigants, and other mostly agricultural products. The containers are moved by a 42-ton Gantry crane and a substantial pool of “for lease” containers, supported by an ample supply of electrical hook-ups for refrigerated containers. Direct rail service is available on dock to the terminal. The Container Barge Terminal has nearly 2 million square feet of building space available to industry interests for warehousing or manufacturing at the

Big Pasco Industrial Center. Related to it are 250 acres of food processing park space with in-place environmental permits, an industrial wastewater treatment plant, sewer, water, and natural gas at the Pasco Processing Center, where manufacturing, warehousing, fruit and vegetable packing, assembly and distribution activities are currently underway.

The operations management of the container facility has been assumed by Northwest Containers Services (NCS), a company that is currently operating a successful short-haul rail service between Portland, Tacoma and Seattle. NCS and its progressive and aggressive management team appear to be moving to develop a similar truck-rail inland terminal concept to Portland that may offer an "agricultural gathering" function for shippers in the Pasco and eastern Washington area.

Mason Inter-modal Facility, Savannah, Georgia

The Port of Savannah, operated under the Georgia Ports Authority, has been experiencing steady growth, with 1,660 vessels calling on the Port in 2002, an 8.6 percent increase or an additional 132 vessels as compared to the previous year. Overall the Authority finished fiscal year 2003 with double-digit growth in containers, for the second year in a row.

The only decline in traffic came from break-bulk and liquid/dry bulk tonnages. Much of the break-bulk, which includes items such as wood products and paper, is now being stuffed and moved by container. During that year, container tonnage grew by almost 1 million tons. Continued growth in container movement has helped the Port grow to being the fourth largest container port in the U.S., according to P.I.E.R.S. Trade Information Services.

This growth is directly associated with the new Mason Inter-modal Container Transfer Facility ((ICTF). The new facility is across the street from the authority's older Garden City Terminal. It allows shaving days off of travel times for containers heading into and out of the terminal. The new inter-modal center, when combined with the five new ocean carriers (arriving according to some sources due to the efficiency of the new inter-modal center) gave shippers more options and quicker movement through the port and surrounding city for the containers. It is expected as the Norfolk Southern utilizes its new switching yard just outside of Atlanta the number of trains will increase even further, putting trains from the Port into Atlanta overnight, allowing the Port to capitalize on its proximity to one of the South's largest consumer markets.

This increased rail traffic is in lieu of truck movements that had been so common, and the container movement is in lieu of the bulk traffic historically moved. The port's aggressive forward thinking has aided them in these transitions.

Port of Quincy, Quincy, Washington

An inter-modal center that is not yet in operation deserved some examination for this study because of the potential movement pattern. The Port of Quincy, known formally as Grant County Port District No. 1, is currently developing an Inland Terminal Industrial Park. It is designed to alleviate congestion on Interstate 90 in the Seattle Metro area. The underlying focus of the Park is to provide a location where truck traffic can drop and pick up traffic from and for the region, allowing the efficiencies of short haul rail to be realized. The existing Burlington Northern Santa Fe rail line, when accessed by a local spur, will provide access to the Chicago and east markets and tie eastern Washington better into the Puget Sound Ports. The larger park may serve in the future as a location for warehousing, bulk and retail distribution centers and container loading/repack facilities.

The Park, to be managed and marketed by Northwest Container Services, is expected to serve as an agricultural gathering center initially, substituting inter-modal movements for the existing truck movements of the products from the local area to the tidewater terminals. This proposed structure may also have a high incidence of backhauls and resultant fully loaded two way movements since it can bring containers from the Ports to the Quincy Park where they can be trans-loaded to trucks for movements to markets in the south, east and southeast. The other directional movement is expected to be agricultural products, fresh and frozen, moving to the west coast for domestic consumption or export.

The new railroad track on site is currently under design and is under construction. The project has attributes of interest to this study both for the directional movements mentioned above, and the fact that it has funding from both Port funds and State funds and has recently succeeded in obtaining some Federal funding. Subsequent investment from the operators and builders of facilities in the Park will make this a noticeable private/public partnership, at least to a modest degree.

The success of this effort is dependent on many factors, including the demand for the service from the local producers, the rate that can be obtained from the Burlington Northern Santa Fe and the arrangement with the Puget Sound Ports, amongst others discussed later in this report.

New River Valley Inter-modal Transportation Center, Dublin, Virginia

The definition of an inter-modal movement and inter-modal center earlier in this report shows how narrow or broad such a definition can be. Similar to projects reviewed above, the New River Valley Inter-modal Transportation Center is a concept that falls into the broadest definition. This area has designs and has underway an effort to market itself as a “center for global transportation”, in both domestic and foreign industrial markets. It is essentially an area that has the capability of inter-modal movements, the means for industrial development and a full system of transportation options for the shipper or developer.

