AN ANALYSIS OF INTERMODAL TRANSPORT CHOICES FOR PACIFIC-RIM IMPORTS TO THE U.S. NORTH EAST

Shashi N. Kumar, Loeb-Sullivan School, MMA
Vijay Rajan, Loeb-Sullivan School, MMA

Shashi N. Kumar
Chair/Professor, International Business and Logistics
Loeb-Sullivan School of International Business and Logistics
Maine Maritime Academy
Castine, Maine 04420 USA
Tel: 207 326-2454
E-mail: skumar@mma.edu

Vijay Rajan
Loeb-Sullivan School of International Business and Logistics
Maine Maritime Academy
Castine, Maine 04420 USA
Tel: 207 326-2485

Shashi N. Kumar is the Founding Chair/Professor of International Business and Logistics, Loeb-Sullivan School, Maine Maritime Academy, Castine, Maine, USA. His credentials include Ph.D. in transport economics (University of Wales, Cardiff, UK) and MS in Maritime Management (Maine Maritime Academy); he is also a certified Master Mariner (UK). He has published extensively and, is a frequent speaker in international transportation and logistics conferences.

Vijay Rajan was a graduate student in Logistics Management at the Loeb-Sullivan School, Maine Maritime Academy, Castine, Maine.

AN ANALYSIS OF INTERMODAL TRANSPORT CHOICES FOR PACIFIC-RIM IMPORTS TO THE U.S. NORTH EAST

ABSTRACT

The introduction of double stack rail services opened up a variety of transportation options for shippers located in the North Eastern parts of the U.S. The availability of transcontinental double stack service from the Canadian West Coast has increased this option even further particularly because of a recent new service introduced by a small U.S. railroad company. The paper uses Analytical Hierarchy Process (AHP) methodology to provide a decision-making framework for the intermodal choices of shippers located in the region suitable for duplication elsewhere where similar options exist.

INTRODUCTION

We live in an era of unprecedented globalization and decreasing barriers to trade. Although various stakeholders may have different perceptions regarding the Janus-face of globalization, it is unlikely that the world will drift away from increasing free trade. While some traders are constantly seeking new sources for their raw materials, components, and/or finished products, others are constantly in search of new markets to distribute their products. Transportation plays a crucial role in facilitating these supply chains (Morash and Clinton 1997). A recent study emphasizes the need for total integration of supply chains into rigidly managed transport links that interface just-in-time for optimizing performance and facilitating continued growth in world trade (Frankel 1999). This paper analyzes the route and carrier determinant criteria in one such supply chain from the Pacific-Rim region to the North Eastern region of the U.S., also known as the New England region.

The transportation chain for a typical Pacific-Rim import to the New England region would consist of a trans-Pacific liner transit to one of the major container ports on the U.S. or Canadian West Coast, and a subsequent rail intermodal transit to the New England destination. With the evolution of the intermodal option, the traditional all-water option to the U.S. East Coast through the Panama Canal has become less sacrosanct. Although there is a viable all-water option for Asian imports to the East Coast through the Suez Canal, it is generally competitive to the west coast intermodal option only for those cargoes originating in South East Asia. The objective of this paper is to provide a decision-making framework for the intermodal choices of shippers once their Pacific-Rim cargoes reach the U.S./Canadian West Coast.

BACKGROUND

The U.S. has been on the forefront of intermodal innovations and infrastructural investments. The nation has a well-established transportation system that is privately owned and highly deregulated. One of the benefits of railroad deregulation in the U.S. has been the evolution of intermodal networks that facilitate the seamless movement of containerized cargoes to interior points. With the current U.S. intermodal infrastructure, a container that is discharged at a port on the west coast such as Los Angeles can be delivered to major East Coast destinations such as New York in 72 hours. However, one region that did not have the privilege of such rapid transcontinental movements has been the northern New England region. Until recently, the only double stack rail hub for the region was in Worcester, Massachusetts, from where containers had to be trucked long distances to serve the states of Maine, New Hampshire and Vermont. This scenario changed significantly in early 2000 with a strategic acquisition made by St. Lawrence and Atlantic Railroad (SLR), a small private railroad.

