What Makes them Viable? Determining the Attributes that Offer Potential Viability to Inter-Modal Truck-Rail Facilities in Washington State

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Abstract

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 recognized 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 requited rate of return on public investment.

This paper reports on the development of an applied methodology for determining the potential economic viability of inter-modal truck-rail facilities in Washington State. The focus is on discerning the attributes, characteristics or market situations that are associated with successful projects, thereby suggesting a framework for economic feasibility analysis, from both the public and private view, of an inter-modal truck-rail facility.

A conceptual approach and general model of investigation is first developed in the paper. A focused review of literature followed by a summary of actual and active inter-modal centers allows the development of a series of case studies/models, chosen as examples of facilities performing differing functions in the overall supply chain for exports and imports. These are then combined with a list of attributes that are useful, even critical, to viability, allowing prioritization of the attributes for each type of case study. This then leads to the conclusions and implications of the paper.

STUDY PURPOSE AND ORGANIZATION

Introduction and 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.

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	+

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

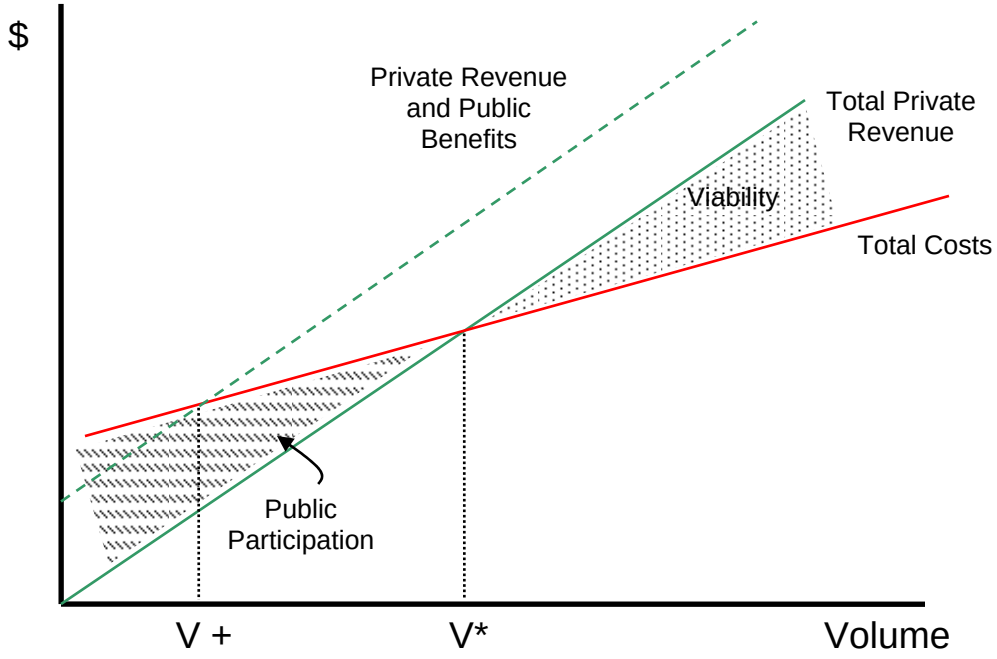
As will be evident in all three of the subsequent case study/models, some degree of public funding participation appears to be a positive attribute aiding economic viability. This activity reflects the desire of development agencies, cities, and ports for economic growth and an understanding of the importance 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



CASE STUDIES/MODELS OF RELEVANCE TO WASHINGTON

A review of the literature, including both governmental and academic reports 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 arises 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.

Case Study/Model 2- Port Clearing Inland Terminal

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 the achievement of economic viability of the private investment, occur 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.

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