Title
Trucking Industry Perceptions of Congestion Problems and Potential Solutions in Maritime Intermodal Operations in California

Authors
Regan, Amelia C.
Golob, Thomas F.

Publication Date
1999-06-15

Trucking Industry Perceptions of Congestion Problems and Potential Solutions in Maritime Intermodal Operations in California

by

Amelia C. Regan

Department of Civil and environmental Engineering
and Institute of Transportation Studies
University of California
Irvine, CA 92697

and

Thomas F. Golob

Institute of Transportation Studies
University of California
Irvine, CA 92697

Published in
***Transportation Research Part A: Policy and Practice,* 34: 587-605**

June 15, 1999
Working paper: UCI-ITS-WP-98-23

Trucking Industry Perceptions of Congestion Problems and Potential Solutions in Maritime Intermodal Operations in California

by

Amelia C. Regan

Department of Civil and environmental Engineering
and Institute of Transportation Studies
University of California
Irvine, CA 92697

and

Thomas F. Golob

Institute of Transportation Studies
University of California
Irvine, CA 92697

ABSTRACT

Efficient maritime transportation is heavily dependent on the smooth operation of land transportation. Swift modal transfers are key to successful intermodal operations. In this paper we examine the efficiency of maritime intermodal transfer facilities in California, from the point of view of the trucking companies that use these facilities. We also examine the perceived effects of traffic network congestion on intermodal carriers' operations. Conclusions are based on a recent survey of nearly 1200 private and for-hire carriers operating in California. Over 450 of the companies surveyed had operations involving maritime ports in California. These provided a rich sample of responses and significant insights into the current state of the industry.

Key words: Intermodal Freight Transportation, Port Operations, Freight Mobility, Commercial Vehicle Operations, Policy Analysis

1 Introduction

Maritime freight transportation plays a significant role in the economy of California and of the US in general. Measured by the value of shipments handled, the ports of Long Beach and Los Angeles are the first and fourth largest international freight gateways in the US respectively. The combined value of international shipments moving through those ports in 1996 was estimated to be nearly $160 billion (Bureau of Transportation Statistics, 1998). The Alameda Corridor Project involves the construction of a twenty mile long grade-separated rail and truck facility connecting the ports of Long Beach and Los Angeles to rail and ground operations. This will no doubt further increase the volume of freight moving from ocean vessels to ground operations in this state. Whether the freight, typically offloaded from ships in containers, is moved long distances by truck or destined for a rail yard, the majority makes the journey out of the port via truck.

In the United States, efficient maritime transportation is heavily dependent on the smooth operation of land transportation. Swift modal transfers (both maritime-truck and maritime-truck-rail-truck) are key to successful intermodal operations. In this paper we examine the perceived efficiency of maritime intermodal transfer facilities in California, from the point of view of the trucking companies that use these facilities. We also examine the perceived effects of road traffic congestion on intermodal carriers' operations. Conclusions are based on a 1998 survey of nearly 1200 private and for-hire carriers operating in California. Over 450 of the companies surveyed had operations involving maritime ports in California. These provided a rich sample of responses and significant insights into the current state of the industry. Questions were asked about typical delays and the predictability of the time required for picking up and delivering loads to these facilities. Operators were also invited to describe the types of problems they faced in operating at intermodal facilities Other aspects of the survey are addressed in Golob and Regan (1998a), Golob and Regan (1998b) and Regan and Golob (1999).

This paper identifies some potentially important issues for policy analysts, port managers, container terminal operators and traffic engineers. Congestion in and around ports is a serious problem for trucking companies and comes at a high cost. These costs are experienced in terms of higher freight rates, traffic congestion experienced by drivers not associated with the ports, diminished road safety, discouraged drivers and potentially reduced regional economic competitiveness. After introducing the survey and describing the sample, we examine the impact of traffic congestion on intermodal carriers' operations. Next we present these carriers' reactions to a set of twelve congestion mitigation strategies. Finally, we examine the perceived magnitude of congestion problems at California ports included in the survey.

2 Related Studies

Several other surveys of the industry have been conducted in the past few years. Holguin-Veras and Walton (1996) and Holguin-Veras (1999) investigated the use of information technologies in port operations through interviews with port operators and a small survey of carriers. Their findings were that, although port and terminal operators were providing information systems and using information technologies themselves, carriers were reluctant to follow suit due to the costs associated with new technologies and the perceived unreliability of these (e.g. container status information systems). The costs and benefits of Intelligent Transportation Systems (ITS) technologies in commercial vehicle operations (CVO) was recently investigated by the American Trucking Associations (ATA) Foundation through a survey of 700 U.S. motor carriers and 180 technology vendors. The analysis of the data from that survey provided estimates of the market potential for motor carrier participation in six Federal Highway Administration ITS/CVO user services: (1) commercial vehicle administrative processes, (2) electronic clearance, (3) automated roadside safety inspections, (4) on-board safety monitoring, (5) hazardous materials incident response and (6) freight mobility (American Trucking Associations, 1996).

As part of an analysis of the future of communications technologies in commercial vehicle operations, Scapinakis and Garrison (1993) surveyed 253 carriers regarding their perceived use of communications and positioning systems. The primary findings were: a) the trucking industry is so diverse as to make it difficult to predict the information technology needs of the industry as a whole; and, b) while short distance operators are heavy users of communication technologies, long distance carriers are likely to increasingly require both on-board communication and vehicle location systems.

Kavalaris and Sinha (1994) also surveyed trucking companies with a focus on their awareness of and attitudes towards ITS (then called IVHS, or Intelligent Vehicle Highway Systems) technologies. The nearly 500 responses to their survey indicated that, in 1993, not only were most trucking companies not using ITS technologies in their operations, the majority were unaware of developments in automated toll collection, weigh station by-pass and related use of automatic vehicle identification devices.

A study by Ng, Wessels, Do, Mannering and Barfield (1996) reported on responses from two nationwide surveys of dispatchers and commercial vehicle operators. The 348 and 325 responses (dispatchers and drivers) were analyzed to determine characteristics that would determine likely acceptance of Advanced Traveler Information Systems (ATIS) technologies, including route guidance, navigation, road and traffic information, roadside services and personal communication. Key insights from their study are that drivers who plan their trips on the road were less likely to value ATIS features than those that began at home, and that drivers and dispatchers who are already using advanced technologies in their operations were much more likely to value additional technologies than those who have not been similarly introduced.