The economic deregulation of U.S. railroads gave them the freedom to abandon or sell off sections of their network deemed unprofitable. This particular freedom has resulted in the creation of a number of entrepreneurial short rail operators, the SLR being one such operator. It is one of the seven private railroad companies serving the State of Maine and a fully owned subsidiary of the Emons Transportation Group of York, PA. SLR operates on approximately 165 miles of track between Portland, Maine and Norton, Vermont. SLR tracks are contiguous to the tracks of Saint Lawrence and Atlantic (Quebec), Inc., (SLQ), another fully owned subsidiary of the Emons Transportation Group. Together, SLR and SLQ operate 260 miles of contiguous main-line track between Portland, Maine and Ste. Rosalie, Quebec, crossing the international border at Norton, Vermont. SLQ connects with Canadian National Railway (CN) through which it gains primary rail connection to points in Canada and the Midwestern United States (1999 Annual Report 6). SLR also connects with Guilford Rail System (GRS) at Danville Junction, Maine, which in turn has direct rail links with CSX Transportation (CSXT) and Norfolk Southern Corporation (NS). CN acquired Illinois Central Railroad (IC) on July 1, 1999. CN also has a commercial alliance with the Kansas City Southern (KS), through which it connects to a major Mexican railway at Laredo, Texas (1999 Annual Report 6). Because of its strategic alliance with CN, SLR is able to provide freight services throughout the North American continent. Presently, SLR has the only route in northern New England for intermodal trains that can safely transport hi-cube, double-stacked containers (1999 Annual Report 6). Maine Intermodal Transfer (MIT) facility situated in Auburn, Maine, is another fully owned subsidiary of the Emons Transportation Group. MIT is the first publicly funded intermodal freight transfer facility in the United States for truck to rail shipments. Figure 1 shows the rail connection between SLR and its strategic partners.

<u>Figure 1 about here</u>

In 1998, SLR purchased a section of the New Hampshire & Vermont Railroad and leased the Berlin Mills Railway ("The St. Lawrence"). This acquisition will help SLR in obtaining direct access to a greater number of customers. SLR also owns an oil transfer facility in Portland, Maine that provides railcar delivery to the Crown Vantage facility in New Hampshire (Foley) for which it won the 1997 American Short Line Railroad Association's "Excellence in Marketing" award ("The St. Lawrence"). The railroad has been recognized by Operations Lifesaver for its efforts to promote safety by providing special trains for law enforcement training ("The St. Lawrence").

SLR handled 24,150 carloads during the fiscal year 1999, a growth of 15% from a total of 20,975 carloads in 1998 (1999 Annual Report 6). It has developed its own computer automation process for tracking and reporting intermodal shipments, customers' rates and tariffs, car counts, car switching, locomotive down time, train crew duty time, and other vital information (Foley, 1999). SLR's operating revenue increased from less than $10 million in 1995 to more than $ 17 million in 1999 (1999 Annual Report 6). Besides the above mentioned ASLRA award, SLR received the 1998 City of Auburn Economic Development Achiever's Award and the 1997 Androscoggin Council of Governments Achievement in Transportation Award.

SLR's introduction of double-stack service in the northern New England region provides a very useful intermodal transportation option for the region's shippers. They are now able to handle their Pacific-Rim import and export containers through the Canadian port of Vancouver, BC. The import containers are hauled from the port on CN/SLR tracks to Auburn, Maine and then distributed in the New England area by trucks. This service becomes an alternative to bringing the containers from the Pacific Rim countries to the U.S. West Coast gateway ports--of Seattle, Tacoma, Long Beach or Los Angles--followed by a double stack rail movement to intermodal freight transfer facilities in Massachusetts and a road movement to the final destination. The traditional option involves a transit through the intermodal hub in Chicago, Illinois where the containers are transferred from the BNSF (Burlington Northern Santa Fe) or UP/SP (Union Pacific/Southern Pacific) tracks to the CSX tracks either by road or rail. The transfer operation in Chicago takes approximately 24 hours. These switching costs and the time-related costs associated with various stops escalate the total logistics cost of the imports significantly and thus, the landed cost. It has been suggested that shippers can save in these areas, especially those related to the potential delays in the congested Chicago area by using the Vancouver BC/CN/SLQ/SLR route (Goo 1999). Thus, the shippers of New England-bound Pacific Rim cargoes have highly competing intermodal options that originate from various gateway ports on the Canadian and U.S. west coasts, and hence, this study.

