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From the Editor...

I am happy to say that the state of the U. S. economy is far better at this writing than the last. The resilience of industry and the American people is evidenced by the continuing economic recovery. While we continue to recover from the aftermath of terrorism, we must remain vigilant and further strengthen transportation security. Our industry is the link that unites commerce and culture around the world.

You will no doubt have noticed the date on this issue of the *Journal*. The Board of Directors of Delta Nu Alpha voted to skip one publication year, in order to "catch up" with the issue date. This issue then, Volume 13, Number 1, Spring, 2002, will reach you in either late spring or early summer. Authors of the articles appearing in this issue will be very pleased with this decision. They will no longer have to explain to their colleagues why their work, published in the current year, carries last year's date. As I have explained to our readers previously, the lag in publication has been due to an insufficient volume of quality submissions—not to slow reviewers! I am confidant that this decision to skip publication dates in 2001 is the right one and that it will not be necessary again.

As a subscriber, you may be wondering whether or not you are due a refund of part or all of your subscription. I have been editor of the *JTM* for the past six years, and have published two issues each year, as will be the case in 2002. Since each subscriber will continue to receive two issues per year, each will receive exactly what they have paid for!

The subject matter of this issue is robust, ranging from trucking profitability to transportation policy issues. There should be something here for every reader, regardless of his or her position in industry. The lead article in this issue, by Hokey Min, describes an in-depth case study measuring the impact of lumper costs, empty miles, and shipment size on motor carrier profitability. The second article, by Ted Farris and Phil Wilson, examines attrition in the on-line grocery industry. They focus on logistics principles that play a large part in determining success or failure in this area of e-commerce. Shashi Kumar and Vijay Rajan follow the path of imports from Pacific-Rim nations to New England in the third article of this issue. They use Analytical Hierarchy Process methodology to develop a framework for shippers to use in evaluating intermodal transportation options. Drew Stapleton and a group of graduate students at the University of Wisconsin–La Crosse take a look at the current state of high-speed rail development in the U.S. in the fourth article of this issue. They report on the feasibility of creating high-speed rail options for passengers and freight in several urban market areas. In the final article of this issue, Steve Rutner and Brian Gibson review the literature and research in the area of Transportation Management Systems (TMS). They also identify several relationships between TMS and other types of information systems in use in logistics and transportation firms. They conclude by identifying numerous future research opportunities in the area. As always, I hope you take the time to read each of the articles in this issue.

In closing, remember that we cannot survive and continue to publish without reader support. Please join or renew your membership in Delta Nu Alpha International Transportation Fraternity and subscribe to the *Journal of Transportation Management.* Remember that, if you join DNA at the Gold level, a subscription to the *JTM* is included in your membership! Share this issue with a colleague and encourage him/her to subscribe today!

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Journal of Transportation Management

OBJECTIVES

Editorial Policy. The primary purpose of the *JTM* is to serve as a channel for the dissemination of information relevant to the management of transportation and logistics activities in any and all types of organizations. Articles accepted for publication will be of interest to both academicians and practitioners and will specifically address the managerial implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to the management of transportation and logistics activities, would be inappropriate for the *JTM*.

Acceptable topics for submission include, but are not limited to carrier management, modal and Intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics and purchasing and materials management are acceptable as long as they are specifically related to the management of transportation and logistics activities.

Submissions from industry practitioners and from practitioners co-authoring with academicians are particularly encouraged in order to increase the interaction between the two groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

The opinions expressed in published articles are those of the authors and do not necessarily reflect the opinions of the Editor, the Editorial Review Board, Delta Nu Alpha Transportation Fraternity, or Georgia Southern University.

PUBLISHING DATA

Manuscripts. Four (4) copies of each manuscript are to be sent to Dr. Jerry W. Wilson, Department of Information Systems & Logistics, Georgia Southern University, P. O. Box 8152, Statesboro, GA 30460-8152. Manuscripts should be no longer than 25 double-spaced pages. Authors will be required to provide electronic versions of manuscripts accepted for publication. Guidelines for manuscript submission and publication can be found in the back of this issue.

Subscriptions. The *Journal of Transportation Management* is published twice yearly. The current annual subscription rate is $50 domestic and $65 international in U.S. currency. Payments are to be sent to the editor at the above address.

THE IMPACT OF LUMPER COSTS, EMPTY MILES, AND SHIPMENT SIZE ON THE PROFITABILITY OF MOTOR CARRIERS: A CASE STUDY

Hokey Min
University of Louisville

ABSTRACT

The passage of landmark deregulatory reforms in the Motor Carrier of Act of 1980 has constantly pressured the U.S. trucking industry to reduce transportation costs. Thanks to such pressure, total logistics costs have declined from 16.5% in 1980 to 10.1% of gross domestic product (GDP) in 2000. In particular, transportation costs have fallen from 7.6% to 5.9% of GDP in 2000. Transportation cost savings definitely benefit shippers, while jeopardizing the viability of carriers. To help transportation carriers cope with enormous cost pressure, this paper examines the impact that "lumper" costs, empty miles, and shipment size have on the very competitive trucking industry. Through an actual case study of a firm based in the Southeast U.S., we illustrate how lumper costs, empty front-haul and backhaul, and shipping weight and pieces can adversely affect the trucking firm's profitability.

BACKGROUND

In 2000, although the trucking industry's share of the nation's freight bill increased slightly to 81.5%, the demand for trucking services declined significantly. Such a decline in demand led to a record number of trucking company failures for the last two years. In fact, Wilson and Delaney (2001) reported that there were over 3,600 bankruptcies in the trucking industry, an increase of 35.5% over the previous high in 1997. In 2001, trucking companies failed at a rate of about 1,000 every three months (Reiskin, 2001). The high failure rate of trucking companies is partially due to slow revenue growth during the recent economic slump. In addition, fuel and carrier insurance costs are rising dramatically. For instance, the average cost of a gallon of diesel fuel has increased 73 % over the last 18 months (Lynch, 2001). Insurance costs have almost doubled as underwriters left the market and the September 11 terrorist attack exacerbated the security problem (Wilson and Delaney, 2001). The concern over the profitability of the U.S. trucking industry is growing despite strong shipment growth and a moderate increase in freight rates over the last few years. Such anxiety often stems from rising fuel prices, chronic driver shortages, and increasing competition. To make matters worse, some

shippers have frequently charged hefty "lumper" costs to their carriers and subsequently undermined the carrier's profitability. Herein, a lumper is referred to as a contract laborer who is hired to unload shipments of goods. The cost of using a lumper is usually charged per load to a carrier. The lumper charge can also vary from one load to another and/or one shipper (customer) to another.

In addition, with the growing demand of shippers for quick-response services and the increasing effort of carriers to meet their drivers' needs for more time at home, empty miles are piling up. These empty miles can further reduce the motor carrier's thin profit margin and decrease competitiveness. During the period between 1980 and 1997, the average business failure rate for motor carriers was 143 per 10,000 compared to an average failure rate of 90 per 10,000 for other businesses (Roth, 1999). An important issue facing motor carriers is whether they should continue to absorb lumper charges. To help the carrier resolve this issue, this paper examines the effect of lumper cost and empty miles on motor carrier profitability. For the analysis, actual data were obtained from a company which primarily uses private carriers.

RESEARCH METHODOLOGY

This study is based on the case analysis of a manufacturing firm that is headquartered in the Southeastern United States. To ensure the confidentiality of the data, this firm is referred to as "*Gamma*." *Gamma* is a leading manufacturer of bed and bath products such as tablecloths, shower curtains, and towels. *Gamma* markets products under different brand names including *Ralph Lauren, Espirit, Martex, Vellux* and *Lady Pepperell*. They also operate over 40 outlet stores in the U.S. and Canada and recorded a total of more than $1.6 billion in annual sales for the past several years. However, in recent years, their annual sales have been somewhat stagnant. Consequently, they have begun to scrutinize their current cost/revenue structure to stay competitive and profitable. One of the areas they have looked at closely is transportation cost.

In particular, *Gamma*'s management team was concerned about the uncontrollable and unpredictable lumper charges made to their fleets of carriers. Among the number of customer stores that they serve, these charges often fluctuate from one store to another and differences in lumper charges among different stores can be as high as $375. These customers include *Ames, Bradlees, Kmart, Macy's* and *Sterns*. In addition to lumper charges, some of the deliveries resulted in significant percentages of empty miles (a maximum of up to 82% for front-haul, 70.6% for backhaul). The added costs resulting from lumper charges and empty miles contributed to a loss reaching as high as $1,800 per store delivery.

A sample of 260 manifests and 191 freight bills was selected from *Gamma*'s customer files for a two-year span to collect data such as the number of miles per run, total shipping weight, number of pieces delivered to each customer store, gross revenue, revenue per mile, average lumper charge per load, percentage of empty front-haul miles, and percentage of empty backhaul miles. The *Statistical Package for the Social Sciences (SPSS) for Windows* (2000) was used to analyze the data collected from this sample.

Hypothesis Development and Testing

Based upon the sample, the following key hypotheses were developed to validate the significance of lumper costs, empty miles, and shipment size to the profitability of the carrier investigated in this study.

H_1: The average lumper charge per load fluctuates significantly from one shipper (store) to another.

Traditionally, some shippers have only allowed a certain lumper, designated by them, on their unloading docks and have not given the carrier much negotiation leverage in controlling hefty lumper charges. In an effort to control the lumper charge, the carrier under study explored the possibility of hiring a common carrier for certain shippers or involving its driver in the

cargo unloading process. However, driver involvement in the cargo unloading process is not considered a viable option, because it increases the carrier's liability due to the potential risk of driver injuries and more stringent hours of service regulations. To determine which shippers should be served by common carriers or completely dropped from delivery services, the carrier needs to know if significant differences exist in lumper charges per load among different shippers.

Thus, the authors made a premise that the average lumper charge per load differs from one shipper (store) to another. To test this hypothesis, a one-way ANOVA test was utilized to see if significant differences occurred within any of the comparisons of the five major customer stores (*Ames*, *Bradlees*, *Kmart*, *Macy's*, and *Sterns*) in our sample. The test result (with F-*value* = 15.365, p-*value* = .000) demonstrates that significant differences exist within comparisons of average lumper charge per load among the five stores. Post hoc multiple comparisons were also made using the *Tukey* (*HSD-Honestly Significant Difference*) test to examine whether the average lumper charge of one store is significantly higher than another. Post hoc tests indicate that one of the stores, called "*Store Four*" (actual name was hidden to ensure confidentiality), tended to incur significantly higher lumper costs than the other four stores at a = .05. Also, "*Store Three*" incurs a significantly higher lumper cost than "*Store One*" and "*Store Five*" at a = 0.05. Hypothesis H_1 was therefore supported by the results.

H_{2}: **The average lumper charge per load is positively related to shipment weight.**

H_{2b}: **The average lumper charge per load is positively related to the number of pieces shipped.**

H_{2c}: **The average lumper charge per load is positively related to the number of miles per run.**

Shipment size may influence the lumper charge,

because a heavy shipment is likely to increase the unloading time at the dock. Similarly, the larger the number of pieces to unload, the higher the likelihood of a higher lumper charge. Since the long haul may increase the likelihood of freight consolidation, it is likely to increase shipment size and the subsequent lumper charge. To test these three premises, correlations among average lumper charges per load, shipping weight, the number of pieces, and miles per run were first calculated. A significantly positive correlation was found between shipping weight and average lumper charge with the Pearson correlation coefficient value of .487 (*p-value* = .000). Another strong positive relationship was found between the number of pieces and the average lumper charge with the Pearson correlation coefficient value of .659 (*p-value* = .000). However, the number of miles per run was not significantly correlated with the average lumper charge (*p-value* = .511). Therefore, hypotheses H_{2a} and H_{2b} were supported while hypothesis H_{2c} was rejected.

H_{3a}: **The revenue per mile is negatively related to the number of empty front-haul miles.**

H_{3b}: **The revenue per mile is negatively related to the number of empty back-haul miles.**

H_{3c}: **The revenue per mile is negatively related to the number of miles per run.**

H_{3d}: **The revenue per mile is positively related to the gross revenue.**

After deregulation, motor carrier revenue per mile declined and significantly lagged behind inflation throughout the 1980s and into the late 1990s (Roth, 1999). A decline in capacity utilization caused by empty miles can further dampen revenue growth and the subsequent profit margin. In particular, considering that a large portion of carrier operating costs are variable, reduction in empty miles would help the carrier control operating cost. As a matter of

fact, controlling cost was perceived to be the most important strategy for enhancing motor carrier profitability in a study conducted by Stephenson and Stank (1994). With this fact in mind, it was hypothesized that the percentage of empty miles for both front-hauls and backhauls is likely to impact carrier revenue per mile significantly. Also, given that total operating expenses such as driver wage, fuel costs, and maintenance/repair costs increase as the carrier travels for longer distances, it was expected that the number of miles per run would be negatively related to revenue per mile. It was also hypothesized that gross revenue contributes to the increase in revenue per mile. As a preliminary test of these hypotheses, the degree of relationship present between dependent (revenue per mile) and independent variables (empty front-haul miles, empty backhaul miles, total miles per run, and gross revenue) was measured through correlation matrices summarized in Table 1. Since signi-

ficant correlations were identified among the independent variables at a = .05, additional statistical tests were conducted using step-wise regression to eliminate redundant independent variables.