This effort is centered in the Dublin, Virginia area and offers key resources for inter-modal movement/distribution/warehousing. Officials feel that the access to all of these functions is what the public will desire and economic development efforts will be successful. The array of resources offered includes the following and is impressive.

An existing rail line, a spur connecting to Norfolk Southern’s Double Stack Rail Line, provides access to the Newport News Ship Yards. This is the opening to transcontinental marine shipping and to other rail lines in the U.S. This rail line provides back flow to a number of major buildings in the nearby Burlington Industries Industrial Park, being marketed by the area promoters as storage facilities.

The site offers land for expansion and installation of shipping and trans-shipping terminals. The double stack rail line, mentioned above, can accommodate double-stacked freight containers with a combined total clearance height of over 20 feet. Finally, the area is covered by Interstate 81 to the northeast and southwest, one of three major highways in the area. Located 20 miles from Dublin, the transportation center is Interstate 77, which supported movement in a north and south direction. Interstate 64 is another major highway lying just north of the New River Valley, again serving east/west locations.

It appears that this “center” is not a facility but a locus of physical and economic attributes that, when combined, provide potential benefits to shippers and manufactures considering locating in the area. The ability of the area to find local demand, some private capital, a critical mass of economic activity and a sense of competitive drive will condition the viability of the area as a transportation center over time.

Alameda Corridor

A project that has received considerable discussion and examination in the press and government studies is the Alameda Corridor. In only the vaguest of terms can this be considered an inter-modal center or facility. And, thus far it has not reached the volumes projected before its implementation, according to various trade magazines such as Traffic World.

The Alameda Corridor consolidates the four port access rail lines of the Port of Los Angeles and Port of Long Beach (POLALB) into a single twenty-mile rail cargo expressway linking the two ports to the transcontinental rail yards east of downtown Los Angeles. There are many participants in the effort: POLALB, the US government, the Union Pacific Railroad, BNSF Railroad, CalTrans (the California Department of Transportation) and the Alameda Corridor Transportation Authority.

The above multi-jurisdictional participants indicate the unique public and private sector partnership of the $2.4 billion project. Funding includes: $1.165 billion in revenue bond proceeds, $400 million loan from USDOT, $394 million from POLALB, $347 million administered by the LA County Metropolitan transportation Authority and $154 million in other state and federal sources and interest income. User fees from the railroads will pay off the bond debt in federal loan.

The two railroads utilized four separate routes consisting of 90 miles of track and have shifted to a single 20 mile, high capacity, below grade train way. Ten miles of the corridor is below grade in an open trench along Alameda Street, eliminating over 200 at grade rail crossings and widening the adjacent major highway.

Clearing of congestion and improving safety and environment standards is the focus of the project. However current use and discussions in trade magazines suggests that, to reach the earlier projected volumes, a dedicated shuttle train to inland distribution centers may be necessary.

CASE STUDIES/MODELS OF RELEVANCE TO WASHINGTON

The earlier extensive and intensive review of the popular literature, the governmental and academic reports followed by case studies from though out the United States reveals the numerous efforts underway to utilize inter-modal transportation to aid trade, domestic movements and overall economic growth. It is apparent that critical cargo handling and inter-modal links are being currently stretched and constrained; hence, there is a good future for inland facilities operated as part of the port and trade system. What is also apparent is that the needs and functions of these facilities or distribution centers appear site specific and characteristics and attributes that contribute to the success of these facilities vary to a large degree.

The concept of “agile ports”, where the attempt is made to use existing or only marginally changed facilities”, does seem to offer benefits to both domestic and international trade. There is an evident need for basic infrastructure, fluid capacity, and tight linkage between ports, modes and distribution/origination centers. If successful, the “urban conveyor belts” espoused by the Boeing Company can help cut dwell times in the ports in half, effectively doubling capacity.

Examination of the above numerous styles and functions of inter-modal facilities, whether ports or inland enterprises, shows many different attributes, but also allows determination of “models” of inter-modal centers of particular relevance to the state of Washington. These models are selected to reflect the current practices in the state, the known commodity flow, and the available mode infrastructure serving the consumers and producers of the state. The three case study/models are identified as “agricultural gathering or assembly”, “port clearing, and “distribution centers”. These models are developed from analysis of the inter-modal centers in the report, interviews with proponents/operators and discussions with potential users.

Case Study/Model 1- Agricultural Gathering and Assembly

As the name indicates, these inter-modal centers serve the rural agricultural regions by gathering the agricultural production in an assembly function, transferring the products to rail and then moving them to ports for access to the foreign markets. It is specifically oriented for the export market. Several of these types of short haul rail inter-modal centers exist or are being contemplated in the state and region.