LITERATURE REVIEW

An efficient transportation system is the backbone of any supply-chain. Transportation costs represent an important part of total logistics costs. It also affects the final selling price of goods to the ultimate consumers. While the need to contain transportation costs is fairly obvious, that is not the only issue to be considered. The time and place utilities that transportation create are important elements of customer satisfaction, and a well-conceived and implemented transportation strategy can go a long way toward sustainable competitive advantage in the global marketplace (Lehmusvaara et al. 1999). The choice of transportation route and mode as well as the carrier, are all vital parts of a firm's overall logistics strategy.

It is becoming increasingly apparent that the selection of transportation route and mode is based on many service-related factors rather than only the cost of transportation. The need for strategic involvement of the transportation service provider in the overall supply-chain process of a firm is also becoming crucial. Transportation cost is a major component of the total logistics cost of a firm and an area of major concern for supply-chain managers seeking efficiency. The predicaments facing the decision-maker in these circumstances include:

- Evaluating choices under multiple criteria that are of conflicting nature at times, viz., get the most effective and efficient service at the most economical rate
- Insufficient information because of the dynamic nature of the market
- The need for considering quantitative as well as qualitative data in decision-making

Over the years, a variety of methods have been used to detect determinant attributes and they include Direct Dual Questioning Determinant Attribute (DQDA) (Alpert 1971) and Saaty's Analytical Hierarchy Process (AHP) (Kent and Parker 1998). Armacost and Hosseini refined the AHP technique and produced a technique referred to as AHP-DA that uses the important results derived from AHP and combines them with different measures based on priorities of alternatives. The DQDA and the AHP-DA methods were found equally effective in handling a small number of attributes while the AHP-DA method was found superior in handling a large number of attributes (Kent and Parker 1998). The ultimate goal of both methodologies is to identify the determinant attributes and to integrate them in the firm's supply chain strategy. A 1989 study found that transit-time reliability, transportation costs, total transit-time, rate flexibility through negotiations and financial stability were the five most important attributes in making carrier choices (Bardi et al. 1989). A 1993 study also notes the shift in transportation selection criteria from cost-related issues to service-related issues (Lehmusvaara et al. 1999). Kent and Parker (1998) used AHP to determine that significant differences exist between the importers and exporters on three of the eighteen service attributes mentioned in their study. Import shippers were more demanding of their carriers by requiring door-to-door transportation rates, shipment expediting, and shipment tracking services (Kent and Parker 1998) which the authors suggest could be because of the nature of the products being imported (Kent and Parker 1998). It is important for U.S.-based importers of consumer goods as well as for importers of components that go into their final product assembled in the country to keep a critical eye on their inventory levels. So, both types of importers are dependent on the tracing and expediting capabilities of their service providers. Carriers should formulate their own service strategies based on such information and become a strategic partner in the importer's supply chain. The import shippers, on their part, will choose the carrier that optimizes their supply-chain and build sustainable long-term partnerships.

METHODOLOGY

Lehmusvaara et al. (1999) used AHP and Mixed Integer Linear Programming (MIP)-based optimization in their study and found that reliability, strategic fit, flexibility, continuous improvement, and quality were the five most important transportation attributes considered by the shippers. They determined that the capabilities and cost competitiveness of the transportation mode and carriers might be different for different market areas possibly resulting in a different preference for each market area. This study uses the AHP methodology to find the transportation route and mode selection preferences of importers in the New England region. This was done so because of the model's ability to blend the cost methodology with the desirable qualitative factors into a unified, quantitative system of evaluation (Miller and Liberatore 1996) and its relative ease in estimation especially given the computing capability of today's commonly used spreadsheet software. Although this study focuses on imports from the Pacific Rim, the selection criteria used in this study could be valid for both importers and exporters, and are not constrained by certain geographical region.

While a variety of evaluation criteria are used for selecting transportation route and mode, there are those few criteria that must be present for the choice to materialize. These criteria are referred to as determinant attributes (Alpert 1971). The attributes that actually lead to the selection of transportation route and mode are best determined through the use of direct questioning techniques, and some attributes are more important in the selection process than others (Kent and Parker 1998). The AHP analysis used in this study determines the level of importance shippers give to each of the attributes of transportation route and mode selection criteria. Ninety companies in six New England states that imported at least 50 TEUs per annum from the Pacific Rim nations were requested to rate their preferences for a selection of transportation service attributes.