Test results shown in Table 2 indicate that revenue per mile is inversely related to the number of empty backhaul miles and the total number of miles per run at a = .05. In particular, the multiple R shows a substantial correlation between the two independent variables "number of empty backhaul miles and total number of miles per run" and the dependent variable "revenue per mile" with R = .705. On the other hand, both the number of empty front-haul miles and gross revenue were not significantly correlated with revenue per mile. Therefore, both H_{3a} and H_{3b} were fully supported by the test results, and both H_{3c} and H_{3d} were rejected.

TABLE 1
CORRELATION MATRIX

	Revenue per Mile	Empty Front-haul	Empty Backhaul	Miles per Run	Gross Revenue
Revenue per Mile	1.0				
Empty Front-haul	-.022	1.0			
Empty Backhaul	-.241**	-.164*	1.0		
Miles per Run	-.708**	.074	.139	1.0	
Gross Revenue	-.484**	-.077	.127	.746**	1.0

$*p < .05$ $**p < .01$

TABLE 2
STEPWISE REGRESSION RESULTS

Dependent Variable: Revenue per mile

Independent Variables	Unstandardized Slope Coefficient	Standard Error	Standardized Coefficient (Beta)	Significance Level
Constant	2.813	.141		.000
Empty Backhaul	-.006874	.003	-.120	.034*
Miles per Run	-.00175	.000	-.679	.000**
Empty Front-haul	Excluded	Excluded	Excluded	.880
Gross Revenue	Excluded	Excluded	Excluded	.216

Adjusted R Square = .497   F-ratio = 80.618, significant at p < .01   **p < .01

These results clearly suggest that both long hauls and empty backhauls are culprits contributing to the decline in revenue per mile. Note that *Gamma*'s revenue per mile of $1.68 during the study period was slightly below the national average of $1.87 (Roth, 1999). A significantly negative relationship exists between revenue per mile and the total number of miles per run (i.e., length of the haul) with the Pearson correlation coefficient value of -.708 (*p-value* = .000). According to *Gamma*'s management team, they have noticed such a pattern over the years, but never had a chance to verify it with concrete evidence prior to this study. *Gamma* was particularly concerned with a long haul exceeding 500 miles for a number of reasons, including potential decline in revenue per mile and difficulty in driver scheduling under the changing hours of service regulations.

FINDINGS AND IMPLICATIONS

This section summarizes key findings from the study and practical implications for motor carriers who face the prospect of losing profit margin and market share.

First, as *Gamma* suspected, average lumper charge per load varies significantly from one customer store (shipper) to another. The test result indicate that one customer store (*Store Four*) tended to charge higher lumper fees per load than any other customer store. *Store Four* not only assessed higher average lumper charge per load (approximately $100 more than the store with the lowest lumper charge per load), its lumper charge also fluctuated substantially from one load to another. Other customer stores' lumper charges remained relatively stable over time. The high variability of lumper cost for *Store Four* was due to the wide variance in shipping weight, ranging from 3,791 to 36,732 pounds per shipment, and total number of pieces ranging from 502 to 5,222 per shipment. It would have been better for *Gamma* to ask *Store Four* to cover its lumper cost. However, *Store Four* is one of *Gamma*'s major customers and *Gamma* cannot afford to take such direct action. Two alternative courses of action suggested to *Gamma* were to: (1) use a common carrier to avoid the excessive lumper cost; (2) design a customized trailer equipped with a built-in conveyor belt on the floor of the trailer to reduce unloading time.

In addition to these options, Gamma should re-evaluate its current accounting procedure to examine whether lumper costs are being accurately estimated. Gamma may want to consider activity-based costing (ABC) to better capture lumper activity in servicing its

customers. The result will be a more accurate assessment of profitability. ABC can provide an economic map to identify which customers are truly profitable by identifying cost drivers.

Second, revenue per mile was *negatively* correlated with empty backhaul miles and the length of haul. Considering that empty backhaul miles represent the underutilization of truck capacity, it makes sense that empty backhaul miles are detrimental to revenue. The negative relationship between revenue per mile and the length of haul can be explained by the increase in variable costs (e.g., driver pay per mile, fuel cost, maintenance and repair cost) as it relates to total miles traveled by the carrier.

Based on the findings, *Gamma* was encouraged to explore the possibility of using common or contract carriers for some delivery lanes that currently involve empty backhauls. The rule of thumb suggested by Schneider (1985) indicates that if empty backhaul miles are within the range of 10% to 20%, management should consider replacing a private fleet with for-hire carriers. *Gamma*'s average percentage of empty backhaul miles was 32.12% (with a standard deviation of 19.58%). This high percentage of empty backhaul miles justifies the for-hire carrier option. In addition, declining revenue per mile associated with long hauls further justifies such an option. *Gamma* also came up with their own rule of thumb: the continued usage of private carriers for a delivery of up to 199 miles per run; the potential use of contract carriers for a delivery ranging from 200 to 399 miles; the potential use of common carriers for a delivery ranging from 500 to 999 miles; the potential use of intermodal operations for a delivery of 1,000 miles or more. Although these rules of thumb sound plausible, their verification requires further research. Once a certain for-hire carrier is selected for outsourcing transportation services, *Gamma* should consider establishing a core carrier program that will allow *Gamma* to take advantage of rate reductions for volume commitments.

Another innovative option to consider is the use of an on-line freight exchange system that can provide *Gamma* with real-time management of freight movement to increase profit and maximize equipment utilization through an e-commerce platform. Carriers may share their excess loads with others to reduce empty backhaul miles and consequently improve their operating ratio (a ratio of operating expenses to gross freight revenue).

For example, *National Transportation Exchange (NTE)* integrates its public marketplace with an on-line auction service that allows closed negotiations for the best truckload-matches between shippers and carriers. *NTE* posts the pre-committed freight rates for each load on its website and presents load opportunities for backhauls by combining small carriers as a single virtual fleet through real-time shipment information and web interfaces. Thus, *Gamma* can exploit such an online freight exchange program that will help it reduce empty backhauls.

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WHERE HAVE ALL THE ON-LINE GROCERS GONE? LESSONS LEARNED FROM THE DEMISE OF ON-LINE GROCERS

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Online grocer Webvan Group, Inc., fired a salvo across the shopping carts of the brick-and-mortar supermarket industry when it announced that within two years it would be delivering Web ordered groceries free-of-charge in 26 major markets throughout the United States (Dembeck, 1999).

~ July 14, 1999

Webvan Joins List of Dot.Com Failures: Online Grocer Burned Up $830 Million Since 1999 (Mangalindan, 2001).

~ July 10, 2001

ABSTRACT

The grocery concept has evolved over many years to drive cost out of the process. Grocery margins are very thin, typically ranging from 1% to 1 ½% such that the grocery business continues to look for innovative ways to take cost out of the process. Ordering groceries on the Internet was initially thought to be a very promising new opportunity. So what happened to on-line grocers? This paper considers what went right and what went wrong for the on-line grocers and uncovers a few logistics lessons along the way.

THE CHANGING FACE OF THE GROCERY INDUSTRY

The grocery concept has evolved over many years to drive cost out of the process. Consider how the frontier store, where the customer gave the storeowner a shopping list and he personally picked out the groceries from his shelves, gave way to the invention of the shopping cart in 1936 (Wilson 1978) and the concept of allowing multiple customers to roam the store to pick out their own groceries. Not only did it lower cost but it allowed the grocery to handle more customers at the same time. The concept has been incorporated in virtually all the current models of grocery retailing from the convenience store to traditional grocery store to warehouse club. All have the common element of customer pick. Today, Walmart, with 2,941 stores, owns 1.6 million shopping carts where up to 550 carts are used at any given time (Cahill, 1999).

According to industry statistics, the average supermarket's labor expense is currently about 12 percent of sales. Of the labor expense, it is estimated that grocery stocking expense is about 10 percent of its labor expense, or 1.2 percent of sales (Anonymous, 1999). Grocery margins are very thin, typically ranging from 1% to 1 ½%. The grocery business continues to look for innovative ways to take cost out of the process. For example, in the distribution process of the typical traditional supermarket, a can of tuna changes hands on average 14 times between the food-packing factory and the customer's can opener. Software, networks and warehouse automation can reduce the tuna can's turnover to 11 pairs of hands or fewer. This leads to lower costs, and, if not completely passed on to the consumer, to higher margins (Anonymous, 2000).

Ordering groceries on the Internet was initially thought to be a very promising new method to lower cost. People generally want convenience, time- and labor-saving approaches, especially in two-worker households where there's little time for leisurely shopping. So if price, ordering, quality, freshness and delivery are the same with an Internet grocer, why not—some would say—bypass the traditional grocery store and the need to traverse long aisles, line up at the checkout, and all that hassle (Sleeper, 1999)?

Dot.com grocers were formed anticipating that information flow would be a means of driving cost out of the process and increasing margins. Table 1 shows a comparison of the typical supermarket and an on-line grocery delivery model utilized by Streamline to sup-port that claim. A 1998 study by Andersen Consulting predicted that the number of households buying groceries on-line would reach 15 million by 2007 (Santosus 1998). Forrester Research estimated that on-line grocery shopping in the United States would grow from $509 million in 1999 to $10.3 billion in 2004. Progressive Grocer (2001) estimates the overall grocery industry in the U.S. to be $494 billion, suggesting the on-line grocery share would grow from 0.1% to 2.1%.

TABLE 1
STREAMLINE VS. TYPICAL SUPERMARKETS

	Typical Supermarket*	Streamline
Cost of Goods Sold	75%	72%
Operating Costs	17%	13%
Distribution	4%	6%
Corporate Overhead	3%	3%
Net Profit	1%	6%

* Figures compiled by Smart Store, a research and development initiative at Anderson Consulting (Hannu and Tanskanen 2001).

So what happened to on-line grocers? The most telling quote came from a *Morningstar* newsletter.

> Peapod...reminds me of the guy who wants to increase his income, and takes

TABLE 2
FINANCIAL RESULTS FROM PUBLICLY-TRADED ON-LINE GROCERS

	2Q '01	1Q '01	4Q '00	3Q '00	2Q '00	1Q '00	1999	1998	1997	1996
Streamline										
Revenue					8.86	8.46	15.38	6.95		
Loss					-11.45	-11.72	-19.50	-11.37		
Peapod										
Revenue		25.27	23.73	21.79	22.73	24.91	73.13	69.27	59.61	29.17
Loss		-15.45	-23.83	-9.80	-10.39	-12.74	-28.45	-21.57	-12.98	-9.57
WebVan										
Revenue		77.23	84.19	52.06	28.30	16.27	13.31			
Loss		-216.97	-173.14	-147.97	-74.37	-57.82	-144.57	-12.00		

out an ad offering $1.20 in return for every $1 bill he receives. To be sure, he'll get a lot of $1 bills— his revenues, so to speak. The drawback is that he loses $0.20 on each one (Kelly, 1999).

As of this writing the financial markets for on-line grocers have been devastated. Publicly traded on-line grocers have closed their doors. Others never reached their anticipated IPO. Table 2 reflects the financial results of the three largest publicly traded on-line grocers. Streamline and Webvan dissolved, and Peapod sold its remaining assets to Ahold NV. Another on-line firm, GroceryWorks, never reached the IPO stage, but sold its remaining assets to Tesco. This article considers what went right and what went wrong for the on-line grocers.

THE VIRTUAL SUPERMARKET

The definition of a Virtual Supermarket or on-line grocer is a store that sells directly to end consumers a full range of grocery products (for example, fresh and frozen food, toiletry, etc.). Customer orders are received through the Internet and picked by shopping personnel or robots. The ordered groceries can be delivered to consumers or can be picked up at a customer collection point. The system is complemented by "back-office" procedures that take care of processing customer orders, inventory, payments, and distribution (Anonymous 2000).