A paper by Regan, Mahmassani and Jaillet (1995) briefly describes a 1992 survey of about 300 companies which attempted to determine carriers' propensity to use new technologies, particularly two-way communication and automatic vehicle location/identification technologies. Primary findings were that interest in technology implementation was closely linked to company size and that carriers believe that the use of communication and information technologies could improve the efficiency of their operations.

A recent report by Hall and Intihar (1997) reports on a series of interviews with trucking terminal managers, focus group meetings with representatives of the trucking industry in California and telephone interviews with technology providers. Their study found that trucking companies were willing to invest and participate in ITS implementation as long as the investment required was modest, there were no new taxes or user fees imposed, the technologies promoted operating efficiency, customer service or safety, and, implementation was voluntary.

Several studies of EDI use in the Motor Carrier Industry have been conducted in the past few years. The most recent, by Crum, Johnson and Allen (1998) compares two surveys of EDI capable carriers that were conducted in 1990 and 1996 and found significant increases in the use of EDI in carrier-shipper transactions during that six year period.

Finally, Hensher, Chow and King (1996) and Hensher and Golob (1998) present analyses of a survey of 150 organizations involved in manufacturing, retailing, warehousing and distribution as well as those involved in providing general (utility) services (electricity, telecommunications), contract distribution, freight hauling, and freight forwarding in the Sydney Metropolitan Area. The survey provided input to support policy decisions in the development of a State of New South Wales freight transport strategy. The New South Wales survey gathered attitudinal data concerning freight industry opinions about potential policy initiatives. As part of their study, Hensher and Golob developed a statistical model that links opinions about specific policies to freight industry sectors.

This study extends the survey-based analyses of information technology use in the industry and combines this with the policy analysis addressed in the Hensher and Golob (1998) study. In addition, this study investigates carrier perceptions of the impact of congestion on their operations.

3 The Survey Data

The survey was conducted as a computer aided telephone interview (CATI) in the Spring of 1998. Questions were posed to the logistics or operations manager in charge of operations in California. The sample was drawn randomly from a set of 5258 freight operators, broken down into: (1) 804 California-based for-hire trucking companies, with annual revenues of over $1 million, (2) 2129 California-based private fleets of at least 10 vehicles (power units) and (3) 2325 for-hire large national carriers not based in California with annual revenues of over $6 million. The list of companies and individual contact information was drawn from a database of over 21,000 for-hire carriers and 25,000 private fleets maintained by Transportation Technical Services Inc. An overall response rate of 22.4% was obtained, with many of the national carriers excluded on the basis of insufficient operations in the state of California. Eliminating the contacts with no operations in California and invalid telephone numbers, the effective response rate was approximately 35% (1177 participants).

Two hundred and seventy-six of the respondents were from for-hire trucking companies headquartered in the state of California. That group had the highest raw response rate, with over 34% of the companies completing the rather lengthy survey. Four hundred and seven were from California-based private fleets. At 19%, this group had the lowest raw response rate. In general, it was more difficult to make contact with the appropriate manager in these companies. The remaining four hundred and ninety-three responses came from national for-hire carriers. Twenty-one percent of these were willing to answer the survey and had operations in California. The for-hire carriers were identified as common carriers which serve the general public or other businesses at established (or negotiated rates), contract carriers which move freight on a for-hire basis, but under contract to a specific set of shippers, or, as those which provide both common and contract services. Approximately 58% of the companies responding provide truckload service only, while another 33% provide truckload and less-than-truckload (LTL) service. Only 9% of the companies surveyed listed LTL operations only as the primary service they provide.

Non-response analyses were conducted for each of the three strata from which the sample was drawn. Golob and Regan (1998a) report that there are no statistically significant differences (at the p = .05 level) between respondents and non-respondents on any of three criteria available in the databases from which the sample was drawn: revenue, overall size of fleet, and number of years in business. The median size of fleet for the 767 for-hire companies in our sample is 81, while the median fleet size for the 2367 for-hire companies excluded from the sample is 78. For private companies, the median fleet size for the 410 companies in the sample is 28, while the median fleet size for the 1722 private fleets not in the sample is 29. From these results, we can conclude that he sample is a good representation of for-hire trucking companies operating in California in 1998.

The database from which the sample of private fleets was drawn also contained the standard industrial classification (SIC) codes of the companies. A comparison of the SIC code distributions for our sample of private trucking companies and their complement of non-sampled companies resulted in a chi-squared statistic of 13.37 with 6 degrees of freedom, corresponding to p = 038 (Golob and Regan, 1998a). Our sample over-represents trucking operations from the wholesale trade sector, and under-represents those from the construction sector. The distribution of the sample is quite close for the other five sectors. Because the sample is not biased in terms of fleet size, and because and the overall deviation in terms of SIC codes for the private operators in the sample is not significant at the $p = .01$ level, we judge that the private fleet component of the sample is a good representation of private trucking companies operating in California in 1998.

4 Trucking Industry Service to Maritime Ports

Nearly forty percent of companies surveyed provide service to ports in California. Most of the companies engaged in intermodal operations (36% of all companies) provide both pickups and deliveries at ports, but a few companies (2%) only make pickups at ports, and a few companies (2%) only make deliveries. The most heavily used ports are Los Angeles and Long Beach, which are served by 23% and 22% respectively of the trucking companies in the sample. Other often-used ports include Oakland, served by 18% of the companies, and the Port of San Francisco, served by 14%. The Port of Sacramento is served by 7% of companies, followed by the Port of San Jose (5%), Port Hueneme at Oxnard and Stockton (1% each).

Most carriers engaged in maritime intermodal operations (63%) serve more than one port and 8% serve seven or more (Figure 1). The mean number served is 2.6 while the median is 2. One in ten of those providing service to ports also serve airports and rail terminals while one in five provide service to ports and airports only or ports and rail terminals only. Half of those providing service to ports do not serve other intermodal transfer facilities (Figure 2).