Determinant Attributes

The first step in the AHP analysis identifies the criteria on which the analysis of transportation mode and route selection is based. The criteria are then structured into a hierarchical form to represent the relationships between the identified factors. Figure 2 illustrates the criteria and sub-criteria at various levels of hierarchy of determinant attributes. The super criteria or the first level of hierarchy considered for the analysis include cost issues, transit time issues and qualitative issues. Transportation costs constitute a major portion of a firm's total logistics cost. Transit time is an important determinant of a firm's carrier selection process because of the critical impact that it might have on the firm's operational and financial strategies. The qualitative component encompasses several sub-components such as the quality of customer service, cargo capacity limitations, and tracking and tracing capability of the carrier.

At the second level of hierarchy, i.e. sub criteria level 1, cost is divided into two components: 1) Freight costs, and 2) Inventory costs. The freight cost includes both the basic freight rate and the flexibility of freight rates. The basic freight rate is defined as the rate for a shipment of a particular type and size, whereas the flexibility of freight rates is the carrier's willingness to negotiate rates based on the volume of shipment.

Inventory cost in this case includes the cost of inventory as well as the inventory carrying cost. Inventory carrying cost includes the capital cost, inventory service cost, inventory risk cost, and storage space cost. Optimal fit of the transportation service with the firm's operational strategy will have a profound impact on the level of inventory the firm will carry for a given customer service level and therefore, it will affect the overall logistics strategy of a firm. The quality of customer service, cargo capacity limitation, and tracking and tracing capability are given the same importance as the freight cost, inventory cost, number of days, and reliability of transit time. These are the various constituents placed at the second level of hierarchy.

At the third level of hierarchy, the second level sub-criteria of quality of customer service, cargo capacity limitation, and tracking and tracing capability are further subdivided into different components. In most industrial domains there is a strong move away from the adversarial relationships of the past towards more collaborative ones. Presently, firms are attributing high importance to lean practices. Lean practices are key to improving supply-chain performance and two important components of lean practice include the high degree of reliance on suppliers and the building of strong partnerships between channel members (KPMG-MIT 1999). The quality of customer service will definitely affect the relationship between the customer and the supplier, and hence, the adoption of lean practices and the supply chain's performance. As more and more firms are realizing the importance of supplier and customer involvement, the issue of customer service is gaining increased attention. Customer service will include the sincerity and the promptness of problem response, the reliability of the service, the billing/invoice accuracy, as well as the EDI capability of the service provider.

A provider of transportation service should have certain regularly available capacity as well as the capacity to meet peak period demand. As an example, the gateway port of Los Angeles handles 70% of its total annual throughput during the five months of July through November. The capacity to meet the peak period demand and the capacity that is regularly available are the two major components of cargo capacity limitation. A carrier's capability to track and trace is becoming another crucial customer service component. Speed, coverage, and accuracy are the three desirable features of a tracking and tracing system. For this reason, these three determinant attributes have been included in the third level of the hierarchy.

In the normal AHP hierarchy, the lowest level of the hierarchy consists of the decision alternatives. However, in order to analyze potential routes and modes with the decision support system, the lowest level of hierarchy consists of ratings instead of actual decision alternatives. During the actual decision making process, the weights of the carriers should be assigned with respect to each of the determinant attributes and after working through different levels of hierarchy, a final choice should be made.

EMPIRICAL ANALYSIS

The sample selected for the study consisted of New England importers that had imported at least 50 twenty-foot containers from the Pacific Rim in 1999. As a majority of the sample came from the states of Massachusetts and Connecticut, 75 importers were chosen randomly from these two states (45 and 30 respectively) to receive the questionnaire developed for the AHP analysis. A total of 15 recipients were randomly selected from the states of New Hampshire, Maine, Rhode Island, and Vermont (eight, three, three, and one respectively). 42 of the recipients were manufacturers and 48, retailers or suppliers.

In a group setting, there are several ways of including the views and judgments of each participant. In this case, the geometric mean of the judgments has been used because it maintains the reciprocal property of the judgment matrix.

The first level analysis was done through pair-wise comparison of individual responses for the supercriteria. Thus, cost, transit-time, and qualitative issues were compared to each other according to the ratings provided by survey respondents and then an average of the normalized values for the attributes was determined for each of the respondents. This was followed by pair-wise comparison of responses at the second level of the hierarchy. That is, freight cost, inventory cost, number of days, reliability of transit-time, quality of customer service, cargo capacity limitation, and tracking and tracing capability were compared to each other within their categories and the average of their normalized values were found.