Such a model would be situated in high volume production areas, often with specialized production characteristics such as need for refrigerated or frozen movement and, though not necessary, are usually oriented to the export market and the ports serving those markets. The types of crops and products that require and could use the functions offered by the “agricultural gathering and assembly” model are often perishable and time-sensitive products; in the North West such products include frozen products, hay, potatoes, grass seed, vegetables, etc. Essentially these are the products that require proper temperature and moisture control and do not move in bulk.

This inter-modal center requires a staging area where trucks can gather and position themselves to transfer cargo, a transfer area, an equipment set of lifts (such as a heavy tonnage fork lift or a Terex Superstacker capable of lifting 20-53 foot containers), rail car availability, and appropriate rate agreements with the relevant railroad companies. Because of the varying products being assembled, this model is particularly space consuming so a substantial acreage is required. The combination of rate agreements and facility efficiencies must compete, in this model, with the alternative of direct trucking from the ports.

Short-haul rail for other products, as utilized in this model, has been shown to be able to compete within 250 miles (based on the performance of Northwest Container Services, Inc.), depending on the efficiencies and rate structure. Part of the efficiencies arise from the operator of the facility’s ability to have a truck fleet available at a competitive rate, the ability to stage and manage that truck fleet and to grow the business volume by increasing the range of the trucks. Depending on the ownership of the facility the truck fleet can be either for-hire or proprietary.

Development of such a facility entails large or at least substantial development costs and initial investment for infrastructure. Additionally, major marketing efforts will be necessary to grow the market and entice shippers to try the new transportation alternative.

Such front-end investments mean that, initially, such facilities usually operate at an annual loss, with the expectation that, as the all-important volume grows, per unit costs will decrease while total revenue increases, bringing the enterprise to long-term viability. Development of these markets is not guaranteed and is not an easy undertaking, or the private market would have been doing so in the past. This is another golden nugget of information that is buried. This needs to be in the executive summary and much more prominently featured.

<u>Case Study/Model 2- Port Clearing Inland Terminal</u>

Cargo movement may now be hampered at the very point in time when American trading activities are growing rapidly and becoming and ever larger portion of the US economy. Forecasts of cargo movement via US ports indicate continued growth well into the next decade. However, the capabilities of critical cargo handling facilities and inter-modal links are being stretched well beyond their capacities.

In this model the basic function is to increase the capacity and efficiency of the tidewater port by moving containers and economic activity as soon as possible from the docks and internal facilities of the port, essentially extending the hinterland of the port and enlarging the physical resources and space available to the constrained port system and the congested roadway system leading to and from the port. This model is designed as a strategic part of the “agile port” concept, utilizing the associated concept of an inland terminal to decrease dwell times in the port and increase efficiencies in the line haul movement away from the port. Examples of such efforts are evident in California ports, in the Alameda Corridor and in several Texas port activities.

The function performed is to use short haul rail to clear the ports and deliver products to the inland distribution centers or warehouses (growing about 8-10 percent annually in major ports) rather than relying on the heavily congested highways and limited trucking services near the port area for this movement. The increases in labor and truck utilization, by the trucks not having to take the short haul drayage in the congested areas but focusing on the movement from the inland terminal facility to the local distribution centers, is apparent.

Dedicated train service provides improved custom clearance, on dock transfer and less labor expenses for the overall movement. The operator would truck the containers to the warehouse/distribution centers for unloading and return the empty containers to the inland terminal facility, again avoiding the increased congestion evident in many of our major port cities (Portland and Seattle have experienced and increase in annual congestion delay per person. of 21 hours and 26 hours, respectively according to the Texas Transportation Institute. An ancillary benefit of such inland terminal facilities is the ability to develop repair and maintenance capability for the containers and chassis. This increases the functional capacity available from a physical capacity, allows the repaired containers to be immediately available for usage and avoids some of the congestion apparent around repair facilities near the port.

Case Study/ Model 3- Distribution Center

In the course of this study the need to broaden the definition of inter-modal centers became apparent if the full value of the study's industry review and analysis was to be achieved. Rather than the inter-modal center serving as mostly direct transfer points between several modes of transportation, as the first two models entail, much interest and desire for information was shown in the location of distribution centers and the feasibility of these centers in various settings. Review of studies and interviews indicated that this model, that of distribution centers, was intricately related to the economies and service characteristics available from inter-modal movement but were offering a different set of functions to the market.

Distribution centers can be either a private center developed by a major corporate entity to handle only its own product line and service its own supply chain or they can be private centers, operated by third party logistics firms (3PL), providing a broad array of services to a broad array of customers. This model is based on the idea that warehousing is not just a box with shelves but can provide customs benefits, shipment consolidation, special labeling and packaging, all within a “transfer facility”. Such a transfer facility may be dependent on inter-modal shipment efficiencies but time and services may occur before the transfer among the modes.