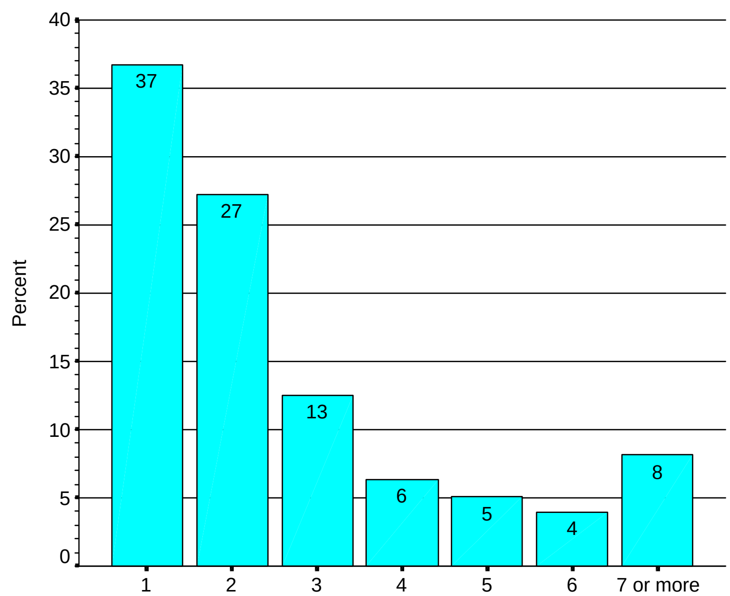

Figure 1 Number of ports served by companies serving maritime ports

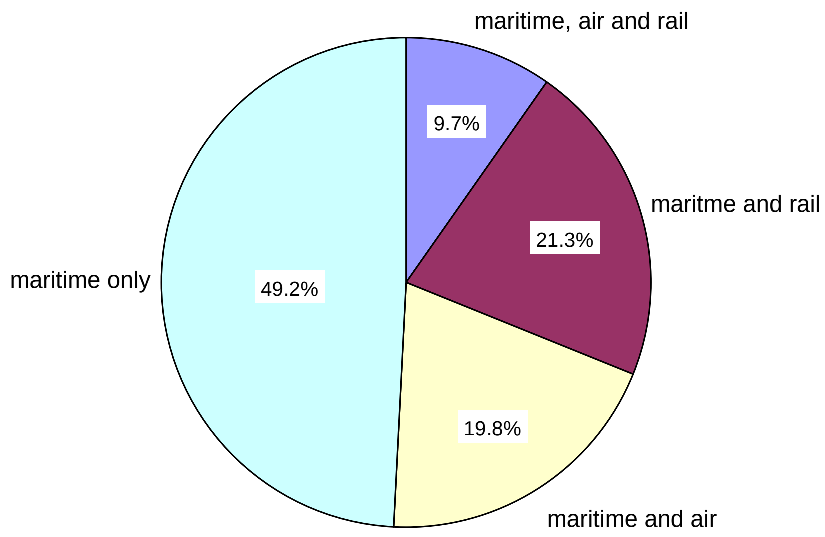

Figure 2 California intermodal services of operators serving ports in California

Those providing service to maritime ports differed from the larger sample in several (statistically significant) ways. Trucking companies that operate both as common and contract carriers are more likely than private fleets to serve ports (Figure 3). Carriers providing certain specialized services are more likely than others to serve California ports. For example, refrigerated and general truckload or LTL carriers were more likely to serve California ports while bulk carriers are less likely to do so (Figure 4).

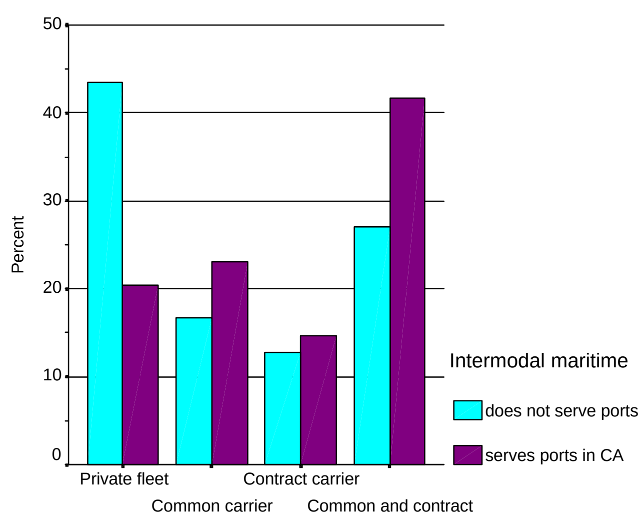

Figure 3 Maritime intermodal operations by type of operation.

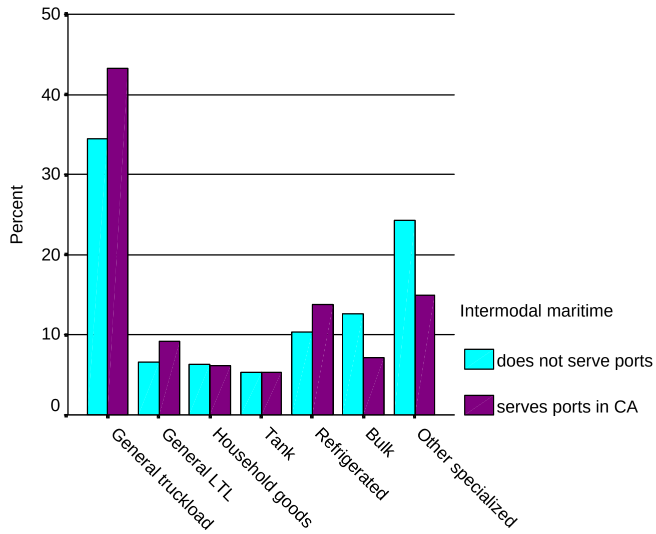

Figure 4 Maritime intermodal operations by primary service
Figure 4 Maritime operations by primary service

Larger trucking companies are more likely to provide services to California ports than small companies. Similarly, long haul companies are more likely to provide such service than companies who typically move loads short distances (Figures 5 and 6).

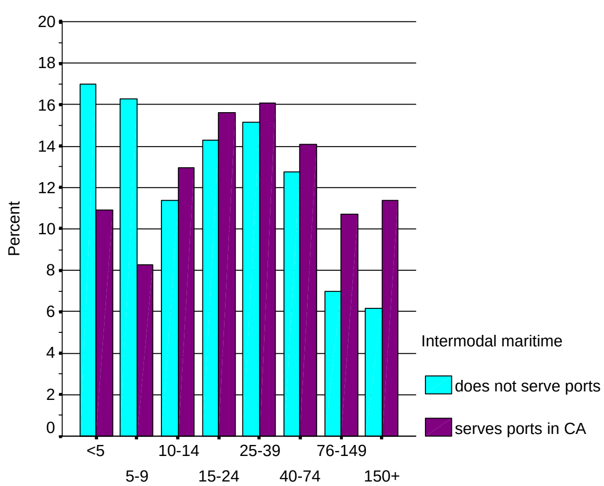

Figure 5 Maritime operations by number of power units typically operated in California

