IDENTIFICATION OF PREFERRED PERFORMANCE MEASURES FOR THE ASSESSMENT OF TRUCK LEVEL OF SERVICE

By

BYUNGKON KO

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2007

To the graduate students of the University of Florida

ACKNOWLEDGMENTS

It may not have been possible for me to complete my Ph.D. study without the advice or assistance of those who have supported me throughout my life in Gainesville. They are my family members, friends, and University of Florida faculties and administrative staffs. Although I cannot adequately describe how blessed I am to have been with them, I would like to show my gratitude to them with this opportunity.

I am especially grateful to my parents, wife, and four siblings. Their consistent care and support have been a true driving factor for me to succeed in preparing for my future as well as earning the degree.

I would like to express my appreciation to Dr. Scott S. Washburn who has served as my academic advisor for my Ph.D. study. He supported me financially and his exceptional knowledge and wisdom has provoked academic curiosity that encouraged me to enhance my research ability onto a higher level.

I also would like to thank my Ph.D. supervisory committee members for their time and effort to provide me with invaluable advice for my research. Dr. Lily Elefteriadou has guided me into the right direction academically and also provided many graduate students with convenient study environment as the director of Transportation Research Center. Dr. Yafeng Yin lent me his acute insight on mathematical expressions and recommended better ways to organize the dissertation. Dr. Siva Srinivasan helped me to improve statistical data analysis and modeling part of my work. Dr. Joseph Geunes in the Industrial Engineering department served as an external committee member. His consistent concerns and advice about my work has become a motivation to improve overall performance of my study.

My friends in Korea or Gainesville have always cheered me up for my successful career at the University of Florida. I will never forget the time and memory I have shared with them.

I certainly appreciate the assistance of University of Florida faculties and staffs. They have always tried to answer my academic or administrative questions in spite of their tight time schedules.

TABLE OF CONTENTS

page

APPENDIX

LIST OF TABLES

LIST OF FIGURES

LIST OF TERMS

AASHO	American Association of State Highway Officials (now AASHTO)
AASHTO	American Association of State Highway and Transportation Officials
ANOVA	Analysis of Variance
ATA	American Trucking Association
BTS	Bureau of Transportation Statistics
CATI	Computer-Aided Telephone Interview
CBD	Central Business District
CBR	Citizen Band Radio
CDL	Commercial Driver's License
CEDR	Center for Economic Development and Research
CMS	Changeable Message Sign
CMV	Commercial Motor Vehicle
EFA	Exploratory Factor Analysis
ES202	Quarterly Census of Employment and Wages
FDHSMV	Florida Department of Highway Safety & Motor Vehicles
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FIHS	Florida Intrastate Highway System
511	America's traveler information phone number
FTA	Florida Trucking Association
FTDC	Florida Truck Driving Championship
GPS	Global Positioning System
HAR	Highway Advisory Radio
HCM	Highway Capacity Manual

HIS	Highway Information System
IRI	International Roughness Index
KYTC	Kentucky Transportation Cabinet
LOS	Level of Service
LSD	Fisher's Least Significance Difference multiple comparison test
LTL	Less-than-TruckLoad
NATSO	National Association of Truck Stop Operators
NHS	National Highway System
NTA	National Truckers Association
NYC	New York City
ODOT	Oregon Department of Transportation
OTA	Ontario Trucking Association
P&D	Pick-up and Delivery
PCE	Passenger Car Equivalent
PSI	Present Serviceability Index
PSR	Present Serviceability Rating
PTBF	Percent-Time-Being-Followed
PTSF	Percent-Time-Spent-Following
QOS	Quality of Service
Q-Q plot	Quantile-Quantile plot
RCI	Roadway Characteristics Inventory
RMI	Relative Maneuverability Index
RV	Recreational Vehicle
SIS	Strategic Intermodal System
SMC	Safety Management Council

S-N-K	Student-Newman-Keuls multiple comparison test
SPRPC	Southwestern Pennsylvania Regional Planning Commission
SUV	Sport-Utility Vehicle
TIS	Traveler Information System
TL	TruckLoad
3PL	Third Party Logistics
TTS	Transportation Technical Services, Inc
TU	Text Unit
TUB	Text Unit Block
UDC	Urban Distribution Centre
UHM	University of Hawaii at Manoa
VMS	Variable Message Sign
XM radio	a satellite radio service

Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

IDENTIFICATION OF PREFERRED PERFORMANCE MEASURES FOR THE ASSESSMENT OF TRUCK LEVEL OF SERVICE

By

Byungkon Ko

May 2007

Chair: Scott S. Washburn
Major: Civil Engineering

Commercial trucks, the leading transportation mode for freight movement, are vital to our economy and people's lives. The importance of this mode has become greater as the demand for just-in-time delivery, lower inventory, electronic commerce, and Less-than-TruckLoad (LTL) shipping has increased. This study was conducted under the Florida's Strategic Intermodal System (SIS) plan for the Florida Department of Transportation (FDOT) in an effort to better understand the needs of the Florida trucking community by investigating their perceptions of truck trip quality on various roadway facilities.