FULFILLMENT MODELS

There were two types of facilities in use; in-store fulfillment centers (SFC) and dedicated fulfillment centers (DFC) (Anonymous, 1999). If the process has low volume, a SFC was the likely choice. The target market and desired products also may have dictated using a SFC. For example, a SFC seems to be appropriate for speciality and small store operations. If volume grows, then moving from a SFC to a DFC is in order. If the objective was to enter into a new geographical territory, or if the company was very optimistic about demand, a DFC was most likely implemented because of its anticipated cost and efficiency benefits (Anonymous, 1999).

It is in terms of fulfillment efficiencies that the models really differ. While Peapod and Tesco fulfilled orders out of actual stores, Streamline, Homerun, WebVan, and GroceryWorks relied on DFCs to process orders (Mathews, 1997).

In-Store Fulfillment (SFC) Model

The store pick model was pioneered by Peapod, which tapped into the existing logistics infrastructure, utilizing the retail store as the

end distribution point. All they did was bridge the gap between store and home, and charge a premium for the service (Casper 1998). In its early days as a Chicago-area start-up, Peapod fulfilled orders by picking items from the shelf of a local Jewel grocery chain. Unfortunately, this method lost Peapod money. So, as Peapod expanded into other markets and increase volume, it switched to establishing its own distribution centers, another money losing strategy (Holst 2001). Peapod's delivery costs averaged about $12 per order. Recall from Table 1 that the typical supermarket's distribution costs run about 6%. A typical Peapod customer would spend $120 per order (Lindsay, 1999) and was charged a $4.95 flat monthly fee, $4.95 per order and 5% of the total order. (Leibs, 1997) so the additional cost per order averaged $13.42 or about 11.2%.

Peapod returned to the SFC model when it aligned itself with Royal Ahold to receive much-needed cash to continue operations. Peapod now uses existing Royal Ahold stores, such as Stop & Shop and Giant, for its inventory. It's a model similar to that employed by Tesco, the U.K. grocery giant that took a 35 percent stake in Safeway's GroceryWorks.com. It is likely Tesco will convert the GroceryWorks operations to the SFC model. Putting itself under the aegis of a brick-and-mortar grocer may help Peapod reduce marketing costs. Webvan spent between 25 and 35 percent of its revenue on advertising, compared with about 1 percent for traditional grocery chains (Moore, 2001).

Dedicated Fulfillment Center (DFC) Model

The warehouse/depot model seeks to create its own efficient home delivery infrastructure. It takes the retail store out of the cost structure, delivering directly from the warehouse, and affords the opportunity to consolidate delivery of multiple product classes as well as services to the home, while creating a lower cost structure

(Casper, 1998). A typical Webvan warehouse cost $30 million to build (Moore, 2001).

Streamline had the most innovative approach to fulfillment using a DFC. A setup team was dispatched to a customer's house where the contents of the kitchen were scanned to create a personal shopping list, which typically accounted for 70% to 75% of a family's weekly order. A delivery day was determined. The family was given a UPC code list as its core shopping list, plus another list of the products and services available through Streamline. To order, family members checked off from their core list and the additional services list to determine their weekly needs, which may include video rentals, dry cleaning and bottled water, among others. As long as the order was placed by midnight, delivery would take place by 6 p.m. the next day (Liebeck, 1997b).

The heart of the Streamline system was the Streamline "box." This was a combination refrigerator, freezer/dry storage cabinet measuring five feet wide by five feet high by two feet deep that was placed in the customers' garage at no charge. The company operated a fleet of trucks that had three different temperature zones to maintain the integrity of the products (Liebeck, 1997a) and make weekly deliveries to the box. The customer did not have to be present for delivery to take place.

To support their delivery model, Streamline built a 56,000-square-foot distribution center in Westwood, Massachusetts, with about 10,000 different items in regular stock (by comparison, the typical supermarket carries about 30,000) (Leibs, 1997). Streamline customers paid a box installation charge of $39 and a monthly fee of $30 (Mathews, 1997). The average Streamline customer ordered goods 47 out of 52 times per year and spent an average of $100 per week, or about $5,200 per year (Liebeck, 1997a). The customer spent approximately 7.7% of the purchases on installation and monthly fees.

ALTERNATIVE FULFILLMENT APPROACHES

Another model, exemplified by NetGrocer, more closely approached the electronic commerce initiatives seen in other industries by outsourcing the delivery function to FedEx. It offered convenient ordering over the Internet, but delivery service was slower than the other alternatives (Casper, 1998). Netgrocer delivered to 49 continental states, as well as APO/FPO and Diplomatic Pouch zip codes (Anonymous, 2001). It offered 2,500 SKUs of only non-perishable groceries for a delivery cost of $2.99 for the first 10 pounds and 99 cents per every additional 10 pounds. (Liebeck, 1997b).

Webhouse Club, a subsidiary of Priceline.com, had buyers log on and bid for items using four pre-selected discounts of up to 50% on 150 grocery items. Customers selected from two brands for each item and could not rank preferences. Customers had to accept Priceline's specified quantities and the chances of having a bid accepted were greater if they bid higher. The results appeared within 60 seconds. Customers paid on-line using a credit card and then printed out a prepaid list. The customer then had to go to any of a number of supermarkets from Philadelphia to Connecticut to pick up the groceries. (Setton, 2000).

The most successful model to date involves an existing grocery chain with a strong market presence that develops its own on-line ordering system and uses its own stores as the warehouse. United Kingdom grocer Tesco was the company that "cracked the code," by discovering that if it rolled out small, by sending just two trucks to the right store, its on-line operation could be profitable (Mahoney, 2001). Tesco says it operates the largest and most successful Internet-based grocery home shopping service in the world with almost 1 million registered customers and processing over 70,000 orders each week. It is profitable with sales of about $420 million a year. (Macaluso, 2001).

BASICS BEHIND GROCERY LOGISTICS

Consider what the on-line grocers are up against. They deal with a relatively low order value (around $100), low margins (1%-1½%), frequent replenish-ment, short shelf life with meat, produce, and dairy products, all shapes and sizes, different strategies regarding depth (defined as the number of different products in a line) versus width (defined as the number of product lines offered), a compressed delivery window and restrictions as to when the customer is available, varying picking costs, and specialized storage and transportation needs.

Quality control is a critical factor. Assume an on-line grocer with sales of $50 million has an average order size of $100. Also, assume the order consists of 50 items. This would require 25 million picking transactions across 500,000 orders. If a company were able to achieve a picking accuracy of 99.5%, one in four orders would contain an error, clearly an unacceptable rate from the consumer perspective, especially with "time-starved" consumers looking for less stress (Beech, 1997).

Streamline tried to capitalize on the trade-off between higher transportation costs and lower real estate costs. Streamline's DFC had real estate costs of about $6.50 per square foot vs. the supermarket's typical $18 to $24 per square foot. Of course, it could be argued that SFC models have no real estate investment since it functions inside existing retail units (Mathews, 1997).

CONSUMER BEHAVIOR REASONS ON-LINE GROCERY WILL NOT WORK

An October 1999 survey by Fast Company revealed significant attitudinal barriers to buying groceries on-line. Indeed, these barriers were even more signi-ficant than barriers to other on-line activities.

Reasons for consumer resistance include the following:

1. Grocery shopping is a habitual act. While the average consumer shops for groceries 2.2 times per week, few consumers shop so often for cars, books, or airline tickets. Thus, grocery shopping is more habitual, and it will take more effort to change consumer buying patterns. Moreover, consumers often visit several stores in a week, presumably looking for specific items or hoping to take advantage of specific promotions.

2. Grocery shopping is a community act. Most grocery consumers shop with someone, be it a spouse, child, or friend. On-line grocers must overcome the "serious social obstacle" that the community function of buying groceries at local supermarkets—where folks can interact with friends, neighbors, and relatives—is sometimes more important than the inconvenience associated with filling up a shopping cart.

3. There is no significant time savings associated with on-line shopping. Excluding driving time, the average consumer spends 45 minutes in his visit to the supermarket while the Peapod buyer spends 37 minutes.

4. Delivery is cumbersome and expensive, but also slow. In the age of instant gratification, Internet delivery will have to offer significant value to make up for slow delivery relative to traditional shopping (Jones, 1999).

LOGISTICS PRINCIPLES COMPONENTS THAT MADE SENSE

The **principle of selective risk** suggests designing logistics systems so that the system performance objectives are directly related to the importance of the product or customer to the firm (LaLonde, 1993). Streamline's research led the company to believe that stocking 55% of the currently available SKU count could cover approximately 90% of retail demand. This premise was strengthened by research showing that 33% of grocery shoppers accounted for 56% of purchases, and that 30% of customers

TABLE 3
ON-LINE USER ATTITUDES

% of Respondents who never plan to do the following on-line		% Who believe the following activities are better on-line than the traditional way
1%	Research	87%
11%	Buy airline tickets	57%
12%	Buy books	38%
34%	Buy cars	24%
44%	**Buy groceries**	**12%**
60%	View pornography	14%

Source: Jones, 1999

accounted for 73% of all branded packaged goods purchases (Mathews, 1997). Seventy-two percent of Streamline's sales came from the lower margin grocery category. The balance came from products and services, such as dry cleaning and specialty foods (e.g., prepared meals, buffet trays), on which margins are higher. For example, their dry-cleaning service charged Streamline 95 cents for shirts, which the company retailed for $1.50. A suit that cost Streamline $3.75 brought in $6.50 (Mathews, 1997).

The **principle of information selectivity** has an underlying assumption that information is as much of a resource to the decision maker as capital, human resources, and facilities. Information should be treated with the same operational, tactical, and strategic importance as any other resources of the firm (LaLonde, 1993). PeaPod recognized the capture of consumer usage patterns held value beyond just driving their delivery process. Peapod received revenue from selling information about its customers' buying habits to food suppliers (Leibs, 1997).

The **principle of transaction simplification** suggests improving the efficiency and effectiveness of the transaction through simplification (LaLonde, 1993). By stocking 75% fewer stock keeping units, on-line grocers could achieve significant cost savings. The average brick-and-mortar supermarket stocks 40,333 items; Home-Grocer.com stocked 11,000 items and Peapod 20,000 items. Lower numbers of SKUs improved inventory control and reduced sales lost to out-of-stocks to typically 3.1%. Approximately 8.2% of SKUs in brick-and-mortar stores are out-of-stock at any one time, so reducing SKUs by 75% should have significantly improved tracking ability and reduced lost sales associated with out of stocks (Jones, 1999).

The **principle of variance reduction** recognized that in any logistics system there are a series of linkages between demand and supply points. Failure to accurately anticipate demands at the next stage in the system often leads to erosion of system productivity. This erosion, in the form of excessive inventory, overtime, increased stock outs, or a variety of other variables, can directly effect system productivity and performance. This principle suggests that a logistics manager can significantly influence the productivity of the system by reducing unplanned variance in the system (LaLonde, 1993). Approximately 85% of grocery purchases are repetitive (Richards, 1996). Most on-line grocers recognized this fact and designed past-use libraries for their customers. This not only reduced the time it took to place an order after the initial learning curve, it served as a prompt to remind the customer of items they had overlooked.

The **principle of inventory velocity** suggests that, in order to achieve asset productivity in the management of inventory assets, logistics managers must focus their efforts on both the level of inventory and the velocity of inventory (inventory turnover) (LaLonde, 1993). Simply put, the on-line grocers never could reach high enough volumes in a concentrated area to achieve the efficiencies necessary for profitability. The bulky nature of the deliveries limited Peapod's trucks to about 22 daily—a fraction the number that a typical FedEx or UPS truck makes (Holst, 2001). In the entire Chicago market, Peapod conducted at most 1,200 transactions a day. By contrast, a single supermarket in that market conducts an average of 2,100 transactions a day (Holst, 2001).

The **principle of shared/shifted risk** has as its guiding objective the shifting of the logistics cost structure from a fixed cost base to a variable cost base. By shifting costs to a supplier upstream in the channel (e.g., Kanban) or downstream to a customer (e.g., placing order by computer terminal), the logistics manager can shift fixed investment cost and risk outside the firm (LaLonde, 1993). While the on-line grocers were able to shift the ordering process to the customer, in return they accepted the burden of picking and delivery, which turned out to be a very inequitable and costly trade.

LESSONS LEARNED

Why did the on-line grocery concept fail? The demise of the on-line grocer was largely the result of the inability to achieve high enough volumes to override the additional costs of the on-line process. Some of these costs were start-up related and others were inherent in the process. It is also possible that the enthusiasm of e-commerce may have allowed some critical oversights in strategic expansion plans.

Many differing models of grocery retailing have evolved over time from the convenience store to traditional grocery store to warehouse club. All have the common element of customer pick. Perhaps the on-line design was too radical. Whether using warehouse automation or personal shopper, the on-line grocers failed to keep this cost element low. Clearly the benefits achieved by passing off the picking process directly to the consumer are great. Peapod's own research indicated a delivery pricing barrier of $10 per delivery. Attempts to incorporate a delivery fee covering additional costs failed.

