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AN EXPLORATORY ANALYSIS OF FACTORS DRIVING INTERMODAL TRANSPORTATION USAGE

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The purpose of this study is to investigate certain aspects of a transportation choice model proposed by Krapfel and Mentzer (1982) pertaining to the influence of shipper perceptions on the selection of a mode. Specifically, this study attempts to identify the impact that shipper perceptions of intermodal and over-the-road truck service, as well as other characteristics of the shipper, have on intermodal usage. The research findings support the notion that shipper perceptions affect modal usage and indicate areas in which intermodal providers should focus their attention to improve intermodal usage.

INTRODUCTION

Intermodal transportation provides an essential integration of modes for freight both within North America and around the world. At the recent Intermodal Transportation Summit (University of Denver, October 1997), U. S. Secretary of Transportation, Rodney Slater, defined a vision of America's transportation system in the 21st century. "It is important it be an integrated system. That is be international in reach, intermodal in form, intelligent in character, and inclusive in service...unless we bring highways, transit, rail, airports, and seaports together, we will not be as efficient as we need to be." Continuing on, he added that intermodal is the fastest growing sector in American freight transportation.

At that same Summit, Ed Emmett, President of the National Industrial Transportation League, noted that, along with being a seamless, integrated method of transport, intermodal transportation must also provide cost-effective customer service to the shipper. It is well known that providing service that meets or exceeds a customer's (in this case, a shipper's) expectations will provide customer satisfaction (Oliver 1980), which often leads to loyalty. However, it is not just service performance that is important, but also customer perception of the service that is essential in determining whether a customer will continue purchasing from a particular company or industry segment (Tucker 1980). Regarding intermodal transportation, Evers, Harper, and Needham (1996) found that the most important service

factors influencing shipper perceptions of the intermodal sector were timeliness and availability.

The purpose of this study is to identify the impact that shipper perceptions of the intermodal and motor carrier sectors, as well as other characteristics of the shipper, have on intermodal usage. Though exploratory in nature, the research findings indicate areas in which intermodal providers should focus their attention to improve intermodal usage. The paper is organized as follows: first, relevant previous research efforts are highlighted as justification for the research question; next, the source of data for this study is discussed along with the methodology; the results are then examined; and finally, conclusions, as well as future research directions, are noted.

SPECIFICATION OF RESEARCH QUESTION

Tucker (1980) suggested that it is not so much the actual performance as it is the customer's perception of performance that is important in a business-to-business transaction. The well-known disconfirmation theory of satisfaction holds that a customer compares his or her expectations with the perceived performance received (Oliver 1980). Only if the perceived performance is equal to or greater than the expectation is the customer satisfied. This was originally applied to consumer transactions but has recently been extended to relational business-to-business settings (Emerson and Grimm 1996).

The level of expectations of performance that are ultimately met, however, may not yield a satisfied customer (Spreng, MacKenzie, and Olshavsky 1996). For example, if a customer expects a low level of performance from a vendor for whatever reason, and the vendor meets that expected low level of performance,

the customer is not necessarily satisfied. Furthermore, social exchange theory argues that choice is determined by a comparison with available alternatives (Thibaut and Kelley 1959). "...For a relationship to be viable, it must provide rewards and/or economies in costs which compare favorably with those in other competing activities (Thibaut and Kelley 1986, p. 49). This comparison may prescribe the level of initial expectation used by the customer in determining his or her satisfaction.

Along the same lines, Krapfel and Mentzer (1982) proposed that shippers choose transportation modes based at least partly on their perception of services offered. Their efforts established a framework for studying the impact that shipper perceptions of transportation service (instead of just the actual service performance) have on shipper choice. In a survey of innesota manufacturers, Harper and Evers (1993) compared shipper perceptions of intermodal, railroad, and over-the-road truck service. They concluded that shipper perception of intermodal service was better than that of rail service but not as good as that of truck service. Evers, Harper, and Needham (1996) determined that shipper perception of timeliness and availability were the most important drivers of overall shipper perception of transportation service, with cost, firm contact, restitution, and suitability also having some influence. Using two different sources of data, the Minnesota data and data from the Intermodal Index (this second source will be discussed in more detail later), they found that these service perception factors varied only slightly in importance over time and by transport mode.