At the third level of the hierarchy, the different determinant attributes were compared to each other within their own categories, i.e. quality of customer service, cargo capacity limitation, and tracking and tracing capacity, for each of the survey respondents followed by the estimation of normalized average values. The weights of the determinant attributes at the third level of hierarchy was determined by multiplying the average of the normalized values for each of the survey respondents with the average of the average normalized value of the category in the second level of the hierarchy. For example, if the average of the average normalized value for EDI capacity is X and the average of the average normalized value for Quality of Customer Service is Y, then the weight for EDI capacity was determined as XY. The weight for the determinant attributes at the second level of the hierarchy was also found similarly. The excel spreadsheet and in particular its solver function was used for doing all mathematical calculations.

AHP Results

The proposed approach provides a systematic decision-making tool for selecting a particular transportation route and mode. The AHP model makes it possible to evaluate both the qualitative as well as the quantitative elements of a selection process. The overall priority of a certain transportation mode and route preference resulting from the AHP analysis represents the overall preference for using this particular route and mode for that particular geographical area, it being the New England region in this case. At sub-criteria level 2, the capacity to meet the peak period demand was considered to be most important as it received the highest weight (0.056). The next most important criterion was the regularly available capacity of the carrier (with a weight of 0.047). Figure 3 shows the relative weights of the determinant attributes at this level.

<u>Figure 3 about here</u>

At sub-criteria level 1, freight cost was the top priority with a relative weight of 0.220, followed by the reliability of transit-time with a relative weight of 0.214. Figure 4 shows the relative weights of the determinant criteria at sub-criteria level 1.

<u>Figure 4 about here</u>

Figure 5 shows the relative importance of the three determinant attributes at the first level of hierarchy. At this level, the cost issue was considered most important and had a relative weight of 0.373, followed by the transit-time issue with a relative weight of 0.362. The quality of customer service was found to be the least important and had a relative weight of 0.266.

Figure 5 about here

CONCLUSION

The study examines the intermodal route choices of northern New England shippers resulting from the recent introduction of a new double-stack rail option in this region. The AHP model was found to be a useful analytical tool to apply in such decisions, especially given the computing capability of today's commonly available spreadsheet packages. The results of the AHP analysis show that the cost element of the supply-chain was the most important consideration for the survey respondents while formulating their overall supply-chain strategy. Among the cost sub-criteria, freight cost received a higher ranking than inventory cost. This is somewhat surprising given the high attention given to inventory costs in contemporary supply chain management. Among the transit time sub-criteria, as was expected, reliability was placed higher than number of days. The ability of a carrier to deliver as promised is instrumental in implementing various manufacturing and distribution strategies. Although qualitative factors received the lowest overall ranking compared to cost issues and transit issues, the importance given to this criterion is by no means insignificant. However, the relative ranking of the sub-criteria under level 2 was surprising particularly at the lower end. The EDI Capability sub-criterion was placed at the lowest rank and the ability to handle peak capacity the highest. This does not appear to be in sync with the current drive towards greater use of information technology in integrating supply chain activities and creating seamless alliances with channel members.

It is concluded that intermodal service providers for the region take note of the results of the study and note the rankings of the issues considered. Although cost issues appear to be at the forefront, transit time and qualitative issues are also vital in the choices of the respondent shippers. The SLR option will become a credible threat to the more established intermodal options if it meets the shippers' determinant criteria. Further research in this area is recommended as the SLR service is still in its infancy.

REFERENCES

Alpert, Mark (1971), "Identification of Determinant Attributes: A Comparison of Methods," *Journal of Marketing Research,* 8(2):184-91.

Bardi, Edward J., Bagchi and Raghunathan (1989), "Motor Carrier Selection in Deregulated Environment," *Transportation Journal* 29(1):4-11.

Emons Transportation Group, Inc. (1999), *Annual Report,* York, PA: Emons.

Foley, Edward J (1999), Personal Interview, 6 Dec.

Frankel, E. J. (1999), "The Economics of Trans-Ocean Supply Chain Management," *International Journal of Maritime Economics* 1(1):61-70.

Goo, Sara K. (1999), Tiny Railroad Seeks Gold in New Northeast Passage, the Wall Street Journal, 1 Dec., pp. 2-3.

KPMG-MIT Joint Study (1999), Performance Trends in Consumer Markets Global Supply-Chain, <http://www.us.kpmg.com/cm/article-archives/actual-articles/chain_1.html>

Kent, John L., and Stephen K. Parker (1998), "Determinant Criteria in the Ocean Carrier Selection Process" *Journal of Transportation Management* 10(2):57-63.