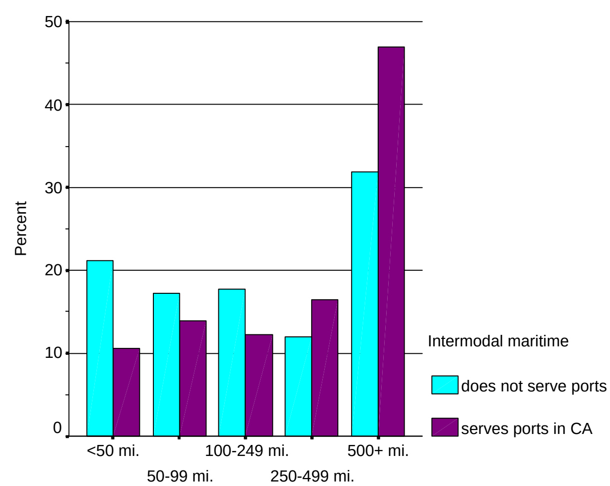

Figure 6 Maritime operations by average length of loaded movement

The mean number of ports served by companies engaged in maritime operations varied by the type of operation, the load type and the primary service of the company (Table 1). Private fleets served fewer ports than other types of companies. Companies that provided both common and contract services served the highest number of ports, on average. Companies whose primary operation was less than truckload served more ports than their counterparts whose operations are primarily truckload or combined truckload and less than truckload. With regard to primary service, tank and bulk carriers are more localized in their use of port facilities, while general LTL carriers are the least localized. As shown in Table 1, the differences in means across each of the three sets of company characteristics are significant at the p = .05 level.

Table 1: Mean numbers of ports served by companies with maritime operations

	Mean	N	Std.dev.	F (d-o-f)	Probability
Type of operation					
Private fleet	2.24	93	1.72	3.135 (3, 451)	.025
Common carrier	2.61	105	1.88		
Contract carrier	2.31	67	1.80		
Common and contract carrier	2.88	190	1.94		
Load type					
Truckload	2.41	248	1.75	3.68 (2, 452)	.026
Less than truckload (LTL)	3.23	31	2.32		
Both truckload and LTL	2.76	176	1.92		
Primary service					
General truckload	2.71	197	1.91	3.265 (6,448)	.004
General LTL	3.38	42	2.21		
Household goods	2.86	28	2.22		
Tank	2.00	24	1.10		
Refrigerated	2.71	63	1.79		
Bulk	2.12	33	1.62		
Other specialized	2.60	68	1.59		

The number of ports served also varied significantly by the average length of loaded movement, as shown in Figure 7. Quite a few respondents were not able to estimate the average loaded movement for their companies, and these companies served the most number of ports. Companies with average loaded movements between 50 and 99 miles were the most localized in their use of port facilities.

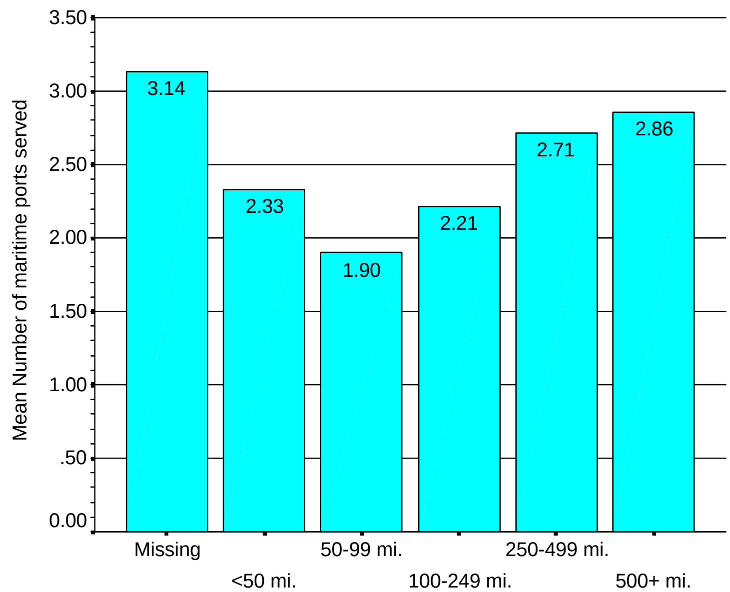

Figure 7 Mean number of ports served by companies with maritime operations, by average length of loaded movement

5 Congestion Problems

5.1 The Overall Problem

Many of the questions in the survey focused on congestion problems in and around ports. Growth in the intermodal freight market is limited to a certain extent to the ability of the ground transportation network around intermodal transfer facilities to accommodate freight traffic. In addition to congestion at intermodal facilities, intermodal operators were more likely than others responding to the survey to be negatively affected by traffic congestion on the road network. Figure 8 shows that maritime intermodal carriers are more likely than others to miss schedules because of traffic congestion. Similarly, Figure 9 shows that maritime intermodal carriers are more likely to be re-routed due to traffic congestion. The likely reason for this is shown in Figure 10 which shows that maritime intermodal carriers are forced by customer and facility time windows to work during peak periods.