Quality control was a major factor. The number of items in the typical order exposed the process to one picking error out of every four orders. The inconvenience of an incorrect order likely prevented some customers from repeating the process.

The initial start-up cost of using an on-line grocer required that customers recognize the learning curve effect and accept this up-front cost in order to achieve future savings. In addition, consumers failed to realize the true value of their time or of the effort of the provider. This is not uncommon. Focus groups interviewed by next-flight-out transportation provider NextJet indicated they felt immediate freight services should cost "a little more" than Federal Express next day. If fact, the total cost of handling a next-flight out shipment typically exceeds $160 per package. Purchasing decisions based on total cost must correctly recognize the costs.

CONCLUSION

This article considered the changing face of the grocery industry. It considered the different types of on-line fulfillment and the basics driving grocery logistics. It looked at what worked and what did not work from a consumer behavior and logistics perspective. Finally it offered important lessons to be learned from the demise of the on-line grocer.

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AN ANALYSIS OF INTERMODAL TRANSPORT CARRIER SELECTION CRITERIA FOR PACIFIC-RIM IMPORTS TO NEW ENGLAND

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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 trans-continental 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 ocean 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 inter-

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 popular. Although there is a viable all-water option for Asian imports to the East Coast through the Suez Canal, it is generally competitive with 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 which 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 the 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 mainline 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.

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 Operation 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. For example, 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 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 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. The AHP was selected 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 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 the 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 the 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)

FIGURE 2
HIERARCHY OF DETERMINANT ATTRIBUTES
FOR TRANSPORTATION ROUTE AND MODE SELECTION

To Ascertain Transportation Route and Mode Selection Criteria
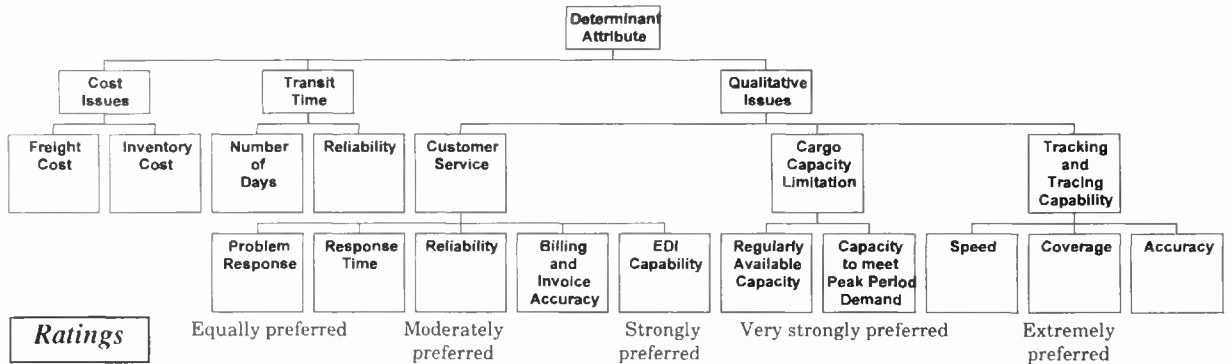
Freight costs, and 2) Inventory costs. The freight cost includes both the basic freight rate and the flexibility of freight rates. The basic freight rate is defined as the rate for a shipment of a particular type and size, whereas the flexibility of freight rates is the carrier's willingness to negotiate rates based on the volume of shipment. Inventory cost in this case includes the cost of acquisition 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 the hierarchy.

At the third level of the 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 a certain level of 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 the 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). Forty-two of the recipients were manufacturers and the remainder were 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 the hierarchy was determined by multiplying the average of the normalized values for each of the survey respondents by 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.

FIGURE 3
RELATIVE WEIGHTS
AT SUB-CRITERIA LEVEL 2
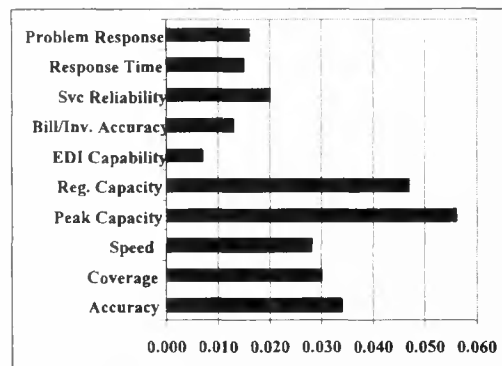
At sub-criteria level 1, freight cost was the top priority with a relative weight of 0.220, followed by the reliability of transit-time with a relative weight of 0.214. Figure 4 shows the relative weights of the determinant criteria at sub-criteria level 1.

FIGURE 4
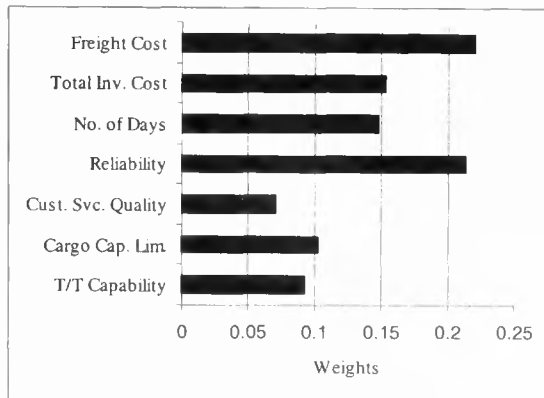## RELATIVE WEIGHTS
AT SUB-CRITERIA LEVEL 1

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
RELATIVE WEIGHTS
AT THE FIRST LEVEL OF HIERARCHY
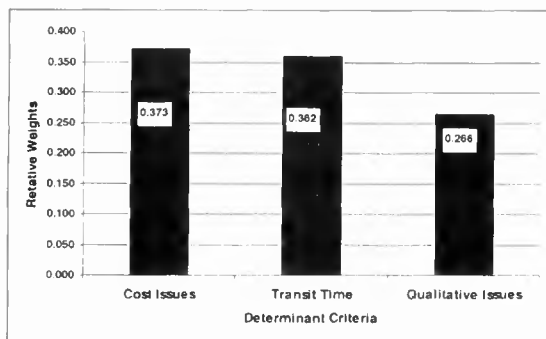
CONCLUSION

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 spread-sheet 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 over-all 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 in transit.

The ability of a carrier to deliver as promised is instrumental in implementing various manu-facturing 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 synchronous with the current drive toward greater use of information technology in inte-grating supply chain activities and creating seamless alliances with channel members.

In conclusion, intermodal service providers for the region should 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 gains maturity.

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THE CASE FOR U.S. HIGH SPEED RAIL

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ABSTRACT

High-speed rail is a form of self-guided ground transportation, which utilizes steel-wheels or magnetic levitation (i.e., Maglev) and can travel in excess of 200 miles per hour. High-speed ground transportation (i.e., HSGT) has been widely used in Europe and Asia, but the debate continues over the usefulness of high-speed rail in the United States. Several metropolitan areas in the United States have been identified as corridors that would benefit from HSGT. High speed rail can offer an alternative or a compliment to over-the-road and air transportation. Initial investment cost for this mode of transportation are high, but other factors such as fewer emissions from trains help to balance these costs. This manuscript examines the feasibility of bringing high-speed rail to clusters of cities throughout the United States (i.e., corridors) for passenger and commercial freight transportation.

BACKGROUND

High-speed rail has been proposed both as an alternative and as a compliment to existing transportation modes in the United States for both passenger and freight traffic. While high-speed rail is prominent in parts of Asia and Europe, the feasibility of such a system, especially on the freight side, is relatively unknown in this country. This manuscript examines the feasibility of bringing high-speed rail to corridors and cities throughout the U.S. for both passenger and freight transportation.

High-speed rail has been used extensively throughout Europe and Japan for decades because of pressing transportation needs. As travel demands grew in these countries, transportation by air and auto suffered from congestion and delays, particularly in the metropolitan areas. The introduction of high-speed rail was one solution to the growing traffic problems and the concomitant decreasing quality of service provided by other modes of transportation.

The passage of the High Speed Ground Transportation Act in 1965 stimulated interest in the use of high-speed rail in the United States. This legislation authorized $90 million to start a federal initiative to develop and demonstrate high-speed ground transportation (HSGT) technologies such as tracked air-cushion vehicles, linear electric motors, and magnetic levitation systems. The HSGT program also included a comprehensive multi-modal transportation planning effort that focused on the long-term needs in the Northeast Corridor of the U.S.

Because carrying freight has proved for decades to be more profitable than carrying passengers, in 1970 Congress stepped in to create and fund passenger service. The Rail Passenger Service Act of 1970 led to the creation of the National Railroad Passenger Corporation (Amtrak), which took over the inter-city rail passenger network from the freight railroads. Unfortunately, Amtrak has required federal capital and operating subsidies totaling over $23 billion since its inception (Belsie, 2001). Federal HSGT emphasis in the 1980's shifted to studies of potential HSGT corridors. In 1984, grants of $4 million were set aside for HSGT corridor studies on the state level under the Passenger Railroad Rebuilding Act of 1980. Unfortunately, none of the proposals was ever implemented. Interest in corridor planning and technology improvements resurged in 1994 with the appropriation of $184 million for studies in fiscal years 1995, 1996, and 1997 through the enactment of the Swift Rail Development Act of 1994. Renewed interest in high-speed rail has emerged as fuel prices continued to escalate (Albanese, 2000). In 2001, Senator Russ Feingold, along with Senators Joseph Biden and Kay Bailey Hutchinson, announced the introduction of the High-Speed Rail Investment Act of 2001. This bill authorizes Amtrak to sell bonds for the purpose of developing eight high-speed rail corridors throughout the country.

CORRIDORS

While much governmental debate has transpired and legislation has been passed regarding the use of HSGT, it has not yet been fully implemented at the national level. Currently, Amtrak's Northeast Corridor, which links Boston, New York City, Philadelphia, and Washington D.C., is the "only mature high-speed rail system" (www.fra.dot.gov) in the U.S. (see Figure 1). Extensions of the Northeast Corridor that are in various planning stages include: New York State's Empire Corridor, Pennsylvania's Keystone Corridor, and the Northern New England Corridor that extends into Vermont, New Hampshire, Maine, and north into Canada. The Southeast Corridor connects with the Northeast Corridor in Washington, DC, and reaches from Virginia to Jacksonville, Florida.

The Chicago Hub is a sprawling network that will link many major U.S. Midwest cities, including the Twin Cities (i.e., St. Paul and Minneapolis, Minnesota), Milwaukee, Chicago, Detroit, Indianapolis, and St. Louis (Pierce, 2000). Extensions are anticipated to further encompass Kansas City, Louisville, Columbus, Cleveland, and Toledo (www.fra.dot.gov).

Additional corridors in the preparations phase are: the Pacific Northwest Corridor that would link Seattle, WA, and Portland, OR; the California Corridor, which would expand service that is currently available from San Diego to Los Angeles to add San Francisco/Oakland Bay area; the South Central Corridor that would connect major Texas communities with Oklahoma and Arkansas; the Gulf Coast Corridor of Louisiana, Mississippi, and Alabama, which is contemplating the possibility of an extension to Jacksonville, FL; and the Florida Corridor that was initially terminated by Governor Jeb Bush in 1999, but was resurrected by a Florida businessman and was approved by the citizens of Florida less than a year later (Pierce, 2000).

FIGURE 1
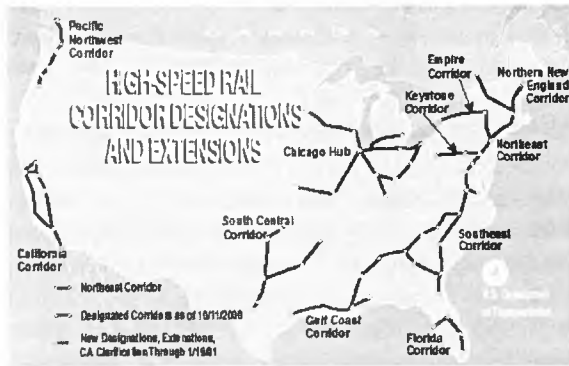
(Source: www.fra.dot.gov, 2001)

IMPLICATIONS OF
OTHER MODES OF TRANSPORTATION

Air Transportation

The Federal Aviation Administration (FAA) projected that domestic air carrier revenue passenger miles (RPM) and passenger enplanements would increase at an average annual rate of 3.7 and 3.5 percent, respectively, between 1993 and 2005. Over the same period, RPM and passenger enplanements for inter-national air carriers are forecasted to grow annually by 6.3 and 6.5 percent, respectively. For regional/commuter airlines, RPM and passenger enplanements were expected to rise at 8.5 and 6.9 percent annually (FAA, Aviation Forecasts, 1994).