This study is intended to examine the notion posed by Krapfel and Mentzer that shipper perceptions influence their choice of modes. Overall shipper perceptions of the modes

(including competing modes as suggested by Harper and Evers) are used to examine this effect, since overall perceptions have been shown by Evers, Harper, and Needham as being comprised largely of shipper perceptions of individual service factors. Of course, other factors besides shipper perceptions also affect modal usage. These factors may include both shipper characteristics, such as items being shipped and size of firm, as well as carrier characteristics, such as actual service performance (in terms of transit times, reliability, etc.) and size of carrier. A model of modal usage incorporating these relationships is shown in Figure 1.

Specifically, the first set of arrows in Figure 1 (linking the individual service perception factors to the overall perception of the mode) has already been addressed by Evers, Harper, and Needham as it relates to intermodal transportation and, therefore, will not be considered in this study. The second set of arrows (connecting overall perception and other characteristics to modal usage) is in accordance with Krapfel and Mentzer and represents the relationships of interest here. In particular, this research focuses on the usage of intermodal transportation versus truck transportation.

SOURCE OF DATA AND METHOD OF ANALYSIS

The data for this research come from the *Intermodal Index*, a five year study (1990-1994) co-sponsored by the Intermodal Association of North America and the National Industrial Transportation League and carried out by Mercer Management Consulting. Approximately 500 telephone responses were compiled each year from a wide range of companies (the responding firms generally differed from year to year), though not every company answered every question.

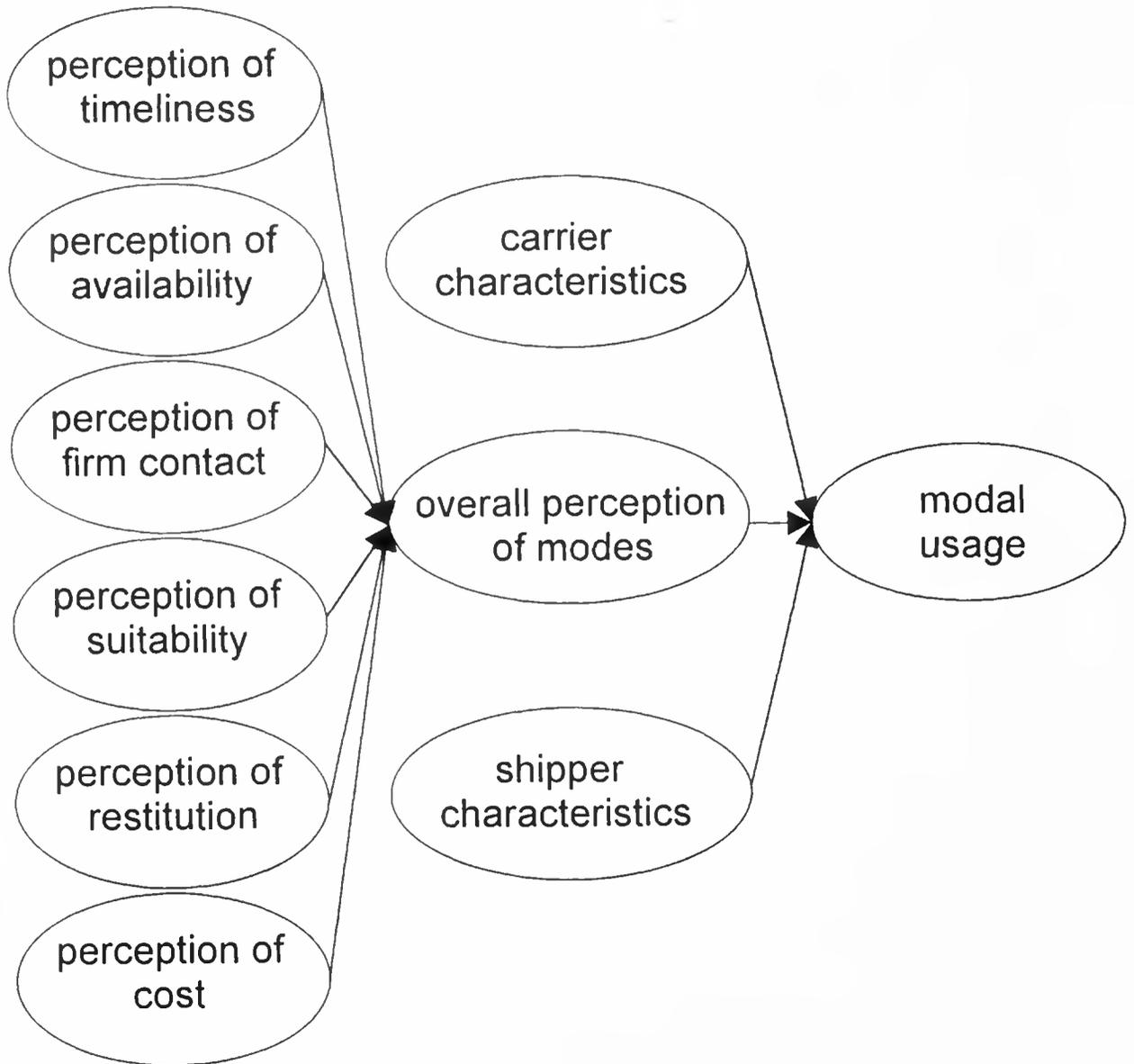
Exploratory regression analysis was used to identify the factors influencing the use of intermodal transportation. The dependent variable, which measured intermodal usage, was regressed onto independent variables measuring overall shipper perceptions and other pertinent characteristics. The specification of the linear regression equation is as follows:

$$\text{Intermodal usage} = \alpha + \beta_1 (\text{overall perception}_i) + \beta_j (\text{shipper characteristic}_j) + \delta_k (\text{year}_k) + \varepsilon$$

where: each β represents a regression coefficient indicating whether a link actually exists between the dependent and independent variables (in Figure 1, this is associated with the second set of arrows); each δ is associated with a year dummy variable to account for any changes that may arise over time; α represents the intercept; and ε represents the error term. Because of the nature of the data, carrier characteristics were not available and, hence, could not be examined.

Regarding the dependent variable, intermodal usage was defined as the proportion of a shipper's total trailerload and containerload shipments moving over 500 miles via intermodal transportation; as this proportion increases, intermodal usage increases relative to over-the-road truck usage. Regarding the independent variables, overall shipper perceptions were obtained for both intermodal and motor truck transportation. Respondents were asked for their overall perception of intermodal and truck service, separately, on a scale of 1 (poor) to 5 (excellent). Shipper characteristics included their awareness of third party providers and of railroad carriers, the susceptibility of their product to damage, the size of their company and its type, the density of their product, and the value of their shipments.

FIGURE 1
MODEL OF MODAL USAGE



Awareness of third party providers was measured as the number of intermodal marketing companies (IMCs) that the respondent was familiar with from a list of seven major ones (Alliance, APL Distribution Services, Con-Way Intermodal, Greater South [GST], Hub City, Mark Seven, and C.H. Robinson). Consequently, 0 indicated that the respondent was not familiar with any of the IMCs, and 7 indicated that the respondent was familiar with all of them. Awareness of railroad carriers was similarly measured from 0 to 7 (in the 1990-1994 time frame there were seven major U.S. railroads: Burlington Northern, Conrail, CSX, Norfolk Southern, Santa Fe, Southern Pacific, and Union Pacific). Susceptibility of product to damage during transit was measured as either 1 for high (very sensitive), 2 for medium (somewhat sensitive), or 3 for low (not very sensitive). Size of firm indicated the responding company's annual revenue level, ranging from a low of 1 (less than \$50 million) to a high of 5 (greater than \$1 billion). Type of firm identified whether the respondent's company was primarily a manufacturer, retailer, or wholesaler/distributor. Product density was measured as either heavy (item weighs out a 48-foot trailer before it cubes out) or light (item cubes out a 48-foot trailer before it weights out). Shipment value was also measured relative to a 48-foot trailer: high (if \$100,000 or more), medium (if between \$30,000 and \$100,000), or low (if \$30,000 or less). These last three shipper characteristics (type of company, product density, and shipment value) were modeled using dummy variables.