Lehmusvaara, Antii, Touminen and Korpela (1999), "An Intergrated Approach for Truck Carrier Selection," *Journal of Transportation Management* 11(1):5-20.

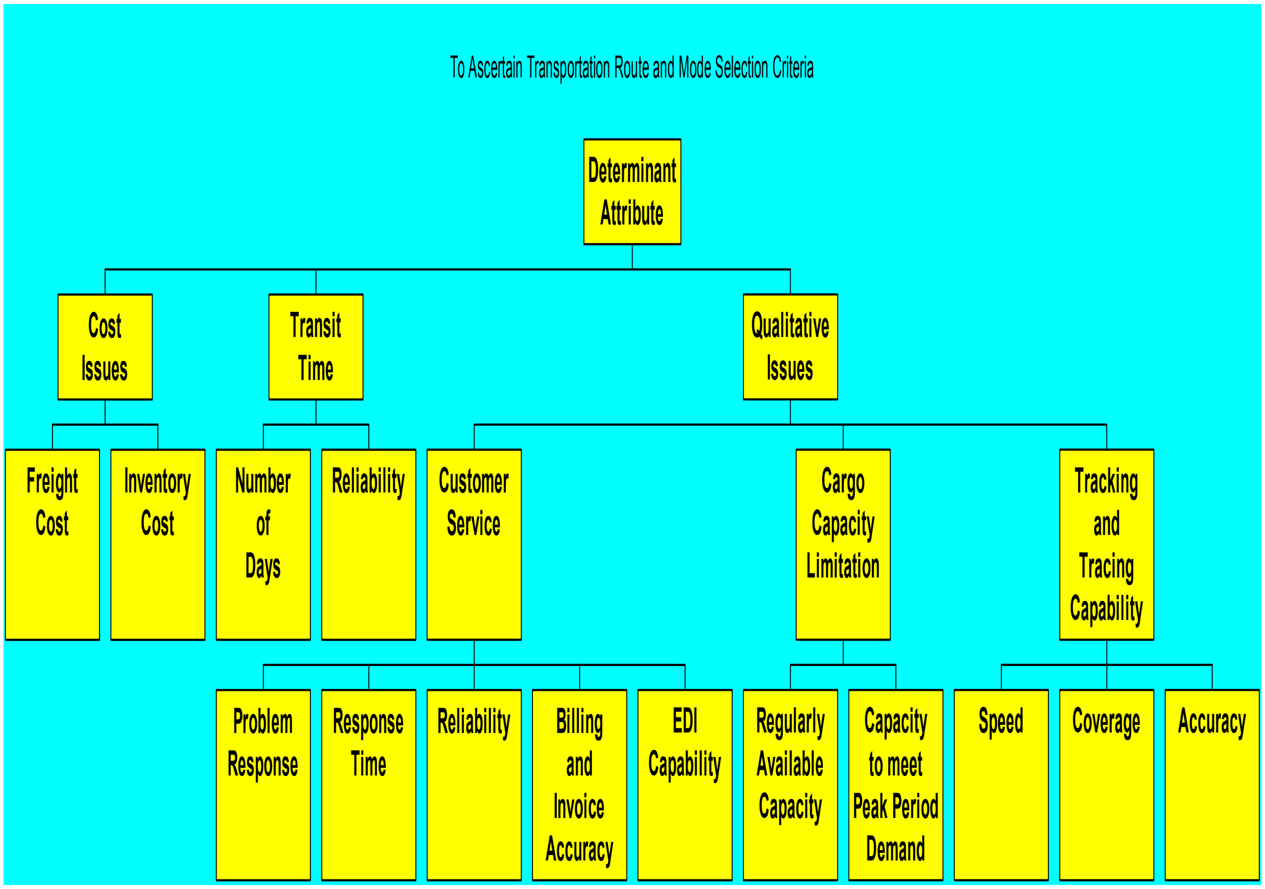
Miller, Tan and Matthew Liberatore (1996), "Strategic Moves in Transportation Pipeline," *Distribution*, Feb., pp. 24-28.

Morash, Edward A and Steven R. Clinton (1997), "The Role of Transportation Capabilities in International Supply Chain Management" *Transportation Journal* 37(1):5-17.