Because of the consistent growth in the airline industry, problems associated with congestion and delays are reaching high levels. Congestion-related delays not only increase airlines' operating costs, they also extend the overall travel time of passengers. These delays may consist of deviations from scheduled flight departures and arrivals and added time on the ground or en route. However, various capacity studies at highly congested airports have found

that significant savings can be achieved by reducing those delays that occur because of the capacity-straining growth in operations such as takeoffs and landings (U.S. Department of Transportation, 1997).

The HSGT option. The FAA realizes that the construction of new airports and new or extended runways at existing airports in the metropolitan areas on the U.S. East and West Coasts would not adequately meet the projected growth in demand. The FAA considers HSGT to be a potential means of relieving the pressure on short-haul traffic by diverting air trips of 500 miles or less to rail travel. The FAA also points out that intercity high speed rail systems could be designed for immediate access to airports and could provide connections between multiple airports in metropolitan areas (FAA, Capacity Plan, 1994). For example, the proposed addition of a rail station to service AMTRAK at Milwaukee's Mitchell Field Airport would essentially make Mitchell Chicago's "third airport." As the HSGT corridors divert some traffic from the airlines, they reduce the need to make capacity-related improvements at the more congested commercial airports.

Figure 2 illustrates the conceptual basis for the airport congestion delay savings. In the absence of HSGT, the study projected traffic growth, assumed a small degree of capacity additions, and developed average delay estimates per aircraft operation for each major airport in a corridor. Average delays were capped at 15 minutes per operation because such crisis-level delays would likely be viewed as intolerable.

Highway Transportation

More than 40 years ago America began develpment of the interstate highway system. More than 46,000 miles of multilane routes were built without stoplights or grade crossings. However, the interstate system was not designed for high-speed travel. The interstate system had dramatic impacts upon mobility, economic growth, and transportation efficiency (Car-

FIGURE 2
DELAY SAVINGS
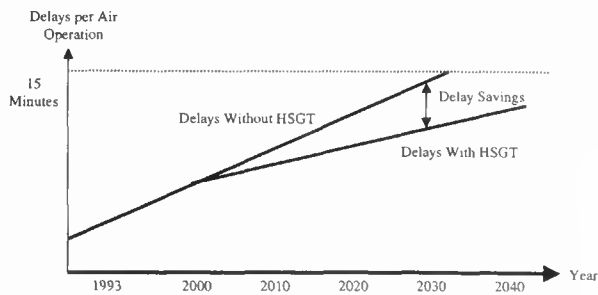
Source: U.S. Department of Transportation, *High Speed Ground Transportation for America*

michael, 2000). Total highway travel continued to increase at an annual rate of 3.5% from 1983 to 1991 (Report to the Secretary of Transportation, 1993), while the population during this same period expanded by only 1 percent (U.S. Census, 1990). Growth in rural travel for this time period was 2.9%, and urban travel increased by 3.9 percent. This growth reflects an upsurge in vehicle trip length and population, a reduction in vehicle occupancy, and a shift to single occupant vehicles. The Federal Highway Administration's (FHWA) forecast for the 20-year period from 1992 to 2011 anticipates that overall highway travel will swell at approximately 2.5 percent per year. This translates into a total increase of 65% (Report to the Secretary of Transportation, 1993), which will create considerable congestion problems unless an alternative mode of transportation is applied, potentially relieving some of the anticipated surge.

The costs of highway congestion are many, including delays, longer travel time, sky-rocketing fuel costs, heightened environmental problems due to increased emissions and reduced air quality, and the rising cost of transporting goods. These problems ultimately translate into consumers shouldering a greater burden. A report conducted by the Texas Transportation Institute states that in 1991, the total cost of

congestion for 50 urban areas was approximately $42.3 billion; delays accounted for 89% of this amount, and additional fuel costs represented the remaining 11 percent (Texas Transportation Institute, 1994).

The HSGT option. Conceptually similar to airport delay savings, highway congestion delay savings measure the value derived from a reduction in congestion and traffic delays on highways; this can be achieved by redirecting auto travelers from driving to HSGT. The value of HSGT experienced by the remaining highway users can be quantified as travel time saved when traffic volumes on major highways decrease and travel speeds improve. The impact of HSGT's effects on highway delays depends upon the relative prominence of intercity travel in a particular road's traffic mix and the share of HSGT markets in that intercity travel, as well as that highway's traffic, capacity, and delay conditions (U.S. Department of Transportation, 1997). The diversion of automobile traffic to HSGT would suspend the need for highway expansion, measured in terms of lane-miles that would otherwise be dedicated to carrying the diverted trips. The costs saved or deferred by not having to expand roadways could not be included in total benefits, since they measure the same phenomenon as the highway congestion delay savings.

BENEFITS OF HSGT TO COMMUNITIES

Transportation

By enhancing the railroad passenger infra-structure in major metropolitan areas, HSGT could theoretically lead to faster and more reliable commuter schedules, with significant time savings for existing riders. The better timings would likely attract new riders, thus reducing highway congestion. HSGT might also reduce the number of accidents, as well as bring about a decline in the fatalities, injuries, property damage, and the human and monetary costs that often accompany such accidents. However, significant methodological and data issues stand in the way of a straightforward,

broadly acceptable projection of the safety benefits of HSGT (U.S. Department of Transportation, 1997).

Economic Development

For one industry to function, its production process requires, as inputs, the outputs (i.e., goods or services) of other industries. Each dollar spent on transportation stimulates additional spending, which affects other industries in the economy. Therefore, expenditures to build and maintain infrastructure and operate transportation services, such as HSGT, could provide a much-needed boost to local or regional economies. To the extent that HSGT expands in the United States as a consistent and predictable market for transportation equipment, the private sector may be willing to consider long-term investments that would increase the American involvement in HSGT vehicle design and manufacture (U.S. Department of Transportation, 1997).

Another possibility to consider is the addition of development investments. The building of offices, retail stores, hotels, and some housing may gravitate to the vicinity of HSGT stations from less attractive locations on the corridor because of HSGT-induced changes in spatial/temporal relationships, as well as the market potential represented by HSGT riders.

Environment/Energy Considerations

According to the Environmental Law & Policy Center's website (www.elpc.org), "high-speed trains would be three times as energy efficient as cars and six times as energy efficient as planes." The dollar value of energy savings can not be considered in the total benefits because fuel and power costs already directly affect the operating expenses of the HSGT options, the perceived cost of auto travel, and the economics of the airline industry. It would be double counting to include, within total benefits, the savings incurred as a result of a reduction in the use of this material of

transport production. Beyond the value of the energy savings per se, lower petroleum consumption due to HSGT use might help to wean the U.S. from its dependence on foreign oil sources (U.S. Department for Transportation, 1997).

Federal regulators have deemed several Midwest urban regions as areas that have "severe" smog problems (www.elpc.org). To be sure, smog is even more of an issue in densely populated areas, such as those found on both the West and East Coasts of the United States. Because of the decreased pollution that trains produce, air quality in these sectors might have the opportunity to recover somewhat as high-speed rail would become increasingly popular. High-speed rail also has the ability to cause a decline in the nation's dependence on auto traffic, which arguably might facilitate the drop in ozone emissions. The differences in emissions among modes of transportation relate to the nature of their respective fuel sources and to the specific power necessary to overcome inertia and to counteract three classes of force: air resistance, which affects all modes of travel; gravity; and contact/rolling resistance, which is experienced by all wheeled modes (U.S. Department for Transportation, 1997).

COST OF IMPLEMENTATION

The initial investment in HSGT, combined with the continuing investment in vehicles, track replacement, and operating expenses, can be quite substantial. These initial costs differ considerably among corridors, in part due to the discrepancies among technological alternatives. The more advanced options represent significantly higher prices and greater variations in cost. For example, the Accelerail 90 is estimated to require an initial investment of $1,000,000-$3,500,000 per route-mile, while the Maglev can cost from $20,000,000-$50,000,000 per route-mile (www.fra.dot.gov). Table 1 details the initial investment costs specific to each HGST choice.

TABLE 1
INITIAL INVESTMENT COST RANGES
FOR ILLUSTRATIVE CORRIDORS

Technology	Typical Range of Total Initial Investment per Route-Mile (Millions of Dollars)
Accelerail 90	$1 to $3.5
Accelerail 110	$2 to $5
Accelerail 125F	$3 to $5.5
Accelerail 125E	$5 to $7.5
Accelerail 150F	$4.5 to $7
Accelerail 150E	$6.5 to $9
New HSR	$10 to $45
Maglev	$20 to $50

Factors affecting initial investment. The layout of a corridor can influence costs both because of the length needed and the area that is to be crossed, including potential appeasments. Shorter corridors absorb a greater share of the fixed cost (e.g., equipment shops, etc.) per route-mile than longer corridors. A short corridor such as the San Diego-Los Angeles route, which is 128 miles, has higher costs compared to the 425-mile route from Los Angeles to the Bay Area. Further, a corridor that involves laying track through difficult mountain crossings requires major tunneling, and one that passes through urbanized landscapes incurs comparatively high initial costs. The initial vehicle purchase also differs with route mileage, HSGT ridership, and associated frequency. The cost of vehicles is typically between 20 - 40 percent of the initial cost of Accelerail 90 and 110. However, vehicles encompass a much smaller portion of total costs in the more technological alternatives.

One other factor that determines the initial investment is the projected use. As potential traffic densities increase with Accelerail alternatives, the need arises to plan for more

double track and passing sidings. Figure 3 summarizes the effects of these factors as they shaped the initial investment needed for each corridor.

The different investment levels share the single purpose of reducing the line-haul travel times. Figure 4 shows a sharp decrease in existing Amtrak running times with the institution of tilt-train Accelerail 90 service and dramatic trip time benefits from New HSR and, especially, Maglev.

Investment requirements grow disproportionately to trip time savings, as the alternatives become more ambitious. Figure 5 shows the dollars of initial investment per timetable-hour that can be saved over Amtrak's 1993 performance in the Chicago-Detroit corridor. The cost per hour saved grows exponentially once technology beyond the Accelerail 110 is analyzed.

Even after allowing for all operating costs, including long-term maintenance and rehabilitation, the system is projected to generate surplus operating revenue. While the projected operating surplus generated by the system will contribute significantly to the capital-financing plan, it is not sufficient to fully fund construction of the system or attract adequate private investment. Thus, a substantial source of public funds will need to be raised for construction (Pierce, 2000).

Travel times, fares, and frequencies are three factors that affect ridership.

Travel times. The ability to redirect customers from existing modes depends on comparative total travel times, which includes access to and exit from the stations, as well as the time spent there. The percentages that comprise these total travel times depend upon the mode of transportation. Figure 6, taken from statistics on the Chicago-Detroit corridor, demonstrates that automotive travel has a natural advantage in the fact that it can offer door-to-door convenience, and air gains an advantage because of its greater speeds.