Average values for the dependent variable (intermodal usage), as well as for certain independent variables (the overall perception and awareness variables), are shown in Table 1 on a year-by-year basis. Over the five-year period, the mean percentage of a shipper's total trailerload and containerload shipments

handled by intermodal over 500 miles was fairly stable, averaging between roughly 22% and 23% (this does not mean that intermodal transportation had a 22-23% market share since these averages are not weighted by volumes). During that same time frame, the average overall shipper perception of intermodal service consistently lagged behind that of motor truck service (a result in accordance with the aforementioned findings of Harper and Evers using a different data set). While shippers were, on average, generally aware of almost all railroad carriers (out of a maximum seven possible, the annual average fluctuated around six), they were less aware of the major third party providers (the yearly average was between four and five, again out of a maximum seven possible).

Of the 1471 respondents during the five years, the overwhelming majority of them were manufacturers (nearly 81% versus 16% for wholesalers/distributors and 4% for retailers). Roughly 70% of the respondents shipped heavy density items while the remaining 30% shipped light density items. Slightly over half of all respondents (approximately 51%) reported making shipments of medium value (\$30,000 to \$100,000), with the rest almost equally distributed between low (23%) and high (26%) value shipments. Susceptibility of product to damage was a bit less unevenly disbursed: 38% of respondents reported low susceptibility; 45% reported medium; and 17% reported high. In terms of annual revenues, firm size was fairly spread out as well. Respondents reporting revenues of less than \$50 million represented about 26% of the total; those between \$50 million and \$100 million represented 19%; those between \$100 million and \$400 million represented 26%; those between \$400 million and \$1 billion represented 13%; and those over \$1 billion represented 17%. All of these observations were fairly stable over the five-

TABLE 1

MEAN VALUES OF SELECTED VARIABLES BY YEAR

<u>Year</u>	<u>Intermodal usage</u>	<u>Overall perception of intermodal</u>	<u>Overall perception of trucking</u>	<u>Awareness of third party providers</u>	<u>Awareness of railroad carriers</u>
1990 (214 ^a)	.231 ^b	3.879 ^c	4.107 ^d	4.107 ^e	6.061 ^f
1991 (282)	.217	3.734	4.138	4.135	6.266
1992 (295)	.219	3.708	4.115	4.136	5.892
1993 (320)	.223	3.662	4.078	4.616	6.316
1994 (360)	.238	3.539	4.008	4.911	6.519
Total (1471)	.226	3.687	4.084	4.426	6.234

^anumber of observations

^bproportion of all vehicle-load shipments over 500 miles

^cscale of 1 (poor) to 5 (excellent)

^dscale of 1 (poor) to 5 (excellent)

^escale of 0 (none) to 7 (all)

^fscale of 0 (none) to 7 (all)

year period. (Some percentages do not add up to 100% due to rounding.)

RESULTS OF REGRESSION

An initial regression was performed that incorporated all of the independent variables mentioned above. However, a number of the regression coefficients proved to be insignificant. Since the research was exploratory in nature (the intent was to determine whether relationships exist), other

regressions with fewer variables were run. By eliminating some of the insignificant variables and combining the susceptibility to damage variable with the density dummy variables, a parsimonious model was readily constructed (the year dummies were left in to show that time does not have an impact on intermodal usage). Results of this model are presented in Table 2.