Examination of the attributes that are related with such an inter-modal model’s economic feasibility and long term viability also indicates, to the communities recruiting such a business, those characteristics or services that the community has to offer in its recruiting efforts. Location, location, location is not just a trite term but reflects the culmination of the many attributes that provide the Return on Investment (ROI) that warrants continued operation of the facility. Such attributes include the competitiveness of modes available at the facility site, the cost of land and labor in the area, the tax structure and zoning constraints, the speed and length of access to product markets for delivery and to input markets for assembly. The size and composition of nearby population centers affects both the costs and market possibilities for the center. Thus, investment and support for infrastructure and operating environment by the recruiting communities becomes a major recruiting tool. 3PLs, with their focus on competition look to how inter-modal service, when combined with warehousing, storage, cross the dock reconfiguration of loads, customs and tax considerations, etc., can make the price-product offered by the logistics firm better than its rivals.

MATRIX OF ATTRIBUTES CONDUCIVE TO ECONOMIC VIABILITY OF INTER-MODAL CENTERS

In this section the differing attributes or characteristics conducive to long term viability are presented, based on their relevance to each of the case study/models. The attributes are prioritized as to importance in each model. The evaluation scheme is A = Critical, B = Necessary, C = Contributory and X = Not Important.

Table 2: Attribute Matrix

Attributes	Agricultural Assembly	Port Clearing	Distribution Center
1) Adequate Land / Space	A	A	A
2) Two Class I Railroads	C	B	C
3) Major Interstate Highway	C	B	A
4) Proximity to Population Center	X	B	B
5) Available Air and Water Transportation	X	A	B
6) On Nodes or Direct Line of Railroad Service	B	A	A
7) Public/Private Partnership	A	A	A
8) Magnitude of Public Participation	B	A	C
9) Positive Working Relationship with WSDOT and other Agencies	B	B	C
10) Need for Changing, Directing and Dividing Cargo	C	C	B
11) Clearly Established Demand Opportunities	A	B	C
12) Combination of Port and Distribution Efficiencies	X	A	B
13) Labor Availability and Training	C	B	C
14) Quality of Life	X	B	A
15) Distance to/from Production Points	A	C	B
16) Distance to/from Destination Market	B	B	A
17) Degree of Facility Automation	C	A	A
18) Time to Build	C	B	B
19) Capacity	B	A	A
20) Available Volume in Local Production Area	A	C	C
21) Commodity Mix	B	X	B
22) Ratio of Transport Rate to Value of Product	A	X	B
23) Tax and Zoning Incentives	C	B	A

The **attribute matrix** above, comprised of twenty-three possible relevant attributes allows a detailed examination of what attributes seem to be important in the economic viability of an inter-modal facility. The numerical weighting allows an understanding of the degree of importance assigned to each attribute for the different case study/models developed in this study. The following discussion will summarize the findings of the analysis relative to those models deemed most applicable to the state of Washington.

Agricultural Gathering/Assembly

Six attributes appear to be critical to the economic viability and success of an inter-modal facility serving an agricultural assembly function, emphasizing exports.   The availability of adequate land/space is the first critical variable because the land acreage has to be large enough to handle the multiple activities ongoing at such a site. This attribute ends up being critical in any and all inter-modal center models. Probably most critical is the proximity to the production areas, areas that are the source of a high volume of potential traffic. This volume of perishable and specialty products is the source of clearly established demand opportunities. Such demand opportunities are realized by a fully developed and focused marketing campaign by the shippers but especially by the developers of the facility.

The ratio of transportation rate to the value of the product is important in agricultural assembly facilities because these products, though value added, are not high in value per unit of movement. Thus, lower transportation rates will generate an expected response in amount carried in the inter-modal movement.

Examining the six attributes that are deemed necessary, it is evident that a degree of public participation is also necessary because of the investment necessary and the time needed to change marketing channels to include and focus on inter-modal movement. Such a private/public partnership may be warranted if the public benefits realized from moving traffic in high-density traffic areas from road to rail exceed the cost of public investment. Associated with the public participation is a good working relationship with the WSDOT as it makes investment decisions on roads and access points important to the facility.

Having the facility on nodes or a direct line of the railroad offers competitive benefits for rates and scheduling flexibility. Both of these are related to the possible combination of port and distribution efficiencies as all subsystems work together in a seamless inter-modal system. Similarly, the destination to the market, in this case the port, affects the ability of the facility, and its inter-modal modes, to compete against direct trucking. This competition, when combined with provision of the physical capacity needed to achieve notable economies of size and scale, is necessary for the economic sustainability of the enterprise. Finally, especially in the agricultural area, commodity mix is necessary to survive the seasonality of production and the variability of production caused by weather, government programs, and market changes.