The current Highway Capacity Manual (HCM) provides analytical methods to evaluate performance levels of transportation facilities and estimate Level Of Service (LOS) perceived by the users. The HCM methodologies yield a single LOS value for all the users in a traffic stream. However, due to the unique size and operating characteristics of trucks, it is possible that truck mode users perceive LOS on various roadway facilities based on different criteria from those of the other mode users. This study focused on identifying the determinants of LOS perceived by truck mode users and measuring their relative importance based on which truck LOS estimation methodologies should be developed.

Three focus group sessions (two with truck drivers and the other one with truck company managers) were held to elicit the factors affecting truck LOS on various transportation facilities and the relative importance of those factors were evaluated through a follow-on survey study with a larger audience. A total of 459 truck drivers and 38 truck company managers responded to the written surveys collected at Florida Truck Driving Championship (FTDC) event or the postage-paid mail-back surveys distributed at four agricultural inspection stations. The survey responses were analyzed with various statistical methods such as descriptive statistics, Exploratory Factor Analysis (EFA), multiple comparisons of the means, non-parametric tests, and chi-squared tests of independence.

The quality of a truck trip generally was found to depend on three issues: travel safety; travel time; and physical and psychological driving comfort. Truck drivers showed more concerns about the driving comfort, while truck company managers were more concerned with travel time. The travel safety aspect of a truck trip was a major concern for both groups. ‘Speed Variance’ and ‘Pavement Quality’ were the two most important determinants of truck trip quality on freeways. Truck trip quality on arterials was a function of multiple factors including ‘Pavement Quality’, ‘Turning Maneuvers’, ‘Speed Variance’, and ‘Traffic Density’. ‘Percent-Time-Being-Followed’ (PTBF), ‘Percent-Time-Spent-Following’ (PTSF), ‘Travel Lane and Shoulder Widths and their Pavement Quality’ were identified as truck LOS determinants on two-lane highways. Among many factors contributing to the quality of a truck trip, ‘Passenger Car Drivers’ Road Etiquette and Knowledge about Truck Driving Characteristics’, ‘Traffic Congestion’, and ‘Frequency and Timing of Construction Activities’ were perceived to be in significant need of improvement regardless of the type of roadway facility. Truck travel restrictions (e.g., truck lane restrictions) on freeways, inadequate curb radii and poor traffic signal coordination on arterials, and inappropriate shoulder width and condition and poor night-time lighting condition on two-lane highways were also considered to be greatly in need of improvement.

The results of this study provide the FDOT with guidelines and recommendations to develop truck LOS estimation methodologies to effectively assess how well it is addressing the needs of freight transportation on the state roadway system and offer transportation service providers and other stakeholders valuable insights for the prioritization of transportation improvement projects for commercial truck traffic.

CHAPTER 1
INTRODUCTION

1.1 Background

Transportation services for freight are vital to our economy and people's daily lives. Various kinds of freight are relocated daily in and out of Florida through several transportation modes such as truck, train, ship, and plane. Among all the modes, trucks moved 76.3 percent of freight value, 79.4 percent of tonnage, and 66.9 percent of ton-miles of the total freight originating in Florida in 2002, according to the Commodity Flow Survey (CFS) (Bureau of Transportation Statistics, 2004). This makes the truck mode the leading mode for freight movement in the U.S. Truck traffic is also expected to grow significantly throughout the State of Florida over the next couple of decades, along with increasing population, as noted in the Freight Analysis Framework (FAF) (U.S. Department of Transportation and Federal Highway Administration, 2002). In addition, the increased demands for just-in-time delivery, low inventory, electronic commerce (e-commerce), Less-than-TruckLoad (LTL) shipping, and more distributed manufacturing, make it necessary for transportation service providers and other stakeholders to look for ways to better accommodate truck traffic on existing roadway systems.

Florida's Strategic Intermodal System (SIS) plan was established by the Florida Department of Transportation (FDOT) in 2003 to support transportation facilities that are necessary for Florida's rapidly growing and ever changing economy (FDOT, 2003). The main goal of the SIS program is to provide safe, efficient, and convenient transportation services for all types of transportation users on the most critical transportation facilities in Florida. The SIS facilities were selected based on national or industry standards for measures of transportation and economic activity. The SIS includes three different types of facilities; hubs, corridors, and intermodal connectors. Hubs are ports and terminals, corridors are highways, rail lines, or waterways that connect major markets, and connectors are highways, rail lines, or waterways that connect hubs and corridors. As one of its first research projects under the SIS program, this study has been conducted for FDOT to better understand the needs of the Florida trucking community by investigating its perceptions and opinions about transportation services for trucks on various state roadway facilities.

1.2 Problem Statement

The Highway Capacity Manual (HCM) (Transportation Research Board, 2000) provides analytical methods to estimate capacity and key performance measures for a wide variety of roadway facilities. The HCM also provides methods for translating performance measure values into a Level Of Service (LOS) value. Level Of Service (LOS) is a qualitative measure used to describe general operating conditions within a traffic stream. The HCM uses a scale of ‘A’ to ‘F’ for LOS, with ‘A’ corresponding to excellent operating conditions and ‘F’ corresponding to extremely poor operating conditions. These LOS values are typically based on performance measures such as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience, and are intended to reflect drivers’ perception of those conditions. The selected performance measures, upon which LOS is based, referred to in the HCM as service measures, can vary from one roadway facility to another. The methods of the HCM have been widely adopted by the transportation community as the primary means of measuring system performance. They are often used as valuable tools for most transportation agencies to monitor or improve the performance levels of existing transportation facilities, or plan for future transportation facilities.