Before examining the regression coefficients and their implications, the overall model

**TABLE 2
REGRESSION RESULTS**

Dependent variable = intermodal usage (proportion of all vehicleload shipments over 500 miles)

Model F-statistic = 8.736

p-value = .0001

R-square = .062

Adjusted R-square = .055

Significant coefficients:

<u>Independent Variables</u>	<u>Parameter Estimate</u>	<u>Std. Error</u>	<u>t-stat.</u>
Intercept	0.208	0.054	3.880
Overall perception of intermodal	0.064	0.009	7.267
Overall perception of trucking	-0.059	0.011	-5.425
Awareness of third party providers	0.011	0.004	2.873
Susceptibility to damage x light density	0.013	0.007	2.000
Medium shipment value	-0.039	0.017	-2.249
Low shipment value	-0.048	0.020	-2.421
Wholesaler/distributor	0.058	0.019	3.053
1990	-0.014	0.023	-0.618
1991	-0.018	0.021	-0.830
1992	-0.014	0.021	-0.667
1993	-0.015	0.020	-0.711

diagnostics need to be discussed. While the F-statistic indicates that the regression model is significant at a 99% confidence level, the adjusted R-square term, a measure of the percentage of total variation in the dependent variable explained by the variation in the independent variables, is very low. The low score obtained in this model (5.5%) suggests that the items considered here do not have a large effect on intermodal usage and that other items not considered here might have a greater effect. This is not surprising since carrier characteristics, including such factors as actual transit times and reliability, were not available. It is expected that these other items, especially those related to actual service performance, would have a substantial impact on modal usage. Nevertheless, overall perceptions and shipper characteristics do, in general, have some substantive effect on intermodal usage.

The results indicate that a number of specific factors have a significant impact on intermodal usage. One factor positively related to usage is the firm's overall perception of intermodal transportation. As the firm's overall perception of intermodal increases, its usage of intermodal also increases. On the other hand, the firm's overall perception of over-the-road truck transportation is negatively related to intermodal usage. The more highly a firm perceives motor carrier service, the less likely it is to use intermodal transportation. In addition, as a firm's awareness of third party intermodal providers increases, its intermodal usage also increases. Moreover, shippers of light density products, especially those that are less susceptible to damage, are more likely to use intermodal. Usage of intermodal transportation is also more likely for firms having higher valued shipments than for those having lower valued shipments. Lastly, the research finds that wholesalers/distributors tend to use intermodal transportation more than either manufacturers or retailers do.

Conversely, a couple of factors had no influence on intermodal usage. Neither shipper awareness of railroad carriers nor shipper size had a significant impact on intermodal transportation use. The year of the data had no effect, either.

Closer inspection of these results yields some interesting insights, most of which would be expected, into intermodal transportation usage. The analysis lends support for the argument made by Krapfel and Mentzer that perceptions influence behavior. The positive relationship between the overall perception of intermodal and the use of intermodal is an obvious indication of this. Indeed, as the perception of intermodal improves, increases in usage are fairly sizeable according to the corresponding regression coefficient. The negative relationship between the perception of over-the-road trucking and the use of intermodal is another clear indication of this. Interestingly, the regression coefficient associated with the perception of trucking is nearly as large as, but in the reverse direction of, the coefficient associated with the perception of intermodal, suggesting that shippers use trucking as a reference point when deciding on whether to use intermodal and to what extent.

The other regression coefficients give some indication of which shipper characteristics are important and which are not. Shipper awareness of railroad carriers has no impact on intermodal usage. This is not surprising since many shippers do not deal directly with railroads for intermodal service; instead, they often use IMCs to arrange for service. In addition, since there are only a handful of major railroads, it is probably the case that most shippers are aware of all or nearly all of them whether they use intermodal or not. Consequently, their awareness of railroad carriers does not affect their use of intermodal.

However, their awareness of IMCs does have an effect. Since IMCs play an integral part in making intermodal service available to the public, it is not unexpected that increased awareness improves intermodal usage. As IMCs and their offerings become more widespread and better known, shippers may be more inclined to use them.