FIGURE 3
INITIAL INVESTMENT PER ROUTE-MILE: MAGLEV EXAMPLES
(http://www.fra.dot.gov)
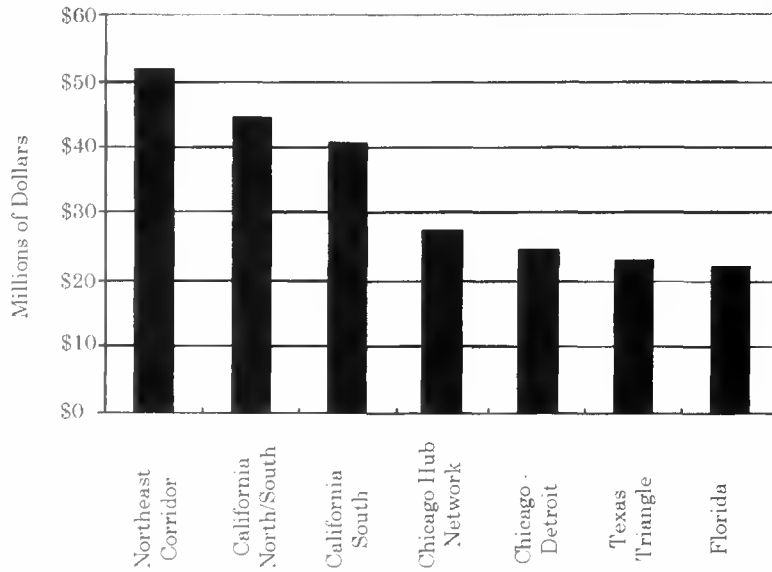
FIGURE 4
LINE-HAUL RUNNING TIMES, CHICAGO—ST. LOUIS
(www.fra.dot.gov)
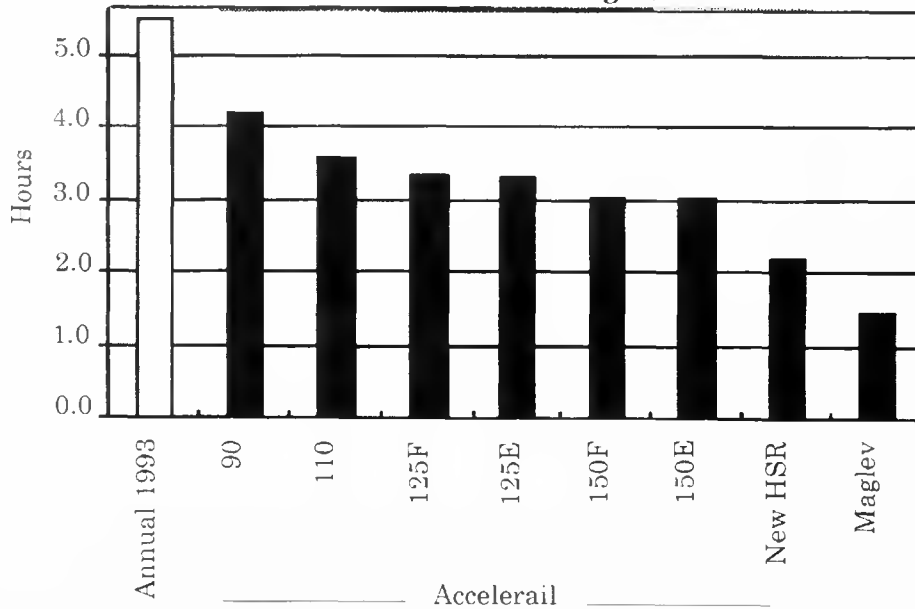
FIGURE 5
INITIAL INVESTMENT PER HOUR SAVED OVER AMTRAK 1993 BASE
(www.fra.dot.gov)
EXAMPLE: CHICAGO – DETROIT
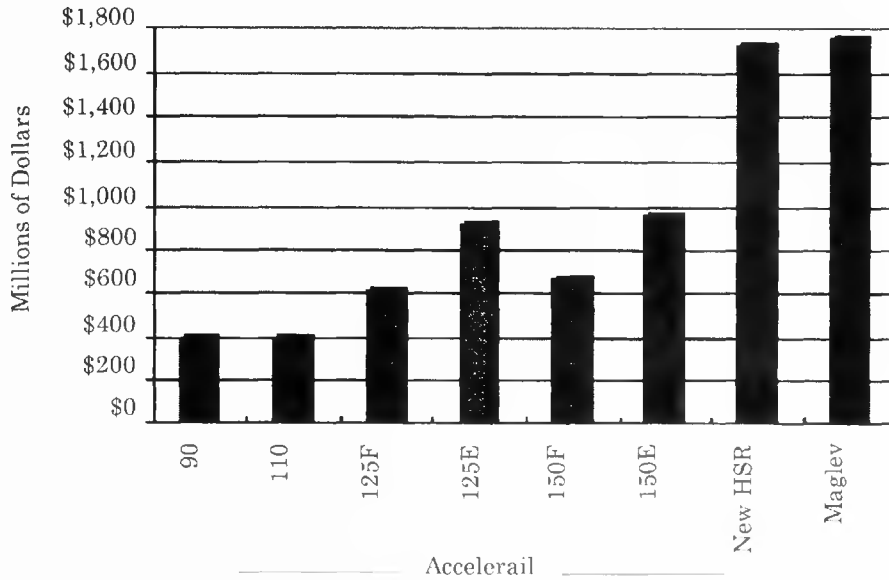
FIGURE 6
COMPOSITION OF EACH MODE'S TOTAL TRAVEL TIME
(http://www.fra.dot.gov)
EXAMPLE: CHICAGO-DETROIT
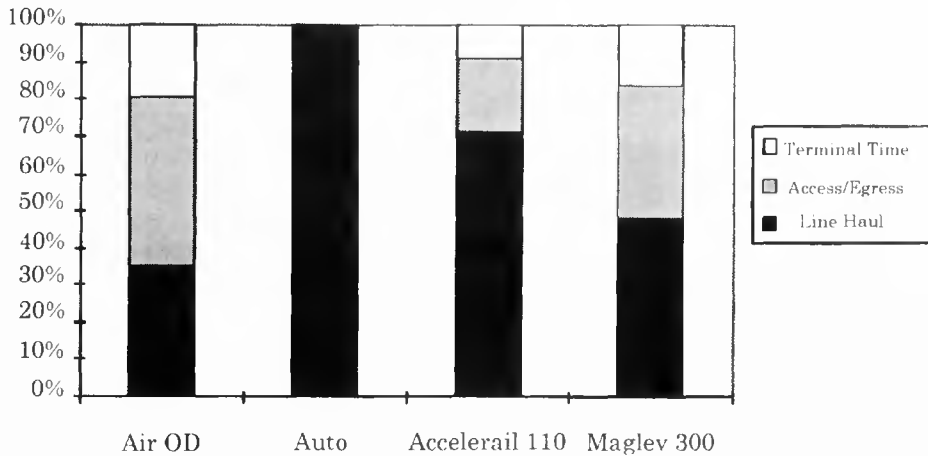
Figure 7 evaluates the total travel times by mode in two sample city-pairs: San Diego-Los Angeles (128 miles) and Los Angeles-Bay Area (425 miles). These graphs illustrate that an Accel-

FIGURE 7
COMPETITIVE POSITION OF HSBT IN TWO SAMPLE CITY PAIRS
(http://www.fra.dot.gov)
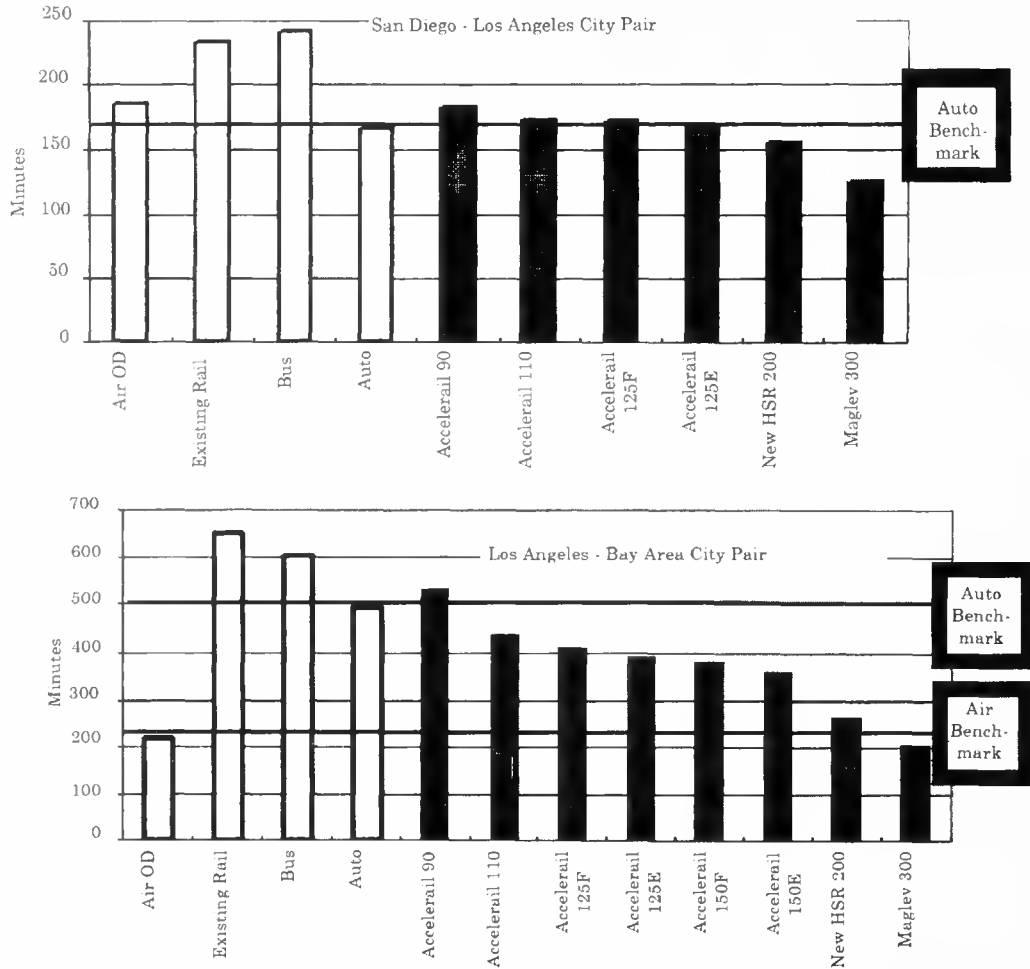
erail trip can take longer than the often-cheaper auto travel in shorter city pair markets, but Accelerail timings can outperform autos in medium and longer distance corridors. Maglev can do better than air on total travel times even in markets in the 400-mile range, whereas New HSR approaches (but does not reach) time comparability with air in longer markets.

Fares; frequency of service. The nature of the competitive market and the quality of the HSGT will affect the fares that a particular corridor can charge. When travel times improve as compared to the alternatives, fares can be higher since the public will endure a higher price for better service. Frequency of service will fluctuate among corridors based on demand. For the Accelerail alternatives, most corridors can sustain 10-20 daily round trips. However, the California Corridor provides an example of how heavier traffic justifies more frequent service.

CONCLUSION

High-speed rail systems have been operated in Europe and Japan for over thirty years. Over

this period, it is estimated that over four billion passengers have been carried without major accidents. High-speed rail has been proven in other countries as a convenient and safe mode of transportation that could positively impact economic growth. A drawback of implementing new technologies is that there could be some resistance to change. The public has been voicing its opinion about the safety of a rail system that moves at speeds in excess of 200 mph. These concerns could be easily addressed by the years of data collected on the use of high-speed rail in other countries.

The Shinkasen was first introduced in Japan in the mid-1960's, and it was a 343-mile line connecting Tokyo and Osaka. Today, the Shin-kasen is a high-speed rail network that connects Japan's major metropolitan areas and carries over 300 million passengers a year. While operating hundreds of high-speed trains a day, the Japanese have a perfect safety record as well as impressive on-time performance. High-speed trains are also used in France and Germany and recently high-speed rail networks have been set up throughout most of Western Europe (California High-Speed Rail Authority).

However, many critics of high-speed rail have been quick to point out that in Europe and Asia, high population densities restrict the number of airports, and this is why high-speed rail is needed in these areas. The critics argue that instead of putting money into a new mode of transportation, the U.S. government should just improve the existing transportation network. While it is true that the U.S. landscape and transportation network vary greatly from those found in Japan or Europe, there are many advantages in implementing a high-speed rail system in the U.S.

The first major advantage is that even though the U.S. transportation network is well developed, high-speed rail will only help future mobility and connectivity. That is, the corridors are in place, the track is laid, and appeasements are sunk. With only incremental improvements in the existing network, labor and commercial goods mobility could be negatively affected. High-speed networks could reduce the burden of increased travel demand and also act as means of connecting existing modes of transportation.

What is far more contentious is the ability of high-speed rail to effectively and efficiently carry freight over the proposed corridors, and is a necessary direction for future research con-sideration. In the 1970's, driven by efficiency pursuits of the maritime carriers, the stack train was introduced to the U.S. The operational advantages of the stack train include dedicated service, less sway, less coupling friction, and the ability to carry twice the containers with the same amount of labor and fuel. These opera-tional advantages led to marketing advantages, including less pilferage, less damage to cargo, more accurate transit times, and greater predict-ability. Overall, the steamship lines increased return on investment by keeping their assets (i.e., containers) in motion with greater pre-dictability and service ability. Can this revolutionary technology be applied to HGST? Can a double stacked rail car withstand 200 MPH stresses? European and Asian high speed trains transport dangerous chemicals (i.e., HazMat) on their runs. Will this be accepted socially in the U.S.? Will the perceived risk of carrying stacked freight outweigh the benefits of doing so? These questions should be answered in order to more fully answer the question of feasibility for freight of HGST in the U.S.

This analysis shows that high-speed rail is vital for sustaining economic growth. It offers a com-plementary mode to air and highway, which would positively affect intercity mobility. With organizations streamlining operations and an increased effort to move toward a just-in-time sys-tem, high-speed rail could be an effective solution for both passenger and freight transportation.