The current HCM utilizes engineering-based measures such as density, delay, and average travel speed in evaluating the performance level of transportation facilities. These measures are conceptually reasonable and easy to apply, but are not necessarily consistent with the measures that the actual roadway users base their perception of the facility performance level on. Furthermore, for the roadway facilities in the HCM (such as arterial, highways, and freeways), the HCM methods result in a single LOS value for the entire traffic stream; that is, they do not distinguish between different modes within the same traffic stream. The methods are generally designed to establish LOS for the passenger vehicle mode. However, commercial trucks (hereafter referred to as just 'trucks') are unique in their size and operating characteristics among various vehicle types in traffic streams. Trucks require more space and time to maneuver due to their difference in size, weight, off-tracking, acceleration, and braking. So they are often used as design vehicles for roadway facilities, and sometimes subject to various restrictions such as lane, route, speed, or time-of-day. In addition, most truck drivers operate their trucks primarily for business purposes and spend a significant amount of time driving, while the trip purposes of other vehicle users vary and they usually drive less frequently.

Due to these special characteristics of truck operations on transportation facilities, it is possible that truck mode users perceive LOS on various roadway facilities based on different criteria from those of the other mode users. However, the current HCM (Transportation Research Board, 2000) only accounts for the mode of trucks in the traffic stream through the heavy vehicle adjustment factor (f_{HV}). This adjustment factor is based upon the percentage of heavy vehicles (e.g., trucks, buses, or recreational vehicles) in the traffic stream and their passenger car equivalents (PCEs). A PCE is the number of passenger cars expected to have same effect on a traffic stream as a single heavy vehicle under specific roadway and traffic conditions. The PCE is used to convert a traffic stream flow rate with some portion of heavy vehicles into an equivalent one with passenger cars only. So, although the current HCM procedures account for the effects of trucks in the traffic stream, the overall methodology does not provide any exclusive LOS evaluation criteria or procedures to estimate how well a transportation facility accommodates truck traffic in a traffic stream.

1.3 Study Objectives and Tasks

The primary objective of this study was to determine the roadway, traffic, and/or control factors important for Florida's trucking community and estimate the relative significance of each factor on overall quality of truck operation on the SIS facilities. Based on information obtained about the perceptions of truck mode users, this study provides the FDOT with guidelines and recommendations to develop actual LOS estimation methodologies to effectively assess how well it is addressing the needs of freight transportation on the state roadway system. These efforts provide transportation service providers, researchers, and transportation agencies with valuable insights as to what should be prioritized to improve truck operations on various transportation facilities.

To achieve this objective, it was essential to obtain input from both truck drivers and truck company managers, as these two groups represent the major stakeholders with regard to truck operations. For this study, data collection was confined to focus group and written survey methods. The major tasks performed to complete this study are described below and presented in their chronological order:

Task 1: Literature review. A literature review was performed to facilitate and enhance this study with regard to the following five areas: 1) truck LOS studies; 2) user-perception based LOS studies; 3) trucking community focus group and/or survey studies, 4) Florida trucking community focus group participant recruitment sources, and 5) trucking community survey methods.

Task 2: Preparation for focus group sessions. In advance of the focus group meetings, the methodology for conducting the focus group studies was determined. This includes clarification of the purpose and scope of the interviews, participant selection guidelines, participant recruitment plans, moderator selection, development of participant background surveys, moderator's guide regarding focus group questionnaires and instructions, focus group discussion recording, and methods of analysis.

Task 3: Focus group sessions of truck drivers and/or truck company managers. Several focus group meetings were held with selected participants to explore the perceptions and opinions of the trucking community on the factors important to truck operations on various transportation facilities.

Task 4: Summary of focus group findings. The focus group discussions were summarized to identify the factors affecting quality of a truck trip on each facility and by different user groups (truck drivers and truck company managers). The summary results were then used as inputs to a follow-on survey.

Task 5: Survey development. Survey studies were intended to reconfirm the focus group findings with a broader audience and to measure the relative importance of each factor quantitatively. Two different survey forms were prepared; one for truck drivers and the other for truck company managers. Both forms contain questions about participants' personal and working backgrounds and their perceptions about the relative importance of each factor identified in the previous focus group studies.

Task 6: Survey data collection. Truck driver surveys and truck company manager surveys were distributed at multiple locations with the assistance of the FDOT and the Florida Trucking Association (FTA).

Task 7: Analysis of survey data. Collected surveys were analyzed statistically to determine the relative importance of each factor on truck trip quality and/or overall trucking business. Relationships between the participants' backgrounds and their perceptions were also explored.

Task 8: Study results and recommendations. The factors influencing truck trip quality and their relative importance were determined based on the focus group and survey results. Potential performance measures to estimate truck LOS were recommended by each transportation facility type.