Contributing but not as necessary or critical to the agricultural assembly model is the availability of two Class 1 railroads and major Interstate highway near the facility, although some competition would be beneficial. The degree of automation in the facility allows labor and technology inputs to generate lower costs and greater productivity. The need to divert or divide cargo would be contributory but doesn't necessarily fit the perishable commodity market but could be useful in a grain/container movement. Related to the financial side of the ledger is the time to build, with its attendant costs, and the tax/zoning incentives in the area. Neither of these attributes has been shown to be problematic in agricultural assembly projects.

It appears that four attributes are not of particular concern to the agricultural assembly facility. Proximity to a population center, availability of air and water transport and efficiencies from port and distribution aren't felt relevant to the projects. Similarly, quality of life, and the attendant access to management and labor, doesn't appear to be a rural location problem.

Port Clearing Inland Terminal

The larger, more complex, port clearing inland terminal project has more attributes that are critical to its success. The availability of adequate land/space for the inland facility, the availability of air and water (obvious to the port function and options), the availability of direct rail service and the construction of adequate capacity in the inland terminal all affect the long term viability of the project. The large capital investments of this type of inter-modal model and the many identified public benefits from moving freight out of the port area without using congested highways suggest a substantial magnitude of pubic investment may be a step to long term viability of such a project if the public benefits exceed the public investment. On the private level, the amount of automation in both ends of the rail move will contribute to the level of port and distribution efficiencies. The level of distribution efficiencies is particularly important to this model because of the flow of the traffic from the inland facility, away from the port and the import function to the distribution into the national markets.

Unlike the above model for agricultural areas, having two Class 1 railroads and access to an Interstate highway available is necessary for competition and flexibility. Again a degree of public participation and a good working relationship with the WSDOT and other agencies is particularly necessary for the port clearing inland terminal, due to the many questions of access and safety. The quality of life and the resultant labor pool also are indicators necessary to viability. Of relevance also is the distance to the destination market because of its impact on competition, both inland and tidewater terminals. Again, the time and problems in building the facility have an impact on costs, as does the obvious impact of zoning and tax incentives.

This model only had one attribute considered only contributory, that of the need to change, direct or divide cargo. This function would contribute to the economic success of the facility but isn’t necessarily a function that has to be performed. Finally, the commodity mix and ratio of transportation rate to the value of the import cargo wasn’t considered critical or necessary because of the preponderance of containers in this movement.

Distribution Center

This model has more attributes considered critical than the other two case study/models discussed above. Land/space availability and cost, access to an Interstate highway, the capacity of the facility, and the distance to the distribution market all portend success/failure, depending on the availability of the attribute. Similarly, the existence of some private/public participation and a good tax/zoning incentive culture positively affects viability. Quality of life appears to attract firms to establish centers, both from a labor and management perspective. Degree of automation and use of technology, coupled with adequate expansion capacity makes a location more attractive and the project more successful.

Noteworthy in that they contribute to viability, but aren't found to be critical or necessary, were attributes dealing with availability of two Class 1 railroads, the magnitude of any public participation and relationship with the WSDOT, demand opportunities and volume of production in the local area. These attributes reflect the desire to develop their facility to the function and shape desired by the private entity, to the extent it is reasonable and profitable.

Of more importance was the proximity to a large population center for marketing purposes and availability of air and water transportation as alternatives to single mode or just rail/truck movements. Labor availability, distance to production points, commodity mix, time to build, and ratio of transportation rate to value of the product were also found to be necessary but not critical. Rationale for each attribute is similar to that discussed above.

SUMMARY AND CONCLUSIONS

Efficient freight mobility is the result of successfully balancing the demand for transportation capacity and service with the quantity supplied of those services and capacities. A growing number of communities and economic interests in the state of Washington recognize that efficient freight movement is directly associated with the health of their local and regional economies. As a result, state and local governments are being asked to improve freight mobility through operational improvements and new public infrastructure. Inter-modal truck-rail facilities, where goods are transferred from truck to rail or vice-versa for shipment to domestic markets or though gateways to international markets, are offered, or sought, as a means of improving the freight movement in the area.

Proposed public investment in such inter-modal facilities raises at least two questions: Will the facility succeed in the private market place by generating a sustaining return as a commercial investment? And, is any public investment justified based on the public benefits involved? It is the combination of internal efficiencies and external competition that will affect the demand for inter-modal services and economic viability of the inter-modal facility itself. A great deal of information and analysis is needed to identify these necessary attributes and those operating characteristics that "would or could" produce private economic viability and, if necessary, a required rate of return on public investment.

The general purpose of this research was to investigate and develop an applied methodology for determining the potential economic viability of inter-modal truck-rail facilities in Washington State. The focus was on discerning the attributes, characteristics or market situations that are associated with successful projects, thereby suggesting a framework for economic feasibility analysis of an inter-modal truck-rail facility.