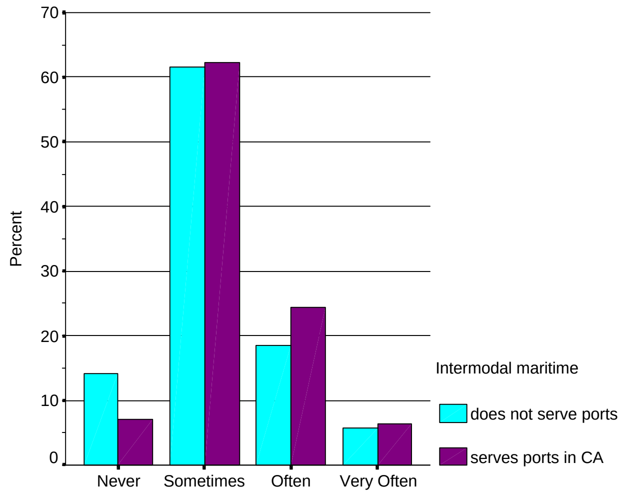

Figure 8 Frequency with which schedules are missed because of congestion

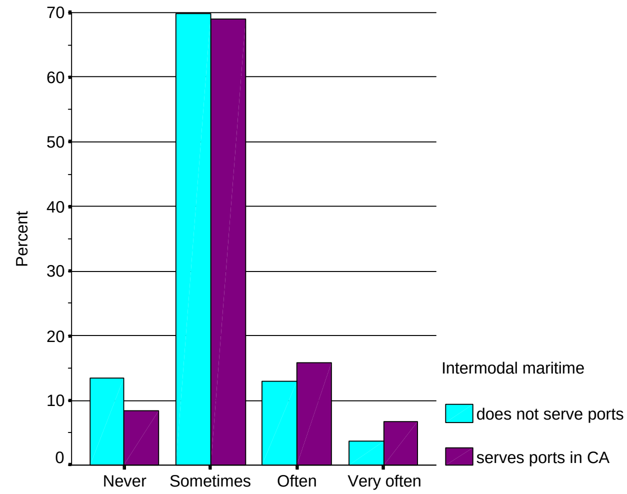

Figure 9 Frequency with which drivers are re-routed because of congestion

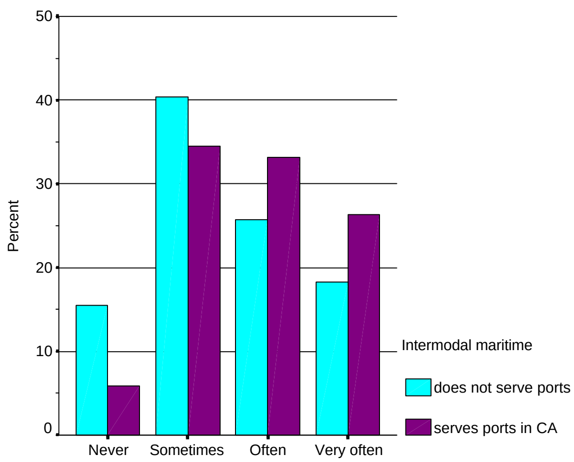

Figure 10 Frequency with which customer time-windows for pickup and delivery force operator to work in congested conditions when the operator would otherwise wait for less congested times

In general, maritime intermodal carriers viewed traffic congestion as a more serious problem than other carriers (Figure 11). The statistically significant difference in the perception of seriousness of congestion problem identified in the responses of maritime intermodal carriers could be due to other differences in the operations of those companies. To test for this, we performed ordered-response probit regressions to determine which characteristics significantly explain ratings of seriousness. The ordered-response probit method preserves the ordinal nature of the scale of the dependent variable. After determining which characteristics were effective in explaining the scale, the dummy variable accounting for intermodal maritime operations was added to the equation. The improvement in the model goodness-of-fit was significant, and the coefficient for maritime operations was positive and significantly different from zero at the p = .05 level, as shown in Table 2. In addition to other differences in characteristics, the fact that these companies were providing intermodal service informed their responses.

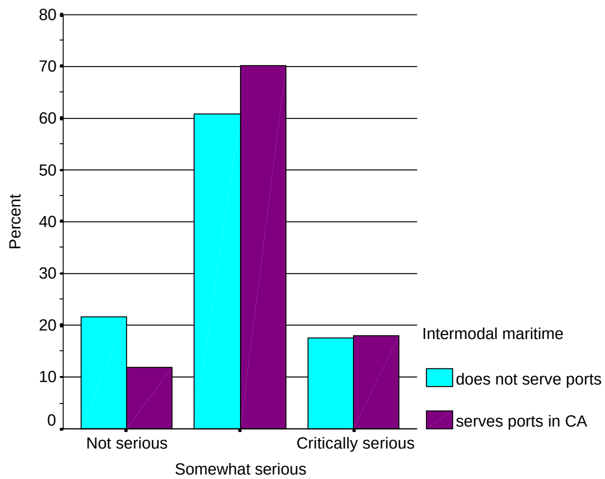

Figure 11 Perceived seriousness of the congestion problem

Table 2. Ordered-response probit model of seriousness of congestion problem

Explanatory Variable	Coefficient	z-statistic
Contract carrier (dummy)	-.066	-1.68
Carrier with typically less than 5 power units in CA (dummy)	-.104	-3.55
Average loaded movement is less than 25 miles (dummy)	-.054	-1.84
Private carrier (dummy)	-.124	-3.09
Primary service as a general truckload carrier (dummy)	-.060	-1.97
Primary service is moving household goods (dummy)	0.059	2.00
Engages in maritime intermodal operations in CA (dummy)	0.060	1.99

5.2 Congestion Problems At Ports In General

The waiting time and variability of waiting time at ports can be significant. Delays are encountered entering the ports as well as inside the gates. Some of the waiting is due to the fact that truckers often arrive at the ports before they have opened for the day or while they are closed for a lunch hour. However, some of these delays occur during the normal operating hours of the ports. Over 40 percent of the dispatching or operations manager of the companies said that drivers typically spend over an hour waiting outside the gate of the port to get in (Figure 12). More than 75 percent said drivers typically spend more than an hour inside the port (Figure 13). More importantly, the vast majority (over 80 percent) said that the time the driver would spend at the port was not predictable to within 30 minutes (Figure 14).