1.4 Organization of the Dissertation

The remainder of this dissertation is as follows. Chapter 2 provides a summary of relevant literature. Chapter 3 describes the study methods and detailed steps taken to complete this study. The study results are presented in Chapters 4 and 5. Chapter 4 discusses focus group study findings and Chapter 5 discusses the results of statistical analyses on the survey data. In chapter 6, conclusions are presented and recommendations are made with regard to roadway facility improvement priorities for truck LOS considerations. Potential truck LOS service measures are also presented.

CHAPTER 2
LITERATURE REVIEW

This chapter describes previous research efforts by other researchers related to this study, conceptually or methodologically. It provides descriptions of the research methodologies and results of those studies, and a summary of the findings. First, the studies regarding truck LOS development are presented. They contain some implications on potential truck LOS service measures. Other research efforts to identify and test potential LOS service measures on a specific roadway facility are described in the next section of this chapter. They provide some insights about how to elicit the perception of travelers and convert the information to develop user-perceived LOS. The final section reviews previous focus group and/or survey studies of the trucking community. Potential sources of focus group recruitment and characteristics of various survey methods were separately summarized to help develop the methodologies suitable for the purpose and scope of this study.

2.1 Truck Level of Service

A study by Washburn (2002) explored and demonstrated the development of a potential method to assess level of service specific to the truck mode. The current LOS performance measure for a freeway segment (density) applies to the traffic stream as a whole, regardless of vehicle types, although they typically have very different physical and operating characteristics from passenger cars in the traffic stream. To assess the level of service of heavy trucks on a freeway segment, a 'relative density' concept was proposed. Relative density for trucks could be obtained by dividing density for the traffic stream by a Relative Maneuverability Index (RMI), which is a function of the ratio of percentage of free-flow speed of trucks to percentage of free-flow speed of passenger cars. Under low density, ideal conditions, percentage of free-flow speed for both trucks and cars should be at or near 100%, yielding the same LOS for both modes (e.g., ‘A’). Likewise, under high density, the percentage of free-flow speed for both trucks and cars would both be very low, producing the same LOS for both modes (e.g., ‘F’). At densities in between, the percentage of free-flow speed for trucks will probably be less that that for cars, resulting in higher relative density values for trucks, which can be referenced to the current HCM density thresholds for determining LOS. Other possible measures for determining LOS for trucks have also been introduced in the document; acceleration noise, passing opportunities, percent-time spent-following, and heavy vehicle factor.

A study by Hostovsky and Hall (2004) focused on the perceptions of tractor-trailer drivers on the factors affecting quality of service on freeways. A focus group meeting was conducted for this study with 7 Road Knight Team members at the annual convention of the Ontario Trucking Association (OTA) in November, 2001. The participants were asked what makes for a good or bad trip for themselves to drive trucks on a freeway. The discussion was then transcribed to be analyzed through NUD.IST (Non-numerical Unstructured Data Indexing Searching and Theorizing), an industry standard qualitative data analysis software program using five criteria (intensity, relevance, frequency, universality, and emphasis). The OTA, Canadian Trucking Association (CTA), and American Trucking Association (ATA) showed an agreement with the study’s conclusions. The study results were organized in this paper by the number of Text Unit Blocks (TUB), which represent the number of times a certain theme was discussed by the participants. With respect to freeway conditions (TUB = 34), the factors identified were road surface (pavement condition, snow removal, road debris), lane restrictions, signage, and lane width and markings.

As far as traffic conditions (TUB = 22) are concerned, congestion, steady flow, and maneuverability were discussed. Attitudes toward other vehicles (TUB = 27) were another big issue mentioned in the meeting. Courteous interplay by automobile drivers was found to be important for them to have a good trip. In terms of safety (TUB = 3), road etiquette, weather, and rubbernecking were considered to influence their trip quality. The participants also mentioned the hazard of aggressive driving and road rage (TUB = 23) and regionally different perceptions of trip quality (TUB = 23) with respect to such various factors as level of congestion, courteous interplay by other drivers, driving skills of other drivers around them in snow condition, and low speed limits. With all the findings mentioned above, the authors indicated that what really matters to truck drivers in terms of traffic condition is traffic flow, not traffic density, which is a service measure used in the current HCM. In this respect, steadiness of traffic flow and an ability to drive at a comfortable operating range of highway speeds without much braking or accelerating were considered to be important for truck drivers' perception of the quality of service.