Conceptually, any examination of the efficiency and performance of inter-modal movements primarily emphasizes the cost characteristics of the modes involved in that movement. Specific attention must be paid to the transfer point between those modes, the inter-modal center. Such a center has to provide the critical linkage between all modes in the inter-modal movement.

The feasibility and viability of an inter-modal facility relies on the ability of that facility to provide a service at a price that generates a Return on Investment (ROI) or Internal Rate Of Return (IRR) that will maintain it in business and warrant continued renovation and reinvestment. The larger volume put through the facility, the lower the costs per handling unit and the higher the total revenue.

This simple accounting profit equation can also vary depending on whether it is examined on a private commercial basis or a private/public partnership basis. Public benefits bring forth the possibility and rationale for public participation in provision of inter-modal facilities.

Basically, the approach used in the study was to determine the functionally relationship, as information allowed, between the dependent variable of economic viability and other relevant variables. Each of these variables, many of which are correlated or a function of other variables, has some measurable impact on the operational success and economic viability of the inter-modal. The dependent variables of profit, volume, and costs were associated initially with 13 independent variables or attributes. The review of the numerous centers and port facilities in the study later enlarged this list to 23 attributes with varying impacts, depending on the case study evaluated.

A review of literature and the intensive review (seventeen of which are summarized in this report) of projects, facilities, centers and ports provided a sense of the importance of the alternative attributes in different situations. Also developed from the reviews were a series of case studies/models of the type of situations that were found particularly relevant to the state of Washington. These case study/models were ***Agricultural Gathering and Assembly***, ***Port Clearing Inland Terminal*** and ***Distribution Center*****.** The three case studies/models were then evaluated, with the use of an Attribute Matrix as to those attributes, which are important to economic viability, and how important that attribute was to the three cases, evaluated as to “critical”, “necessary”, “contributory” and “not important. This evaluation mechanism provided the findings of the study as to a methodology to determine probability of economic viability.

Five attributes were found to be critical to the **Agricultural Assembly** function: The *availability of adequate land/space* was critical in all case studies. *Proximity to the production area* was probably the most critical in this model. Other variables that were critical to this case were found to be *clearly established demand opportunities, ratio of transportation rate to the value of the product, and public/private partnership.* The only four attributes found not important for the agricultural gathering model were *proximity to population center, quality of life, combination of port and distribution efficiencies, and available air and water transportation.*

The larger, more complex model of **Port Clearing Inland Terminal** has more attributes that were found to be critical to its success: *The availability of adequate land/space for the inland facility, the availability of air and water, and the availability of direct rail service and the construction of adequate capacity in the inland terminal. The magnitude of public investment, the amount of automation and the level of distribution efficiencies* were also found critical. The only attributes that weren't found critical or necessary were the commodity mix and the ration of transportation rate to the value of the import cargo. The other attributes received a contributory or necessary ranking.

The **Distribution Center** has the most attributes established to be critical. Attributes not mentioned above that were critical in this situation were access *to interstate highway, the capacity of the facility, the distance to the distribution market, quality of life, expansion capacity and a good taxing/zoning incentive culture*. All of the attributes were found to have value to this type of inter-modal center, to varying degrees.

It was evident in all three of the models that some degree of public participation seems to be a positive attribute aiding economic viability. These benefits, quantified in numerous publications and studies, and in the review of inter-modal centers and ports, include the value of reduction in highway congestion, air pollution, chances of accidents, fuel dependence, cost of maintaining /expanding the highways and economic development. The availability of public investment can make these public benefits and achievement of economic viability of the private investment occurs earlier. The analysis revealed the efficacy of public investment when long term private investment may not be initially feasible. In some investments, the case for sustained public investment can be made because of the public benefits achieved.

The following **key findings** may be drawn from the reviews analyzed in this report.

- The most important element for assessing the viability of any inter-modal facility or location is the market and demand for inter-modal freight services moving through the area.
- The three models developed from the reviews reflect several of the current concerns for the state of Washington so they do serve as a useful analytical framework.
- The viability of the inter-modal centers increases when the traffic flow of the agricultural gathering model is combined with the port clearing model, generating backhauls to each respective movement.
- The list of attributes developed from the conceptual framework, the review of literature and the analytical review of inter-modal centers/facilities/ports seem to be basic determinants of economic feasibility.
- The attributes vary by model and situation as to importance and even applicability.
- Many of the attributes developed in the study are directly and critically affected by the competitive ratio of rail rates relative to door-to-door truck rates.
- Each inter-modal center or project is independent in that the relevant attributes are site specific and the methodology developed in this report should be used carefully and with discretion.
- The availability and magnitude of public participation should be evaluated on the basis of public benefits produced by each individual project.
- The overall methodology of evaluating the appropriate attributes of each proposed facility or project to determine economic viability can inform both private decision makers and policy makers of the state of Washington.