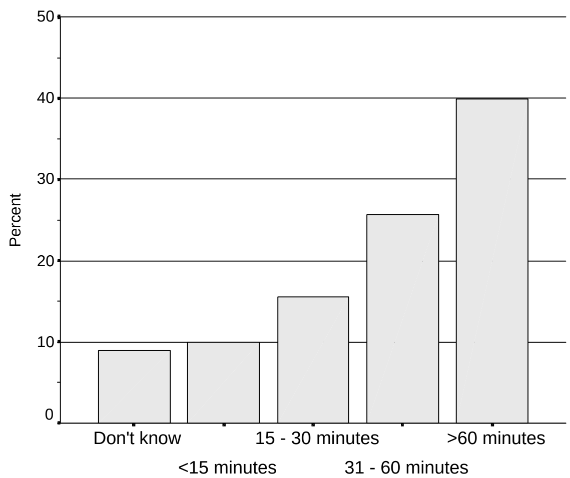

Figure 12 Distribution of typical time spent waiting outside a port to get in

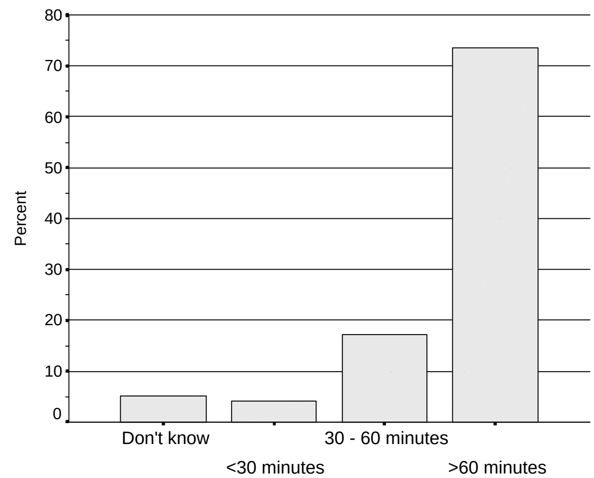

Figure 13 Distribution of typical time spent inside a port

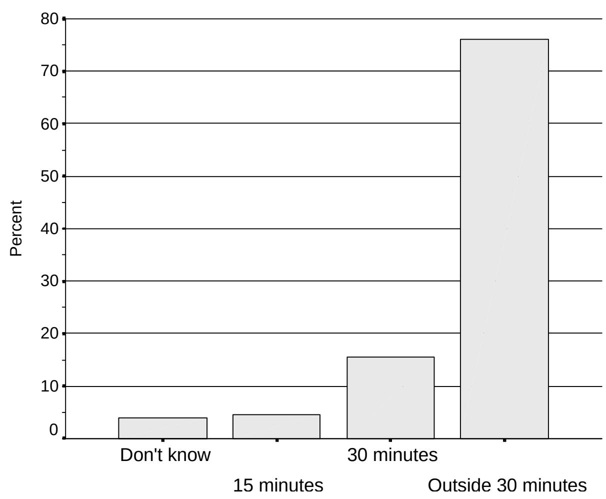

Figure 14 Predictability of time spent at a port

Of the 469 trucking companies in our sample which serve ports in California, less than 15 percent of the operators reported never encountering problems, while approximately 19 percent said that congestion or other problems at the ports impacted upon their operations always or very often. An additional 25 percent said that congestion at the ports often impacted upon their operations (Figure 15). Thus, almost 44 percent of operators serving ports reported that their operations were often affected by congestion at the ports. An examination of the connections between operational characteristics and the impact of congestion at ports identified only average length of haul as statistically significant as an indicator of the frequency with which operations are affected (X^2 = 34.4 with 12 degrees of freedom; p = .001). Figure 16 shows the differences in responses as a function of fleet size. Over 40% of carriers with average loaded movements of less than 50 miles reported that congestion problems at ports always or often impacted upon operations; less than 20% of operators with loaded movements of over 100 miles experienced similar problems.

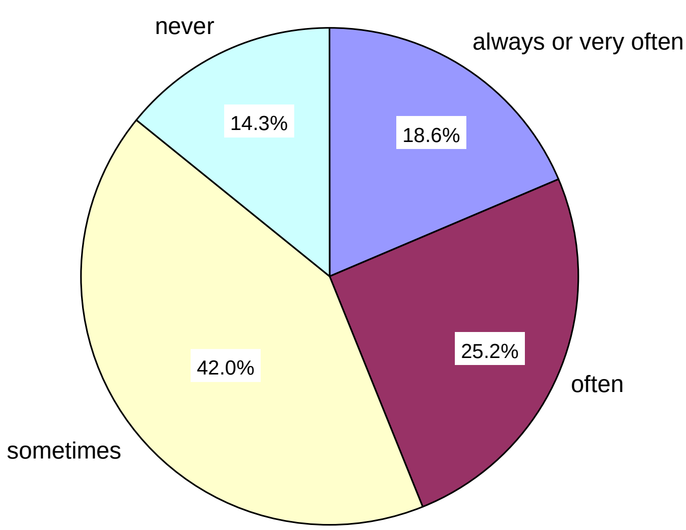

Figure 15 Frequency with which congestion or other problems at maritime port facilities impacts operations

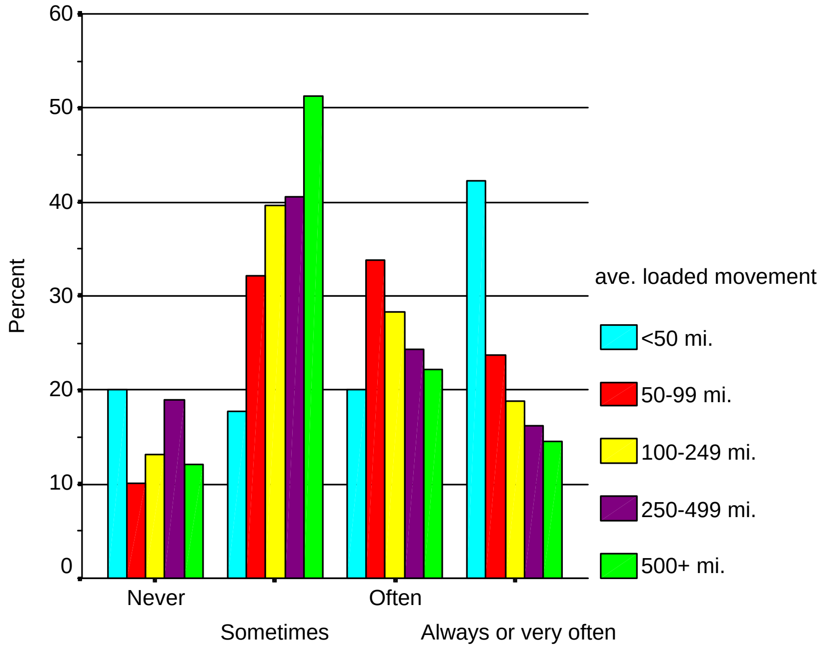

Figure 16 Frequency with which congestion or other problems at ports impact upon operations, by average length of loaded movement

5.3 Congestion Problems at Specific Ports

Some ports appear to be more problematic than others. When carriers who serve more than one port were asked to identify the most problematic ports, Los Angeles, Long Beach and Oakland were selected most often (Figure 17). These are the ports that are used most by the operators in our sample and are the busiest in California (U.S. Army Corps of Engineers, 1997). The Port of Los Angeles ranks second to Long Beach in terms of freight moved by weight and in terms of usage by carriers in our survey, but it ranks first in terms of perceived problems. However, these rankings of ports in terms of perceived congestion problems might simply reflect frequency of service, in that the port that a company serves the most presents the worst problems to that company. Data on comparative levels of service to ports were not collected in the survey, but it is possible to compare perceptions of ports by managers of trucking companies that serve multiple ports.

The three major ports in California, Long Beach, Los Angeles and Oakland, can be compared directly by identifying which if any of these ports is singled out as the most problematic by operators who serve all three. Figure 18 shows that Los Angeles was rated worst twice as often as Oakland and nearly twice as often as Long Beach by carriers who serve all three ports.