A study by Hall, et al. (2004) developed a method to evaluate the access routes for large trucks between intermodal or other truck-traffic-generating sites and the National Highway System (NHS) and used it to prioritize and program the truck access routes for improvement. The study began with identifying clusters of truck-traffic generating facilities based on total trucks per day, distance to NHS, and recommendations on the sites with truck access problems by transportation planners from highway district and area development district offices. Then telephone surveys were conducted with the operators/managers of the selected sites to identify problem routes to be evaluated in this study. Each route was evaluated with respect to three types of features: subjective, point, and continuous. Using the Kentucky Transportation Cabinet (KYTC) statewide Highway Information System (HIS) database and some field observations, the following characteristics of each route were collected: 1) point features: curve off-tracking, maximum safe speed on horizontal curves, stopping sight distance, turning radii; 2) continuous features: grade, lane width, shoulder, route LOS. The point and continuous elements on each route were ranked as "preferred", "adequate", and "less than adequate" based on the recommendations in AASHTO (American Association of State Highway and Transportation Officials)'s "A Policy of Geometric Design of Highways and Streets" and "Roadway Design Guide." The features subjectively evaluated by the researchers include clear zone, pavement condition, accident history, parking, pedestrian traffic, land use conflicts, dust/noise issues, and so on. The rankings of point and continuous elements were converted to a relative urgency rating by assigning a relative weight with respect to truck volume and section length. Problem truck-points and problem truck-miles were calculated based on these rankings to prioritize the problem routes. They were adjusted by predominant subjective features, where appropriate. Finally, with all the evaluation data of each problem route, the researchers inspected the routes and graded them on a subjective scale of 1 to 10 (10 represents good access for trucks).

All the three studies presented in this section focused on developing methods to evaluate operating conditions on a specific roadway type for truck traffic. Washburn (2002) devised the RMI concept to evaluate truck LOS on freeways, based on a hypothetical reasoning that maneuverability of trucks is inferior to that of passenger cars because of unique physical and operating characteristics of trucks. A study by Hostovsky and Hall (2004) found that traffic flow is more important than traffic density to truck drivers' perception of trip quality on freeways. The two above mentioned studies imply that traffic density, the current HCM service measure for freeway facility, may not reflect the perception of truck drivers adequately. Steady traffic flow and maneuverability may be more important to truck drivers than traffic density, considering the large size, heavy weight, low acceleration and deceleration capability of trucks.

Hall, et al. (2004) developed a methodology for evaluating large truck access routes between NHS and truck-traffic generating facilities to prioritize and program the routes for improvement. Overall quality of each route for truck access was determined by many various factors. They included geometric adequacy measures, pavement condition, clear zone, accident history, traffic LOS, and other subjective measures such as parking, pedestrian traffic, land use conflicts, dust/noise issues, etc. As this study investigated so many different characteristics of each route, it may not be appropriate to identify one or two performance measures to effectively estimate quality of an access route for trucks.

2.2 User-Perceived Level of Service

A study by Hall, et al. (2001) conducted two focus groups (one with five members, and the other with seven members) to explore what freeway users perceive as important to level of service on freeways. Focus group participants were chosen by a snowball sample selection process to identify commuters going from the city of Toronto, Ontario, Canada to McMaster University (the research center) in Hamilton, Ontario Canada. The participants were all university faculty members in various departments, and were selected to ensure that all the participants traveled the same stretch of freeway so that all knew about the situations that were being discussed and all had had relatively similar experiences. Both groups were moderated by the same member of the research team to ensure consistency in technique across groups. The following general questions were asked in the discussions;

- Tell me about the usual freeway route you take when you are commuting.
- Have your perceptions of the drive changed over time?
- I want you to talk about both the ideal or best trip you've ever made and also the worst trip ever.

The factors important to perceptions of trip quality were listed with respect to the number of Text Units (TUs) in which each theme was mentioned in the two discussions, as follows;

- Travel time (TUs = 103 (6%))
- Density/maneuverability (TUs = 86 (5%))
- Road safety (TUs = 81 (5%))
- Commuter information and communication (TUs = 65 (4%))
- Civility (TUs = 38 (2%))
- Photo radar (TUs = 31 (2%))
- Weather (TUs = 23 (1%))

The participants indicated travel time as the first thing to describe the quality of particular trips. Having time constraints on their arrival from a trip was thought to greatly increase the stress involved in the trip. Time spent commuting was also considered to be lost time. Maneuverability also came up in the discussions in light of travel time, accident avoidance, adequate gaps between cars, weaving in and out of traffic, and changing lanes. Another important issue for participants was safety. They were concerned about accidents not only in terms of congestion but also because of the risk to their personal safety. Materials from trucks and other debris on the road were concerns for many participants, and the effects of sport-utility vehicles (SUVs) and minivans on other drivers' visibility were also mentioned in the safety perspectives. Having adequate information about what was happening to traffic while they were on the road was also important to the participants. This issue was discussed along with the possibility for them to avoid traffic congestion by finding alternative routes. Some other factors were mentioned occasionally in the focus groups as well; driver civility, the use of photo radar, and weather and its effect on driving conditions. Passengers' perceptions also were different from drivers' with respect to travel time, mainly due to their ability to undertake activities other than driving. The participants indicated that travelers on the bus would have different perspectives; they usually do not notice the traffic conditions when they are in the bus. The authors also indicated that the participants do not think of freeways in terms of distinct segments classified by the HCM (basic segments, ramp-freeway junctions, and weaving segments), proposing further studies about LOS breakpoints.