REFERENCES

Ballis, Athanasios and John Golias. Comparative Evaluation of Existing and Innovative Rail-Road Freight Transportation Terminals Transportation Research Part A, Vol. 36, (2002), pp. 593-611.

Beuthe, Michel, Bart Jourquin, Jean-Francois Geerts, and Christian Koul a Ndjang' Ha. Freight Transportation Demand Elasticities: A Geographic Multimodal Transportation Network Analysis. Transportation Research Part E, Vol. 37, (2001), pp. 253-266.

Cullinane, Kevin, Dong-Wook Song and Richard Gray. A Stochastic Frontier Model of the Efficiency of Major Container Terminals in Asia: Assessing the Influence of Administrative and Ownership Structures. Transportation Research Part A, Vol. 36, (2002), pp. 743-762.

Fernandez, Enrique J., Joaquin de Cea Ch. and Alexandra Soto O. A Multi-Modal Supply-Demand Equilibrium Model for Predicting Intercity Freight Flows. Transportation Research Part B, Vol. 37, (2003), pp. 615-640.

Friesz T.L., Gottfried, J.A. and Morlok, E.K.,1986. A sequential shipper–carrier network model for predicting freight freight flows. Transp. Sci. 20 (2),80–91.

Guelat,J., Florian,M.,Crainic,B.C.,1990. A multimode multiproduct network assignment model for strategic planning of freight flows. Transp. Sci. 24 (1),25–39.

Nierat, Patrick. Market Area of Rail-Truck Terminals: Pertinence of the Spatial Theory. Transportation Research Part A, Vol. 31, No. 2 (1997), pp. 109-127.

O'Kelly, M.E and D.L. Bryan. Hub Location with Flow Economies of Scale. Transportation Research Part B, Vol. 32, No. 8 (1998), pp. 605-616.

Oum, Tae Hoon. A Cross-Sectional Study of Freight Transport Demand and Rail-Truck Competition in Canada. The Bell Journal of Economics, Vol. 10, No. 2 (Autumn, 1979), pp. 463-482.

Ozment, John. "Demand for Intermodal Transportation in Arkansas", Walton College of Business at the University of Arkansas, http://ntl.bts.gov/data/MBTC%201018.pdf

Pierre, Arnold, Dominique Peeters, and Issabelle Thomas. Modelling a Rail/Road Intermodal Transportation System. Transportation Research Part E, Vol. 40 (2004), pp. 255-270.

Sanjay Melkote and Mark S. Daskin. An Integrated Model of Facility Location and Transportation Network Design. Transportation Research Part A, Vol. 35 (2001), pp. 515-538.

SELECTED BIBLIOGRAPHY

Stark Development Board. Stark Development Board Fact Book, 2002.

R.L. Banks & Associates, Inc. Twin Cities Region Intermodal Terminal Needs Study. January, 1995.

U.S. Department of Transportation, Federal Highway Administration. Funding and Institutional Options for Freight Infrastructure Improvements, 2002.

CPR Augments Expressway Fleet, Adds Track. Canadian Pacific Railway. http://www8.cpr.ca. June 10, 2004.

New River Valley Intermodal Transportation Center. New River Valley Port Development Center. http://www.nrvpdc.org. May 21, 2004.

Newport News Marine Terminal. Virginia Ports. http://www.vaport.com/FAC-term-nnmt.htm. May 12, 2004.

Newports News Marine Terminal (NNMT) Specifications. Virginia Ports. http://www.vaport.com/FAC-term-nnmt-specs.htm. May 12, 2004.

Inland Intermodal Industrial Park. Port of Quincy, http://www.portofquincy.org/intermodal.html, May 21, 2004.

Werner, Ben. "Ports are moving full steam ahead", Savannah Morning News, July 24, 2002.

Big Pasco Industrial Center. Port of Pasco, http://www.portofpasco.org/bpichome.htm, June 7, 2004.

Intermodal Terminal Planned at New York Port. TDC Trace.com. http://www.tdctrade.com. June 1, 2004.

Lotz, Donald. "Elizabeth Port Authority Marine Terminal Permanent Express Rail Intermodal Terminal", Port Authority of New York and New Jersey, July, 1996.

Port Inland Distribution Network. Port Authority of New York and New Jersey, http://www.panynj.com.

BethIntermodal, Transportation and Logistics Services Provider. Bethlehem Intermodal. http://www.bethintermodal.com/home2.htm. June 7, 2004.

Bethlehem Commerce Center. Bethlehem Commerce Center. http://www.bethcommercecenter.com. June 7, 2004.

Intermodal Terminal Network. Gaston County Fact Book 2003. Gaston County Economic Development Commission. 2003.