The product being shipped also affects intermodal usage. Items that are low in density and difficult to damage, as well as those that are high in value, are more likely to be shipped via intermodal. Rightly or wrongly, intermodal service may still be associated by many with railroad service, which may directly lead to the finding that light density items not prone to damage have a greater tendency to be shipped via intermodal. Along these same lines, though, the finding that higher valued shipments have a greater tendency to be shipped by intermodal is surprising.

The conclusion that time does not have an impact on intermodal usage is also interesting. The early 1990s represented a period of dramatic growth in intermodal traffic. However, this did not translate into any fundamental changes in terms of when shippers decide to use intermodal transportation. Nor did shipper size (in terms of annual revenues) influence this decision. Lastly, according to the analysis, wholesalers and distributors are more inclined to use intermodal than either manufacturers or retailers are. Since most retailers have little opportunity to effectively employ intermodal transport, it is not surprising that they do not use it much. However, it is difficult to explain why manufacturers do not use intermodal as much as wholesalers and other intermediaries do; perhaps it is the nature of the latter's business that somehow lends itself better to intermodal transport.

CONCLUSIONS AND IMPLICATIONS

The study reported here was performed chiefly to determine whether a relationship existed between overall perceptions and modal usage. Specific shipper characteristics were factored into the analysis to determine their impact as well. Since this research was exploratory in nature, it would be inappropriate to generalize a lot of conclusions. Indeed, a follow-up longitudinal questionnaire (similar to the original *Intermodal Index*) is presently being administered. This subsequent survey will be used to test hypotheses derived from the above findings. Nonetheless, the current work sheds some light onto the shipper's decision to employ intermodal transportation.

An important managerial implication of this research is that intermodal providers (including IMCs, railroads, and drayage carriers) should work to improve the overall perception of the transportation service they offer. By enhancing shipper perceptions of the service, the percentage of a shipper's total vehicleload shipments handled by intermodal should increase. As previous research has shown, timeliness and availability are the two primary areas that should be addressed when attempting to improve shipper overall perceptions. This may not be easy, but it is necessary. For example, while recounting its efforts to improve the perceptions of intermodal held by two large shippers at the most recent International Intermodal Expo (Dallas, May 1998), a major IMC noted that it was a tough task but, ultimately, should lead to increased usage (Cottrill 1998).

Another managerial implication involves actual service performance, since satisfaction is also related to desires (Spreng, MacKenzie, and Olshavsky 1996). That is, if customer expectations are low, and intermodal providers simply meet those low expectations, it is likely

that the customer will remain unsatisfied and thus be unwilling to continue choosing intermodal. Therefore, service improvements might be necessary as well.

Intermodal providers also need to recognize that shipper perceptions of over-the-road trucking also affect intermodal usage. As a result, these providers must develop effective strategies to counter this tendency. One possible strategy is for intermodal providers to ensure that shipper perceptions of trucking are not unjustifiably high. Two additional strategies include focusing attention on traffic lanes in which trucking services are perceived as inferior and improving perceptions (and performance) of intermodal in lanes where perceptions of trucking are high in order to offset the latter's effects.

While the preceding implications are relatively straightforward, the final two implications are a

bit less obvious. According to the findings, intermodal usage was directly related to shipper awareness of third parties but not to shipper awareness of railroads. Thus, if shippers are unaware that intermodal service is available, that IMCs arrange for intermodal service and deal with the issue of complexity, or that multiple and competing IMCs exist, they will avoid using intermodal transportation. On the other hand, knowledge of the actual railroad service providers does not matter to shippers. To increase intermodal usage then, third party providers should strive to enhance awareness by expanding marketing communications. The positioning may be related to ease of use and cost savings relative to over-the-road trucking. Railroads, however, can refrain from making significant marketing expenditures since they do not have an effect, perhaps using the monies instead to improve their service offerings.

AUTHORS' NOTE

Along with an abstract, the results of this paper were presented at the 1998 Intermodal Distribution Education Academy, held in conjunction with the 1998 International Intermodal Expo in Dallas, TX.

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