The factors that affect traveler-perceived quality of service on rural freeways were explored using in-field surveys of motorists traveling on rural freeways (Washburn, et al., 2004). A total of 233 responses from a good mix of respondents were collected at several different locations along I-75 and the Turnpike in Florida. The researchers decided to perform an 'in-field' survey data collection effort, as opposed to a mail-back survey or something similar, as this provided the advantage of obtaining input while the specific characteristics of the traveler's trip were still fresh in their mind. The surveys at the rest stops, which offered respondents a $2 food discount voucher, also showed a good overall productivity (about six respondents per hour).

The importance of 16 traffic and roadway factors was ranked by respondents on a seven-point ordinal scale (1 being not at all important, and 7 being extremely important). The six top ranked factors based on mean scores and/or percent time in top three are as follows:

- Ability to consistently maintain your desired travel speed (mean = 6.09, % time in top three = 64.3%)
- Ability to change lanes and pass other vehicles easily (mean = 5.79, % time in top three = 33.3%)
- Smooth and quiet road surface condition (mean = 5.68, % time in top three = 20.3%)
- Ability to travel at a speed no less than the posted speed limit (mean = 5.58, % time in top three = 33.0%)
- Other drivers' etiquette/courtesy (mean = 5.38, % time in top three = 22.1%)
- Infrequent construction zones (mean = 5.37, % time in top three = 23.4%)

A probit modeling technique was used to discover any possible relationships between personal characteristics and current trip information of the respondents, and their opinions about the top four ranked factors (from 1 to 4 above). For the first factor, the more highly educated an individual, the more likely they were to rank this factor highly. The respondents that were driving a tractor-trailer, or with higher estimated average speeds, were also more likely to rank this factor highly. For the second factor, the respondents that had higher education or with higher estimated average speeds, were more likely to rank this factor highly. Travelers that indicated they were experiencing mostly very dense or dense traffic flow conditions on their trip were less likely to rank this factor highly. For the third factor, travelers with higher income were more likely to rank this factor highly. Travelers who indicated their trip purpose was ‘other’, that is, neither business nor leisure, were less likely to rank this factor highly. Travelers that were on a business trip and very familiar with the route they were traveling were also less likely to rank this factor highly. For the fourth factor, older people were more likely to rank this factor highly. On the other hand, the respondents that were strictly drivers on the trip or driving a large auto (pickup truck, SUV, minivan, or full-size van) were less likely to rank this factor highly.

The authors indicated that in addition to density, there are some factors that are just as important to travelers, such as speed variance and percent of free-flow speed. Some non-traffic performance measures were also found to be important through the study, such as pavement quality, and driver etiquette.

A web-based survey was conducted at the University of Hawaii at Manoa (UHM) in 2005 to see how road users evaluate signalized intersection LOS (Zhang and Prevedouros, 2005). E-mail messages with group-specific survey hyperlinks were sent to selected samples asking them to fill out the motorist survey on-line. Six groups comprise the sample; random UHM students, faculty, and staff, Hawaii engineering and transportation professionals, drivers from other groups in Hawaii, and drivers from the mainland U.S. The response rate was 12.2%, 16.0%, 18.9% for

UHM students, faculty, and staff respectively, yielding 2,017 usable surveys. The survey questions focused on factors important to drivers at signalized intersections, driver opinions on protected left-turn signals for various sizes of intersections, and trade-offs between perceived safety risk and delay. Analysis of variance (ANOVA) was applied to dependent variables with ratio- or interval-level data to assess if there were significant differences among the independent groups. The influence of several independent variables such as gender, age, and driving experience on the dependent variables were investigated simultaneously through ANOVA (Analysis of Variance).

The ten factors important to drivers at signalized intersections were evaluated with a five-point ordinal scale (1 being not important, and 5 being extremely important). The factors are listed as follows in order of decreasing importance.

1. Traffic signal responsiveness
2 Ability to go through the intersection within one cycle of light changes
3 Availability of left turn only lanes and protected left turn signal for vehicles turning left
4 Pavement markings for separating and guiding traffic
5 Availability of a protected left turn signal for vehicles turning left
6 Availability of left turn only lanes for vehicles turning left
7 Pavement quality
8 Waiting time
9 Heavy vehicles such as trucks and buses that are waiting ahead
10 Availability of right-turn only lanes for vehicles turning right

The respondents were also asked to rate the difficulty in making a left turn without a protected left turn signal and their preference for a protected left turn signal, on a scale form 1 (not difficult or not preferred) to 5 (extremely difficult or extremely preferred). The difficulty increases with intersection size, and female drivers perceived more difficulty than male drivers. The preference also increases with intersection size, and female drivers prefer protected left turn signals more than male drivers. As high as 91% of the respondents stated that they much or extremely prefer a protected left turn signal at an intersection where left turn vehicles have to cross three lanes of opposing through traffic.

Safety was stated to be three to six times more important than delay, depending on the type of conflict; drivers turning left are more concerned than drivers going through, and pedestrians are more concerned than drivers turning left. Female drivers, non-risk-prone drivers, and pedestrians valued safety more than delay to a significantly greater degree. Drivers and pedestrians would be willing to wait a longer time at signalized intersections in exchange for protected left turn signals. The average additional delay to exchange for protected left turn signal is 20.6 sec, 25.4 sec, and 27.2 sec for drivers going through, drivers turning left, and pedestrians respectively.