Figure 1

Figure 1: North American Rail Connections of SLR
(Source: Emons Transportation Home Page)

Figure 2



Ratings Equally preferred | Moderately preferred | Strongly preferred | Very strongly preferred | Extremely preferred

Figure 2. Hierarchy of Determinant Attributes for Transportation Route and Mode Selection

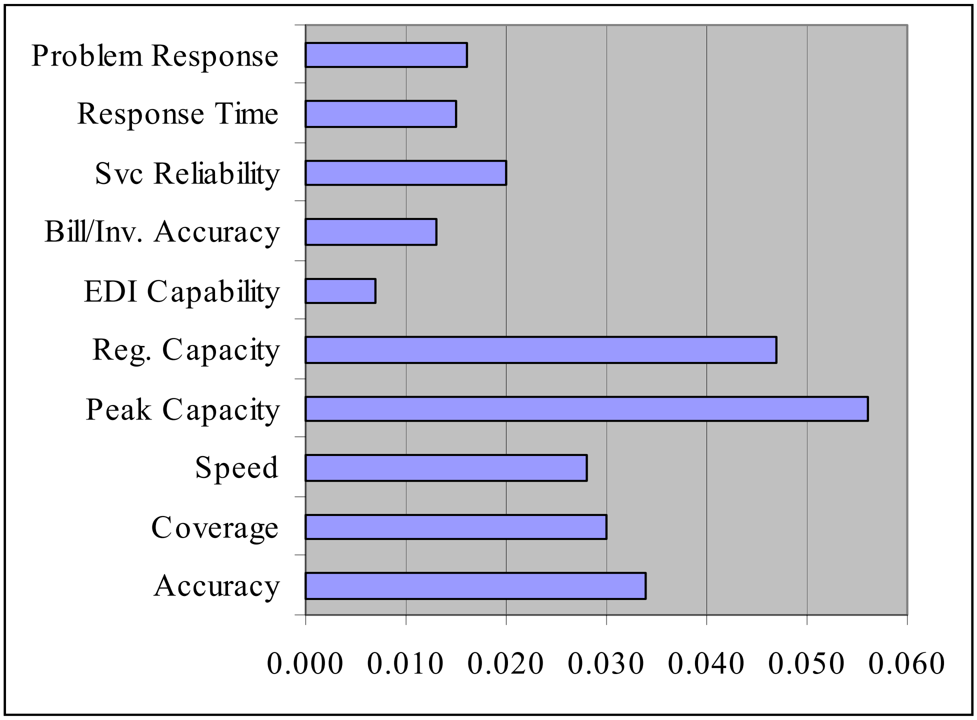


Figure 3. Relative Weights at Sub-Criteria Level 2

Figure 4. Relative Weights at Sub-Criteria Level 1

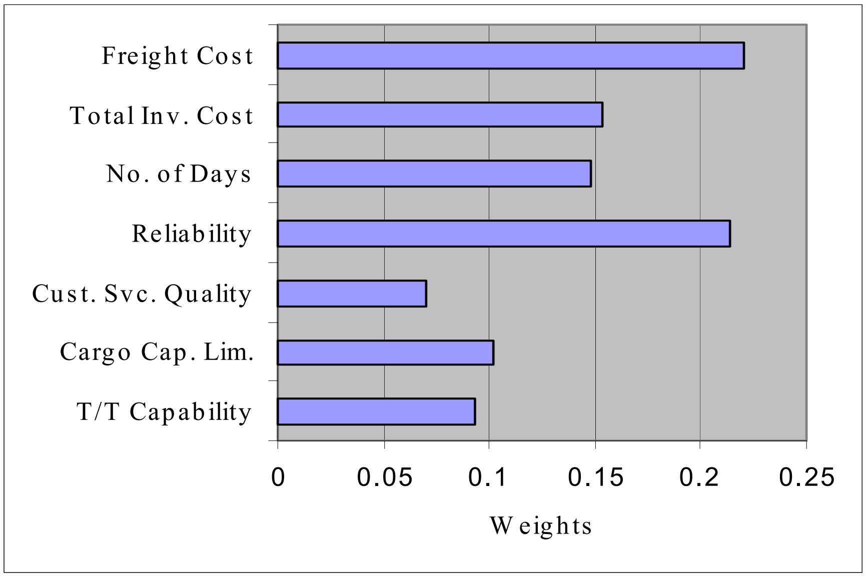


Figure 4. Relative Weights at Sub-Criteria Level 1

Figure 5: Relative Weights at the First Level of Hierarchy