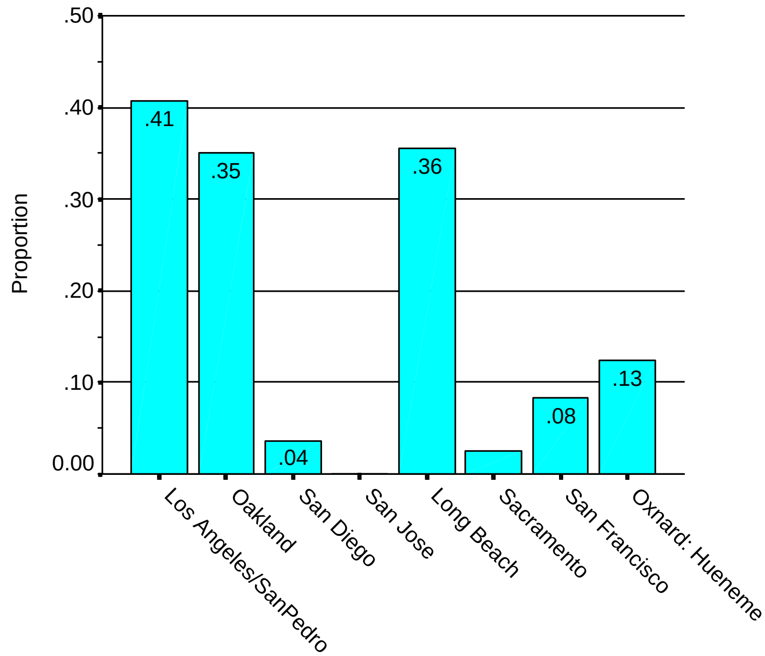

Figure 17 Proportion of times each port is identified as presenting the most problems, by operators who use that port and at least one other port

The specific problems identified at each port were fairly similar. In fact, the top two problems at each port were the same: congestion and labor problems. The hours of availability were also identified as a problem at all three ports. Table 3 displays the descriptive responses offered by the industry spokespersons in their own words (with limited truncation and or abbreviation).

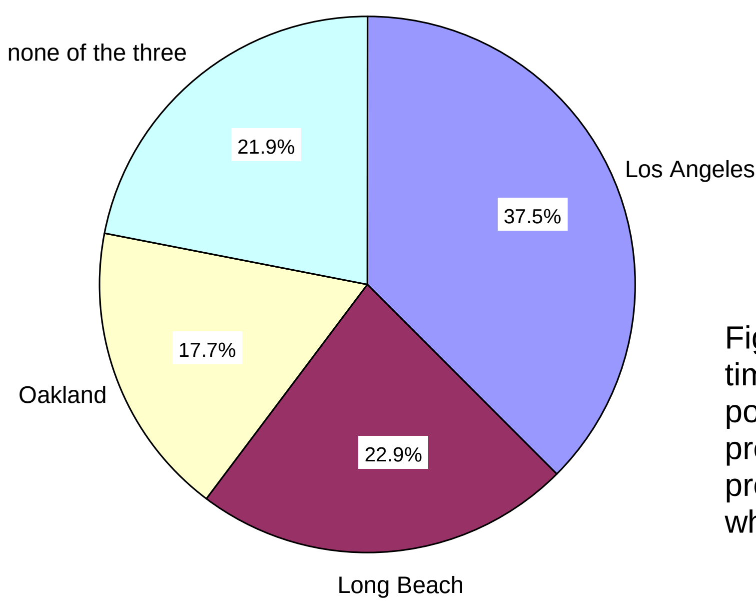

Figure 18 Percentage of times each of three major ports is identified as presenting the most problems, by 96 operators who use all three ports

Table 3 Answers to what kind of problems are faced at the port which presents the worst problems

Port of Los Angeles	Number of responses
Congestion/waiting/delays	103
Longshoremen union: not enough/ don't care	10
Disorganization/ confusion	5
Hours of operation	4
Not wide enough for trucks/ clearance	3
Product not being available	3
Construction	2
"Red tape" on harbor dispatchers	1
Drivers who don't speak English	1
Connections too far away from port	1
Containers being littered	1
Port of Long Beach	**Number of responses**
Congestion/ waiting/backups/delays	84
Union worker problems/service problems	8
Hours too rigid	7
Paperwork/proper booking numbers	7
Availability of containers	4
Slow operation/ late pickup	2
Lack of public scales	1
Accessibility	1
Accidents "jam up" road	1
Rail traffic	1
No adequate parking/ overnight parking	1
Construction	1
Port of Oakland	**Number of responses**
Congestion/delays/crowding	64
People at ports don't care/rude/labor relations	10
Limited work hours	7
Trouble unloading	4
Shipping problems: often late	3
No consistency/ unreliable times	2
Safety	1
Wanting flat fee for unloading	1
Streets not well marked/ little parking	1
Equipment not available/ doesn't match	1
Train congestion	1

6 Trucking Industry Reactions To Congestion Mitigation Policies

As part of the survey, industry spokespersons were asked to react to twelve hypothetical congestion-relief policies, gleaned from discussions with transportation planners and researchers and from public policy documents (e.g., Caltrans, 1998). The reactions were collected on a five-point ordinal scale, so the Mann-Whitney U test was used to assess the significance of differences in central tendencies of ordinal distributions; this test is the ordinal equivalent of a *t*-test for interval-scaled (numerical) variables. The responses of operators serving ports were more positive than operators not serving ports with respect to four of the twelve policies (Table 4). These four policies are: completing installation of electronic clearance stations (like PrePass™); having longer hours at ports and distribution centers; having truck-only streets for access to ports, rail terminals, and airports; and, installing electronic clearance stations at international border crossings. These opinions from users of the transportation network links associated with maritime ports should be taken into account in the policy analysis process.

7 Use of Information Technologies

Improvements in operations at ports are likely to come from increased use of information technologies. Ports are installing or have installed container-status inquiry systems that allow carriers to call ahead for information on the readiness of their loads. However, port operators report that motor carriers are using these systems much less than was expected (Holguin-Veras and Walton, 1996) and carriers report that the systems are not as reliable as they would like (Holguin-Veras, 1999). However our survey does show that companies serving ports are using key technologies with higher frequency than those who do not serve ports (Table 5). The fact that only 44% percent of these companies are using EDI and that only 20% are using automatic vehicle identification systems is surprising. Nonetheless, these numbers are increasing (Crum *et al,* 1998).