Overall findings suggest that the current measure, delay, should be supplemented by a number of quantifiable attributes of signalized intersections for determining a LOS that represents road user perceptions.

Some potential performance measures for LOS on rural freeways were evaluated with microscopic traffic simulation (Kim, et al., 2003). Although density-based LOS is thought to be well suited to the assessment of urban freeways, some have questioned whether density is also a proper indicator of the quality of service on rural freeways because drivers may think more in terms of psychological or emotional comfort for rural freeways, which generally serve long, high-speed trips and rarely experience more than moderate congestion levels. Acceleration noise, number and duration of cruise control applications, and percent time spent following (PTSF) were examined as some possible means of determining Level of Service (LOS) of rural freeway sections as they have at least an intuitive relationship to the concept of driver comfort. The three measures were estimated for a hypothetical section of rural freeway. Acceleration noise is a measure of the physical turbulence in the traffic stream. The instantaneous acceleration of each vehicle at each second is computed from the speed differential with respect to the previous second, and the standard deviation of acceleration for each vehicle is computed over the 6,000 feet segment. A post-processing routine was written to analyze the simulation results and infer the application and release of cruise control. Cruise control was applied to a vehicle when it had been traveling at its desired speed for three or more seconds. Cruise control was released when the vehicle began to decelerate for any reason. For PTSF, a vehicle is considered to be following its leader if the relationship between its position and speed with respect to the leader places it within the car-following influence zone. A nonlinear relationship between acceleration noise and traffic volume shows that acceleration noise increases more rapidly in the lower volume range and levels off as volume increases. It is also observed that the nonlinear effect is most pronounced on single-lane freeways and diminishes as the number of lanes increases. The nonlinearity for proportion of time with cruise control applied was only discernible to any degree in the case of the single-lane freeway. The nonlinearity for number of cruise control applications was too pronounced to be useful. The nonlinearity for PTSF was more pronounced than that for acceleration noise, and there was no discernible difference between two and three lane freeways. Based on the investigation of the nonlinear relationship shapes between level of volumes and three candidate measures by number of lanes, the authors concluded that a nonlinear relationship between acceleration noise and traffic volume on rural freeways could be used directly as the basis for a new set of LOS criteria for rural freeways, given further studies focusing on driver opinions, behavior, and field measurement to support this finding. The other two measures also have conceptual appeal, but used individually would not be suitable as the basis for determining LOS on a rural freeway.

The above described studies concerning the exploration of user-perceived level of service performance measures identified some interesting findings. The study by Hall, et al. (2001) found from two focus group meetings that total travel time is the most important LOS determinant for travelers on a freeway. It was noted that passengers did not consider the travel time as important as drivers did because they can do something else other than driving. It would be worth investigating how freeway drivers' perceptions on importance of total travel time can be influenced by their trip purposes. The study by Washburn, et al. (2004) found from surveys of rural freeway travelers that "consistently maintaining desired travel speed" is more important than "ability to change lanes and pass other vehicles easily" or "traveling at or not less than the posted speed limit." This implied that the cruise control factor is more important than the density factor or percent of free-flow speed factor. Other important factors included pavement condition, other drivers' etiquette/courtesy, and infrequent construction zones. A web-based survey study by Zhang and Prevedouros (2005) found that the current service measure of delay for signalized intersections is less important than a number of other factors such as "traffic signal responsiveness", "ability to go through the intersection within one cycle of light changes", etc. It may be possible that drivers are more sensitive to stop and go conditions than actual delay experienced at signalized intersections. Kim, et al. (2003) identified acceleration noise as a potential service measure for rural freeways due to its desirable properties of relating to drivers' sense of safety and comfort and its non-linear relationship with traffic volume. Many previous studies of this type verified that some current service measures do not reflect the perception of the users adequately.

2.3 Trucking Community Focus Groups and Surveys

With increasing importance on urban freight mobility, Morris, et al. (1998) conducted a study on cost, time, and barriers related to moving freight into New York City's Central Business

District (CBD). The study consisted of 13 focus groups with different industry-sector senior logistics executives and freight mobility interviews with logistics, transportation, or distribution managers. The research team cooperated with the Center for Logistics and Transportation Executive Committee in the development of a focus group moderator's guide, recruitment of focus group participants, pretest of the guide, and the guidance of the freight mobility interview. Each focus group was scheduled at participants' convenience, allowing the use of speakerphones, and included 2–4 participants to explore the issues in depth within a 2-hour time frame. Participants also received the focus group guide and informational material before the meetings so that they would have time to think about the issues in advance. At the meetings, a flip chart listing seminal points for focus group questions and probes, and a large CBD area map were displayed to reinforce attendees' attention to topics. Transportation barriers listed in the order of greatest frequency of mention in all the meetings were; congestion, inadequate docking space, curb space for commercial vehicles, security, and excessive ticketing of high-profile companies. A freight mobility interview followed with logistics, distribution, or transportation managers, who were recruited with the help of the previous focus group participants or from the membership lists of Council for Logistics Management and the Center for Logistics and Transportation. An on-site interview was planned initially, but the response was generally negative. So phone interviews were requested to be scheduled after sending letters containing a freight mobility interview, the study goals and purpose, and focus group findings. Follow-up calls were made 2–4 weeks after the letters were sent. But due to the lower than expected response rate, another attempt was made with follow-up calls made 1 week after sending letters, resulting in 51 completed interviews. Data on costs, time, distance, product types, and major barriers in the movement of freight into Manhattan's CBD by shippers and carriers were collected. Major barriers to freight mobility identified through the interviews were; widespread congestion, security, physical constraints, and institutional barriers.