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AN EXAMINATION OF
THE IMPACTS OF TRANSPORTATION
MANAGEMENT SYSTEMS

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ABSTRACT

There is a great deal of research regarding Supply Chain Management (SCM) and Logistics Information Systems (LIS). However, there has not been a recent examination of the current state of Transportation Management Systems (TMS). This article provides an overview of the previous research and examines the current state of TMS and the relationships between these systems and other information systems in general. The results of over twenty years of LIS and TMS data are presented to highlight potential information gaps and significant relationships between TMS and other functions.

INTRODUCTION

The rapidly changing area of information systems (IS) has created a number of challenges for transportation professionals. Practitioners must evaluate current systems, make budget allocation decisions to purchase new systems and software, and employ TMS to measure and improve the operational performance of their organizations. However, there is a lack of benchmark data regarding the relationships between TMS and other supply chain management information systems (SCMIS).

Therefore, a goal of the research is to identify gaps in the current LIS literature and research.

These gaps provide a foundation for the examination of the impacts of TMS within the transportation organization and across the company. Also, the findings highlight the data areas that are being collected and used to support transportation operations and assist transportation and information managers' decision process.

After this introduction, there is a brief overview of the relevant literature. The methodology section discusses the data collection process. The results cover both the basic data and present interesting relationships between TMS and other areas of the organization. Finally, the managerial implications and conclusions are discussed.

LITERATURE REVIEW

A large number of articles have been written on the various aspects of LIS and TMS. A complete review of all of the previous literature is beyond the scope of the current research. However, a number of original studies have helped to establish the field of LIS (House and Jackson, 1976; Lambert et al., 1978). These previous studies have framed much of the LIS research that has followed. Also, there have been two recent articles that presented extensive literature reviews (Williams et al., 1998; Whipple et al., 1999). All of these articles helped to frame the overall format and goals of the present study.

One key point made repeatedly in previous literature is the constant evolution of the field. TMS, LIS and SCMIS systems are constantly changing. Therefore, a current study was needed to update previous findings and to evaluate new and emerging trends. Various studies had collected different types of information including usage of various programs, usage rates over time, data collection elements and a number of other factors (Waller, 1983; Kling & Grimm, 1988; Langley et al., 1988). Also, there were a number of transportation management system specific trends examined in a series of articles beginning in 1975 (Gustin, 1984; Gustin, 1993; Gustin, 1995).

Changes and updates in a number of new IS programs and concepts have been developed since the final Gustin survey (Gustin et al. 1995). Other recent studies have discussed new types of supply chain management tools (Harrington, 1997), inventory related software (Maclead, 1994; Forger, 1999), functional execution systems for logistics and operations (Smith, et al., 1998), and transportation and distribution software suites (Anonymous, 1998). In addition to these new SCMIS and TMS improvements, two of the most important changes that have also received extensive attention in the current literature are Enterprise Resource Planning (ERP) (Bradley et al., 1998; Shaw, 1998; Bradley et al. 1999a; Piturro, 1999) and Electronic Commerce (EC) (DeCovny, 1998; Bradley et al. 1999b; Brooksher, 1999; Witt, 1999).

The literature review also identified a gap in the previous research. While there was some reported research on the impacts of TMS, no broad overview of TMS or its relationships to other areas of the LIS was presented.

DATA COLLECTION

A primary goal of the research was to gather LIS/TMS information from appropriate users. Therefore, a mailing list was derived from two sources: the Council of Logistics Management and the Distribution Computer Expo attendee list. To reach large numbers of logistics and transportation professionals that were users and knowledgeable of LIS/TMS, each list was pre-screened to eliminate unlikely candidates. The CLM list was screened to identify information systems managers working for logistics and transportation operations. The Distribution Computer Expo list was reduced to include only attendees that worked for logistics and transportation companies. Finally, consultants and academics were eliminated from the potential mailing lists. From these two reduced lists, the overall mailing list was created.

A secondary goal was to continue to gather data across time. While it was not possible to replicate the exact sample of companies used in the previous Gustin surveys, most were incorporated to create a longitudinal study (Gustin, 1984, 1993, and 1995). Furthermore, the previous survey formed the basis for the current questionnaire. Based on these factors, the Dillman (1978) research method was used with a pretest, an initial survey, follow-up mailings and reminders.

The questionnaire included not only the previous instruments' questions, but also items of current interest regarding topics such as EC and ERP. The instrument was an eight page booklet with a total of 160 responses covering a full range of historical, current and projected topics of SCMIS.

A total of 1,950 surveys were mailed of which 265 were completed and returned. After removing undeliverable questionnaires, the final response rate was 13.6%. The response rate was compared to articles in the *Journal of Business Logistics* from 1990 through 2000 and it was determined that similar articles and survey instruments had very comparable response rates. Therefore, this response rate appears to be acceptable given the difficulty and length of the survey. Also, to test for non-response bias, early respondents were compared to late respondents on a number of variables (Lambert et al. 1978). No significant differences between the groups were found. Therefore, it was assumed that the respondents were a representative sample.

FINDINGS

With over 250 respondents, a wide range of companies were represented in the data sample. Numerous types of companies and industries were represented. However, the largest single group in the sample consisted of manufacturing firms. To ensure that the large number of manufacturing respondents did not influence the data, a test for bias was conducted on a number of variables between manufacturers and service respondents. There was no bias for any of the test variables. Table 1 summarizes the overall demographic data of the respondent group.

Descriptive Data

The first important area of examination was the use of various TMS components. To examine use, the questionnaire collected a number of data items. First, respondents identified which transportation data elements their company collected. These items were compared to the previous surveys to identify trends. Over time, there was a steady increase in the collection of all the various transportation data elements (Table 2). While there were some small declines on individual variables, there was an increase of data usage for every variable when viewed across the entire time period.

TABLE 1
SUMMARY DEMOGRAPHIC DATA

Demographic Category	Percent of Companies
Primary Business	
Manufacturing	61.9%
Services (retailing, wholesaling, etc.)	25.4
Not indicated	12.7
Industry	
Consumer Durable Products	11.6%
Food Production & Processing	9.7
Textiles	8.5
Chemicals	6.9
Electrical Machinery & Equipment	6.2
Third Party Logistics	5.4
Drug	4.2
Paper, Packaging, & Related	4.2
Other (6 remaining categories)	6.9
Not indicated	35.1
Division Annual Sales*	
Under $100 million	75.7%
Between $100 million and $1 billion	10.8
Above $1 billion	0.1
Not indicated	12.7

* Both Division and Total Sales were gathered; however, Division Sales was chosen as a more appropriate measure for various analyses.

It appears that companies are doing a relatively good job of using TMS to gather basic operational data. The respondents had a very high level of information on shipping locations for customers and open order files. However, regarding the areas that were not as tactical, there appears to be a lower level of computerization. Companies were less likely to use their TMS to gather rates, pay freight bills or schedule shipments. The least collected data element was transit time. Apparently, many of the respondents did not feel a need to record transit times within their current TMS.

The other descriptive portion of the research included the use of data elements by the

TABLE 2
TRANSPORTATION DATA ELEMENTS

Data Element	1975	1982	1987	1992	2000
Shipping Locations	92%	97%	97%	98%	98%
Open Order Files	84	85	89	92	94
Manifest/Bill of Lading	49	55	70	71	83
Carrier File	57	53	64	66	75
Freight Rates	45	36	61	63	71
Freight Bill Payment	51	56	62	63	71
Shipment Schedules	34	51	57	59	70
Transit Times	35	30	35	37	52

respondents. As with the large differences between the levels of data gathered by organizations, there was a sizeable disparity between the importance for different transportation activities and the information needed (Table 3).

The outbound information was the most important to the respondents. Their companies were not as concerned with inbound or especially intra-company transportation information. However, the level of dissatisfaction with the information provided by the TMS was similar for both inbound and outbound transportation. The only mildly surprising point was that intra-company movements had a lower rating on meeting information needs than outbound shipments. This may be due to the low level of importance which has not forced internal carriers to provide higher levels of internal in-transit visibility. One key point is, regardless of the transportation activity, the ability of the TMS to meet the needs of the organization was significantly lower than the demand (pair samples t-test).

Another important descriptive statistic is the TMS used by the respondent companies. There was a very wide range of products employed by transportation organizations. There were 58 different TMS products in use by the 196 companies using a TMS. None of the responses accounted for over 10% of the total. The most common choice was an internal TMS (17 respondents). The second most used system was part of a Manugistics package, including the Global Transportation and Trade Management software (12). The vast majority of respondents used either an internally developed or "off-the-shelf" package. No single TMS vendor or program dominates the market at this time.

The final descriptive item involved the use of TMS to improve the company's performance. Respondents were asked about the level of satisfaction with their TMS systems. Of the respondents using a TMS, 77% were either satisfied or very satisfied with their system's impact on the organization's performance (Figure 1).
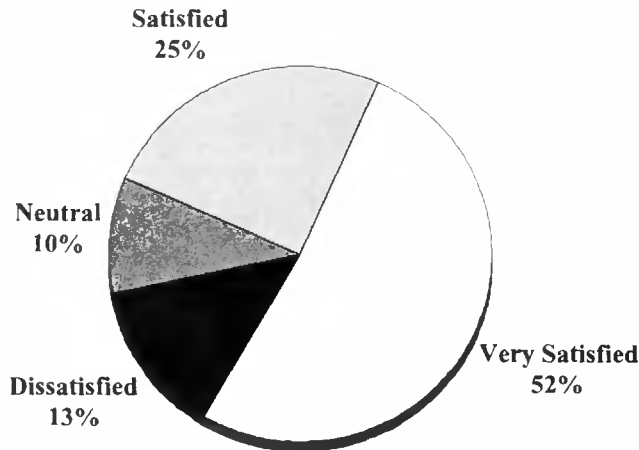
Significant Findings

The descriptive items provided an interesting set of findings. However, the more in-depth examination of the data identified additional

TABLE 3
TRANSPORTATION DATA AREA INFORMATION GAPS

Transportation Activity	Information Need (mean rating)	TMS Meets Info Needs (mean rating)	Gap Between Mean Ratings	t	Sig.
Outbound Transportation	6.05	4.80	1.25	12.178	.000
Inbound Transportation	5.28	3.92	1.36	10.378	.000
Intra-company Transportation	4.67	4.31	0.36	2.731	.007

"Information Needs" rating scale: 1 = Low to 7 = High
"TMS Meets Information Needs" rating scale: 1 = Not at all to 7 = Completely

FIGURE 1
TRANSPORTATION MANAGEMENT SYSTEMS SATISFACTION

Satisfied 25%
Neutral 10%
Dissatisfied 13%
Very Satisfied 52%

items. First, there were a number of "obvious" findings in the data. For example, companies that employed a TMS were significantly more likely to track freight rates than those that did not, based on an analysis using a Pearson Chi-square test (Value = 13.602, p < .001). There were a number of similar items in this category. These findings, while not surprising, confirm the benefits of TMS by providing a much higher level of transportation related information (Table 4).

While it is logical that the TMS creates a significant increase in the volume of transportation related data, an interesting finding concerned the relationship with non-transportation specific variables. A number of variables that were not likely to be linked to the use of a TMS were significant. Companies that used a TMS had a much higher level of computerization with a number of inventory, production and sales data elements. They were more likely to track inventory costs and storage levels. Also, they demonstrated a higher level of forecasting. Table 5 presents the unique data elements where TMS use has significant relationships.

There are a number of important points that are related to the findings in Tables 4 and 5. First, companies that implement a TMS collect a much higher level of information than those organizations that do not. At least two reasonable explanations for this can be found. Either the TMS is an indicator of firms that are more technologically advanced or the implementation of a TMS facilitates the sharing of information throughout an organization.

The second key point based on the findings is that there is a clear relationship between the use of a TMS and the collection of non-transportation data elements within the firm. A transportation organization that operates a TMS is much more likely to gather information from other areas of the business: distribution, sales, and production. For example, only 8.3% of non-TMS companies track stockout costs, but 16.0% of the TMS organizations measure them. While both are low, the TMS users are significantly ahead of their competitors ($p<.087$). Also, it is likely that the transportation function shares more information with other business areas.