Auburn Intermodal Facility, Auburn, Maine. Taylor Engineering Associates. http://www.tayloreng.com/inter.htm. June 7, 2004.

Port of Lewiston. Idaho Transportation Department. http://www.idahofuturetravel.info/PDFs/IDPortTrns.PDF. Feb 2003.

Port of Anchorage: Municipality of Anchorage, Alaska. Port of Anchorage. http://www.muni.org/port/index.cfm. June 7, 2004.

Indiana's Public Ports. Ports of Indiana. http://www.portsofindiana.com. May 2004.

Dempsey, Ph.D., J.D., Paul Stephen. "The Law of Intermodal Transportation: What It Was, What It Is, What It Should Be". University of Denver. www.ie.msstate.edu

Chapter Two: Effects of Rail-to-Truck Traffic Shifts. Washington State Department of Transportation. http://www.wsdot.wa.gov/rail/plans/DTA/DTAch_two.cfm. April 26, 2004.

Consdorf, Arnie. "Freight's Fte in the Congestion Quagmire". Better Roads, May, 2003.

Muller, Gerhardt. Intermodal Freight Transportation. Eno Transportation Foundation, Inc. & Intermodal Association of North America. 4th edition. Washington, DC. 1999.

Middendorf, David P. "Intermodal Terminals Database: Concepts, Design, Implementation, and Maintenance" Center for Transportation Analysis, January, 1998.

Taggart, William A., Nadia Rubaii-Barrett, Christopher Good. "Funding and Operation of an Intermodal Transportation Facility at the Santa Teresa Border Crossing". New Mexico State University Department of Government, Public Administration Program. December, 1992.

Hickey, Kathleen. "Location, Location, Location". TrafficWorld, April 28, 2003.

"Steamship Ports: Relating to Inland Intermodal". Cargo Transport Corporation. http://www.ecargotport.com/steamshipLines/ports.htm. May 21, 2004.

Sebo, Donald. "A System Dynamics Approach to Intermodalism at the Port of Lewiston", Idaho National Engineering Laboratory, October, 1995.
Mongelluzzo, Bill. "Bitter Medicine", TrafficWorld, September 8, 2003.

Water Transportation. Tennessee Department of Economic and Community Development, Marketing Division, http://www.state.tn.us/ecd/pdf/water.pdf.

Partnership to Promote Enhance Freight Movement at Ports and Intermodal Terminals. United States Department of Transportation Volpe Center. February, 2000.

Rail Short Haul Intermodal Corridor Case Studies: Industry Context and Issues. Foundatin for Intermodal Research & Education.

Review of ‘The Quonset Port Feasibility Study. TransSystems Corporation. February 14, 2001.

California Marine Transportation System Infrastructure Needs. Marine Exchange of Southern California. March 11, 2003.

Intermodal Connector Needs on the National Highway System: Procedure for Estimating Needs. Oregon Department of Transportation, December 17, 1997.

Louisiana Statewide Intermodal Plan, National Ports and Waterways Institute at Louisiana State University. July, 1995.

Stewart, Richard D., Robert J. Eger III, Libby Ogard, Frank Harder. “Twin Ports Intermodal Freight Terminal Study: Evaluation of Shipper Requirements and Potential Cargo Required to Establish a Rail-Truck-Marine Intermodal Terminal in the Twin Ports of Superior, Wisconsin and Duluth, Minnesota”. University of Wisconsin Transportation and Logistics Research Center, July 15, 2003.

Meyer, Dan. “Twin City Area Railfan Guide”. http://www.skypoint.com. April 17, 1997.

Lakshmanan, T.R., William P. Anderson. “Transportation Infrastructure, Freight Services Sector and Economic Growth: A Synopsis”, Center for Transportation Studies at Boston University, January, 2002.

Paulson, S. Lawrence. “Giving Freight a Voice”, Public Roads. U.S. Department of Transportation Federal Highway Administration. March/April 2001.

Identifying High Priority Freight Mobility Projects. Oregon Department of Transportation, February, 2004.

Davies, Llewelyn, David Banister, Sir Peter Hall. "Transport and City Competitiveness -Literature Review", School of Planning at the University College of London, January, 2004.

Prince, Theodore. "Intermodal Introspective", American Shipper, November, 2002.

Gallagher, John. "Piecing It Together", TrafficWorld, November 11, 2002.

Thomas, Cathy Booth. "On A Faster Track: How America's No. 2 Railroad Went High Tech To Grab a bigger Slice of the Booming China trade", Time, March 8, 2004.

Hickey, Kathleen. "Box View", TrafficWorld, March 24, 2003.

Vantuono, William C. "The Magnificent 7", Railway Age, February, 2004.

Gallagher, John. "Retooling the Gateways: Increasing Customer Visibility on the TRRA could help St. Louis Compete as Gateway Between East and West", TrafficWorld, May 5, 2003.