Table 4 Evaluations of effectiveness of congestion mitigation ideas on five-point scale from 1 = "not at all effective" to 5 = "very effective"

	Operators **not** serving ports		Operators serving ports		Mann-Whitney U Test	
	Median rating	% rating 5	Median rating	% rating 5	Z-stat.	Prob.
Adding more freeway lanes wherever possible	5	67	5	62	-1.169	.243
Complete installation of electronic clearance stations (like PrePass©)	4	36	4	43	-2.981	.003
Dedicating a single freeway lane to truck traffic wherever possible	5	48	4	51	-.867	.366
Having longer hours at ports and distribution centers	5	40	4	51	-4.679	.000
Imposing a toll on all vehicles travelling during rush hours	1	7	1	6	-.031	.975
Better coordinating of traffic Signals	4	40	4	34	-2.021	.043
Having truck-only lanes on some surface streets	4	34	4	37	-1.676	.094
Having truck-only streets for access to ports, rail terminals, and airports	4	40	4	48	-4.178	.000
Having a real-time database of HAZMAT load information for use by emergency crews in clearing accidents	4	36	4	37	-.769	.442
Installing electronic clearance stations at international border crossings	3	18	3	28	-4.228	.000
Having devices available to allow trucks to pre-empt some traffic signals	3	18	3	25	-1.419	.156
Eliminating some on-street parking during certain periods	4	33	4	34	-.834	.404

Table 5. Use of key information technologies (percent of companies)

Technology	Operators **not** serving ports	Operators serving ports	All operators
Electronic data interchange (EDI)	25%	44%	32%
Automatic vehicle location (AVL)	21%	33%	25%
Automatic vehicle identification (PrePass^{TM})	14%	20%	16%

8 Conclusions

Congestion experienced by truck drivers at California ports is considerable. The continued growth of traffic through her busiest ports, Los Angeles, Long Beach and Oakland is threatened by the current situation. The Alameda Corridor project will no doubt have a significant and immediate affect on freight flows in and around the Los Angeles/Long Beach port complex. However, whether additional congestion mitigation measures will be needed in that region is unclear at this time. Growth spurred by the more efficient and mostly grade (and mode) separated complex may in fact lead to new problems.

Information technologies hold particular promise for reducing delays inside and outside ports. Increased use and reliability of container status inquiry systems which supply carriers with information about what has been unloaded and where on the port property containers are stored could go a long way in preventing the problem of drivers arriving at the port before their loads are ready to be moved. Additionally, information about when carriers have scheduled their pickups at the port could help port operators make more appropriate decisions about short, medium and long term staging areas for unloaded containers.

It seems likely that further improvements in maritime intermodal operations will be the result of creative public/private sector collaboration. Goods movement, once primarily a private sector concern is of increasing interest to local, regional and state governing agencies determined to support "sustainable" growth.

9 Acknowledgements

The research described in this paper was supported by a grant from the University of California Transportation Center (UCTC). Thanks are due too, to Mr. Sreeram Jagannathan for his assistance in the preparation of the survey data and its analysis and to the referees who provided many helpful comments. Any errors or omissions remain the sole responsibility of the authors.

10 References

American Trucking Association Foundation (1996). *Assessment of Intelligent Transportation Systems/Commercial Vehicle User Services; ITS/CVO Qualitative Benefit and Cost Analysis*. (Alexandria VA, American Trucking Association).

Bureau of Transportation Statistics (1998). The Pocket Guide to Transportation, BTS-98-S-02, http://www.bts.gov/pg.pdf.

Caltrans (1998). Statewide Goods Movement Strategy, California Transportation Plan, Discussion Draft, March 1998. (http:/www.dot.ca.gov/hq/paffairs/ctp/paper3.html).

Crum, M. R., D.A. Johnson and B.F. Allen (1998). A longitudinal assessment of EDI use in the U.S. Motor Carrier Industry. Transportation Journal, 38. 1., 15-28.

Golob, T.F. and A.C. Regan (1998a). Freight Industry Attitudes Towards Policies to Reduce Congestion. Report UCI-ITS-WP-98-09, Institute of Transportation Studies, University of California, Irvine.

Golob, T.F. and A.C. Regan (1998b). Trucking Industry Demand For Information Technology: A Multivariate discrete choice model. Report UCI-ITS-WP-98-10, Institute of Transportation Studies, University of California, Irvine.

Hall, R.W. and C. Intihar (1997). Commercial vehicle operations: government interfaces and intelligent transportation systems. California PATH Research Report UCB-ITS-PRR-97-12, Institute of Transportation Studies, University of California, Berkeley.

Hensher, D.A., G. Chow and J. King (1996). Assessment of freight-related industry needs, perceptions and expectations in NSW, Parts I and II, Report prepared for the Roads and Traffic Authority of NSW, Institute of Transport Studies, University of Sydney.

Hensher, D.A. and T.F. Golob (1998). Searching for policy priories in the formulation of a freight transport strategy: An analysis of freight industry attitudes toward policy initiatives. *Transportation Research, E - Logistics and Transportation*, in press.

Holguin-Veras, J. (1999), On the attitudinal characteristics of motor carriers toward container availability systems, *International Journal of Technology Management* (In-Press).

Holguin-Veras, J, and C.M. Walton (1996). State of the practice of information technology at marine container ports, *Transportation Research Record*, No 1522, pp. 87-93.

Kavalaris, J.G. and K.C. Sinha (1995). Intelligent vehicle highway system commercial vehicle operations: Perceptions, needs and concerns of Indiana-based motor carriers. *Transportation Research Record*, No. 1511.

Ng, L., R.L. Wessels, D. Do, F. Mannering and W. Barfield (1995). Statistical analysis of commercial driver and dispatcher requirements for advanced traveler information systems. *Transportation Research*, 3C: 353-369.

Regan, A.C. and T.F Golob (1999). Freight operators' perceptions of congestion problems and the application of advanced technologies: Results from a 1998 survey of 1200 companies operating in California. *Transportation Journal,* 38, 3, pp. 57-67.

Regan, A.C., H.S. Mahmassani and P. Jaillet (1995). Improving efficiency of commercial vehicle operations using real-time information: potential uses and assignment strategies. *Transportation Research Record 1493*: 188-198.

Scapinakis, D.A., and W.L. Garrison (1991). Communications and Positioning Systems in the Motor Carrier Industry, PATH Research Report, UCB-ITS-PRR-91-10. (Institute of Transportation Studies, University of California, Berkeley).

United States Army Corps of Engineers (1997), U.S. Waterway Data, http://www.wrsc.usace.army.mil/ndc/datappor.htm.