Another set of important findings deals with the value of information as identified in Table 3. The overall respondent group identified the importance of inbound, outbound and intra-company information and the gaps in current technology. An interesting finding is that the use of a TMS does not appear to dramatically change

TABLE 4
TMS RELATIONSHIP WITH
TRANSPORTATION DATA ELEMENTS

Data Element	Value	p-value
Shipping Locations	5.881	.053**
Open Order Files	6.288	.098**
Manifest/Bill of Lading	16.331	.001*
Carrier File	7.921	.048*
Freight Rates	13.602	.001*
Freight Bill Payment	6.789	.034*
Shipment Schedules	23.254	.000*
Transit Times	2.074	.355
Freight Claims	10.213	.005*

*Significant at the .05 level
**Significant at the .10 level

TABLE 5
TMS RELATIONSHIP WITH NON-
TRANSPORTATION DATA ELEMENTS

Data Element	Value	p-value
Warehousing Costs	14.394	.002*
Storage Costs	4.983	.083**
Handling Costs	6.694	.035*
Production Costs	9.909	.007*
Inventory Levels	14.488	.001*
Packaging Costs	11.058	.011*
Stockout Costs	6.556	.087**
Back Orders	15.281	.002*
Customer's Financial Limits	13.973	.001*
Master Order File	6.195	.045*
Forecasted Sales	26.274	.000*

*Significant at the .05 level
**Significant at the .10 level

these results. The only significant finding was that companies using a TMS believe that outbound transportation information is much more important than non-users. This might account for the implementation of the TMS in the first place. However, there was not a significant difference in the ability of the TMS to meet the information needs. It is likely that the implementation of the TMS increases the expectation levels of the users which raises both the level of information need and also affects the perception of how well the TMS meets that need. Therefore, while the TMS does improves the quality of information, the perceived gap remains. Table 6 supports this finding.

The final area of examination concerned the impact of the TMS on current information trends: EC and ERP. Unlike some of the other relationships, there were no significant differences based on the implementation of a TMS. The widespread adoption of ERP (74.9%) by logistics organization may make any minor differences by TMS users insignificant. Also, the wide variation of the EC results identified the lack of strategies by most companies.

The data presented a number of logical and unique findings. The indicated relationships between the TMS and information areas outside of transportation were the most unexpected. Furthermore, the lack of significant findings in a number of areas highlights that the TMS is not a solution for all areas of need. Finally, the descriptive data present useful information for managers.

MANAGERIAL IMPLICATIONS

The first item that practitioners could use is the identification of data that are being collected by companies' TMS. Table 2's usage rates provide an excellent set of benchmark data with which transportation organizations can compare. Each company can determine if it is collecting appropriate transportation elements based on industry wide practices. Also, the data allow companies to benchmark their transportation information gaps. Finally, organizations can evaluate the success of their TMS compared to other companies' satisfaction levels. Furthermore, if a transportation division is attempting to justify the purchase of a TMS, the results provide strong support.

TABLE 6
TRANSPORTATION DATA AREAS INFORMATION GAPS AND TMS RELATIONSHIPS

Transportation Activity	Information Need		TMS Meets Information Needs	
	Value	p-value	Value	p-value
Outbound Transportation	11.134	.049*	2.144	.906
Inbound Transportation	8.580	.199	5.757	.451
Intra-company Transportation	4.669	.587	4.289	.638

*Significant at the .05 level   **Significant at the .10 level

In addition to viewing the satisfaction of other users of TMS, there are other positive indicators for the implementation of a TMS. The relationships between non-transportation elements and the TMS highlight the positive effects and synergy that occur with the sharing of data. The inclusion of a TMS in the overall LIS strategy increased information throughout the system. Also, this allows practitioners to gather information from other business areas that may impact transportation operations.

Another piece of information that executives can use concerns the findings on ERP and EC. In both cases, there was no perceived benefit to implementing a TMS when compared to ERP or EC. Neither EC nor ERP had significantly different results when compared to TMS implementation. Therefore, transportation professionals should be careful in committing limited resources from their budget for EC or ERP. The use of EC and ERP appear to be a senior executive level decision and cross functional boundaries. The findings illustrate that, rather than providing specific improvements to transportation functions, most benefits from EC and ERP are general and support the entire company.

Finally, managers can use the findings to evaluate the role of transportation within the overall SCMIS strategy. While most of this article's findings are operational and tactical, the next step of IS integration will be strategic and occur across the entire supply chain. The findings presented here can help to identify standardized, key data elements that should be shared with business partners outside the company. Executives will have to determine which, if any, of these items are sensitive or proprietary to their operations. Furthermore, the value of these interactions is still not clearly defined. While it appears that there are benefits and satisfaction from sharing information, this study did not perform a benefit-to-cost analysis, which would need to be considered in any implementation of SCMIS.

CONCLUSIONS AND FUTURE OPPORTUNITIES

In general, the use of the TMS appears to create value within transportation and logistics organizations. The TMS improves transportation operations by incorporating specific transportation data elements. Also, the interactions with other data sources within the firm, and possibly across the supply chain, improve information sharing. The overall impact of TMS appears to be very positive.

A future opportunity for research might involve measuring the financial impact of the TMS. A continuation of this longitudinal study should include the financial considerations of implementing TMS improvements. Furthermore, it could evaluate the economic effects of other SCMIS as well.

A second research opportunity stems from the apparent lack of impact on TMS from the implementation of EC or ERP. A further examination could help to identify the reasons for this finding. The next study would also provide ERP suppliers more time to produce advanced transportation packages to incorporate into ERP systems. Furthermore, a few years would allow the eLogistics portion of EC to mature, consolidate and stabilize. This would allow a more accurate analysis of impacts on transportation.

The final future area of study is directly related to the findings of the present study. Will the growing interaction between TMS and other IS areas of a company continue? Will this relationship form a more standardized SCMIS in the future? These are relevant questions to pursue in future research efforts.

This research highlighted the growth and successes of TMS within industry. While Thomas Jefferson once said, "Information is the currency of democracy," it appears that now 'Information is the currency of transportation."

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Guidelines for Submission/Publication

FRONT MATTER

1. First Page—Title of the paper, name and position of the author(s), author(s) complete address(es) and telephone number(s), e-mail address(es), and any acknowledgment of assistance.

2. Second Page—A brief biographical sketch of each author including name, degree(s) held, title or position, organization or institution, previous publications and research interests.

3. Third Page—Title of the paper without author name(s) and a brief abstract of no more than 100 words summarizing the article. The abstract serves to generate reader interest in the full article.

FORMATTING

1. Manuscripts should be typed, double-spaced (body of text only), on white 8 ½ by 11 inch paper.

2. Submit four (4) paper copies of the manuscript for review. It is not necessary to send a disk for the initial review. However, to save time and effort if accepted, the article should be prepared using either:

   WordPerfect **9.0 or lower**
      OR
   Microsoft Word **2000 or lower**

3. Accepted articles, in final form, are to be submitted on disk (in WordPerfect or Microsoft Word format as described above) and in hard copy. Note: Macintosh versions of WordPerfect and Microsoft Word are NOT acceptable.

4. The entire manuscript should have 1" margins on all sides in Times 10-point font. Times New Roman or Century Schoolbook are both acceptable.

5. The entire manuscript must be typed LEFT-JUSTIFIED, with the exception of tables and figures.

TITLE PAGE AND ABSTRACT

1. The manuscript title should be printed in Times 11-point and in all capital letters and bold print.

2. Author(s) and affiliation(s) are to be printed in upper and lower case letters below the title. Author(s) is(are) to be listed with affiliation(s) only.

3. The abstract should be 100 words or less.

BODY OF MANUSCRIPT

1. Main headings are bolded and in all caps.

2. First level headings are upper/lower case and bolded.

3. Second level headings are upper/lower case.

4. The body is NOT indented, rather a full blank line is left between paragraphs.

5. A full blank line should be left between all headings and paragraphs.

6. Unnecessary hard returns should not be used at the end of each line.

TABLES AND FIGURES

1. ONLY Tables and Figures are to appear in camera-ready format! Each table or figure should be numbered in Arabic style (i.e., Table 1, Figure 2).

2. All tables MUST be typed using either WordPerfect table or Microsoft Word table functions. Tables should NOT be tabbed or spaced to align columns. Column headings should not be created as separate tables. Table titles should not be created as part of the table. All tables MUST be either 3 1/4 inches wide or 6 7/8 inches wide.

3. All figures MUST be saved in one of these formats: TIFF, CGM, or WPG.

4. Tables and figures are NOT to be included unless directly referred to in the body of the manuscript.

5. For accepted manuscripts, tables and figures must be included on the submitted disk and each should be printed on a separate page.

6. Placement of tables and figures in the manuscript should be indicated as follows:

    Table or Figure About Here

EQUATIONS, CITATIONS, REFERENCES, ETC.

1. Equations are placed on a separate line with a blank line both above and below, and numbered in parentheses, flush right. Examples:

    $$y = c + ax + bx \tag{1}$$
    $$y = a + 1x + 2x + 3x + ax \tag{2}$$

2. References within the text should include the author's last name and year of publication enclosed in parentheses, e.g. (Cunningham, 1993; Rakowski and Southern, 1996). For more than one cite in the same location, references should be in chronological order, as above. For more than one cite in the same year, alphabetize by author name, such as (Grimm, 1991; Farris, 1992; Rakowski, 1992; Gibson, 1994). If practical, place the citation just ahead of a punctuation mark. If the author's name is used within the text sentence, just place the year of publication in parentheses, e.g., "According to Rakowski and Southern (1996)...,". For multiple authors, use up to three names in the citation. With four or more authors, use the lead author and et al., (Mundy et al., 1994). References from the Internet should contain the date the page/site was created, date page/site was accessed, and complete web address.

3. Footnotes may be used when necessary. Create footnotes in 8-point font and place them at the bottom of the page using numbers (1, 2, etc.). Note: footnotes should be explanatory in nature and not for reference purposes.

4. All references should be in block style. Hanging indents are not to be used.

5. Appendices follow the body of the text but do not precede references.

6. The list of references cited in the manuscript should immediately follow the body of the text in alphabetical order, with the lead author's surname first and the year of publication following all author names. Work by the same author with the same year of publication should be distinguished by lower case letters after the date (e.g., 1996a). For author names that repeat, in the same order, in subsequent cites, substitute a .5 inch underline for each name that repeats. Authors' initials should have a space between the initials, e.g., Smith, Jr., H. E., Timon, III., P. S. R., etc. A blank line should separate each reference in the list. Do not number references.

7. All references to journals, books, etc. are *italicized*, NOT underlined. Examples are as follows:

Journal Article:

Collison, Fredrick M. (1994), "Transpacific Air Service with Hong Kong: Characteristics and Issues," *Journal of Transportation Management*, 6(2):1-39.

Book Chapter:

Hatch, R. W. (1923), "A Program for the Social Studies in the Junior and Senior High Schools," In G. M. Whipple (Ed.), *National Society for the Study of Education Yearbook 1922* (Pt. 2, pp. 126-154) Bloomington, IL: Public School Publishing.

Book:

Johnson, James C. and Wood, Donald F. (1996), *Contemporary Logistics*, 6th ed., Upper Saddle River, NJ: Prentice-Hall, Inc.

Internet Reference:

Lankard, B. A. (1995), "Service Learning," *Eric Trends and Issues Alerts*, [Online]. Available: http://ericave.org/docs/service.thm. Accessed: 3/2/00.

MANUSCRIPT SAMPLE

TEACHING LOGISTICS STUDENTS TO TAKE OWNERSHIP OF INFORMATION INFRASTRUCTURE DEVELOPMENT

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Kenneth J. Preissler, Logistics Insights Corporation

Logistics systems, developed gradually over the past decades, are undergoing necessary radical change in this era of increasing global competition. This article describes an approach taken by the authors to teach logistics students how to take ownership of designing their own information infrastructure and how to use it to make their organizations more flexible, providing more strategic options.

INTRODUCTION

Advances in information systems technology such as data base management systems, bar code scanning, telecommunications, and image processing have enabled logistics and information managers with vision to reengineer the way the firm conducts its business. The usage of mainframe computers, personal computers, and logistics information systems has been widely studied (Gustin 1989). These studies have universally concluded that there has been a rapid growth in the usage of computers and logistics information systems.

Computer Usage in the Classroom

The usage of computer applications in a logistics course has also been studied. Rao, Stenger and Wu stated that there are several approaches to integrating computers into the classroom in a business curriculum, each with its individual advantages and drawbacks (1992).

Table 1 about here

Systems Development in Practice

The study of the information systems development process of computer applications has been almost universally left up to the computer science, software engineering, and information systems educators and practitioners.

$$y = a^2 - 2ax + x^2 \tag{1}$$

REFERENCES

Collison, Fredrick M. (1994), "Transpacific Air Service with Hong Kong: Characteristics and Issues," *Journal of Transportation Management*, 6(2):1-39.

Crum, M. R. (1996), "On the Improvement of Carrier EDI Implementation Strategies," in *EDI Implementation in the Transportation Industry*, New York: Transportation Press, 387-404.

Johnson, James C. and Wood, Donald F. (1996), *Contemporary Logistics*, 6th ed., Upper Saddle River, NJ: Prentice-Hall, Inc.

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