In a study by Veras, et al. (2005), various types of efforts such as focus group studies, in-depth interviews, and internet surveys were made to obtain the perceptions on challenges and the potential of off-peak deliveries to congested areas. The targeted groups for this study included private stake holders; shippers, receivers, third party logistics (3PLs), trucking companies, and warehouses. Off-peak deliveries to the New York City (NYC) metropolitan region were proposed to avoid traffic congestion and lack of parking spots hampering daytime commercial vehicle deliveries. The strategy may reduce the price accompanied by congestion and illegal parking, pollution, and frustration to the public, but it may pose additional costs to shippers, receivers, and carriers mainly due to workers necessary for night shifting. It may also involve regulatory and legal impediment. On January 20, 2004, two focus groups with truck dispatchers were conducted in NYC as part of the Evaluation Study of the Port Authority of New York and New Jersey's Value Pricing Initiative. The focus group findings indicated that both shipper costs and receiver costs would increase due to the need of night time workers, regardless of feasible toll discounts, or compensation due to traveling hours. In-depth interviews with 17 stakeholders of various types (trucking companies, shippers, receivers, lobbyists, trucking-warehouse combination companies, and shipping-trucking-warehouse combination companies) were performed to explore the issues further. Companies with trucking operations prefer to make deliveries during off-peak hours due to congestion and parking problems, but they are often discouraged to do it because of the recruitment of night-shift workers, and security of drivers, receivers, and products. The shippers were natural on the subject of off-peak deliveries. They do not care when their products are delivered only if the products get to the destination on time.

The two receivers operating restaurants stated that off-peak deliveries would help reduce severe parking problems, but fresh food is typically not delivered during off-peak hours. Thirty-three internet surveys were gathered from private stakeholders (shippers, receivers, 3PLs, trucking companies, warehouses) in several states. Seventy-five percent of warehouses and 70% of shippers, 3PLs, and trucking companies were performing off-peak deliveries. Many others at least have considered using this alternative. None of the shippers was currently performing off-peak deliveries, but majority of them indicated that they could do them if they are provided with some incentives. Reasons given by stakeholders for performing off-peak deliveries included faster deliveries, faster turn-around times, and lower costs. Reasons given for not performing off-peak deliveries included businesses not being open at those times, customers not accepting off-peak deliveries, and employee costs. With respect to incentives to implement off-peak deliveries, most stakeholders were interested in all of the tax incentives and subsidies. A significant number of trucking companies and 3PLs indicated that they would be responsive to a request from many receivers to do off-peak deliveries. The author also brought up carrier-centered policies, receivers as key stumbling blocks, financial incentives, and targeted major traffic generators.

Two studies focused on developing an effective methodology to survey the freight community (i.e., shippers and carriers) in Oregon state by comparing various survey data collection methods (Lawson and Riis, 2001 and Lawson, et al., 2002). The researchers did an extensive literature review on the previous trucking community survey studies and experimented with several data collection methods to find out the most effective method to survey shippers and carriers. Traditional structured interviews conducted in person or by telephone have a high response rate from purposeful sampling procedure. These surveys can focus on broad issues and are useful in obtaining detailed information about the specific topic, but may not accurately reflect the large population. Computer-Aided Telephone Interviews use a script of predetermined questions with random sampling techniques. This method allows for a large sample size, and is less costly, but, reduces the opportunity to fully explore a certain aspect of any given topic. The response rate from the method is lower than traditional structured interviews, but higher than mail out surveys. Response rates for previous written surveys ranged from 8 to 24 percent, but can be improved with telephone follow up. Written surveys are the least costly, good for broad sampling, but it typically produces low response rates and does not ensure that the right person will complete the survey.

Nine types of survey methods were tested as a pilot study to search for the best one to use for surveying the freight community.

- Type 1 — mail out/mail back questionnaire with follow up reminders (ES202 database, response rate of 15%)
- Type 2 — mail out/mail back questionnaire and a map, with follow up reminders (ES202 database, response rate of 11%)
- Type 3 — postcard invitation to participate, for positive respondents, mail out/mail back questionnaire with follow up reminders (ES202 database, response rate of 6%)
- Type 4 — postcard invitation to participate, for positive respondents, mail out/mail back questionnaire and a map, with follow up reminders (ES202 database, response rate of 4%)
- Type 5 — telephone invitation to participate, for positive respondents, mail out/mail back questionnaire with follow up reminders (ES202 database, response rate of 19%)
- Type 6 — telephone survey (ES202 database, response rate of 60%)
- Type 7 — telephone survey (Oregon DOT Motor Carrier Transportation Division truck registration database, response rate of 64%)
- Type 8 — mail out/mail back questionnaire with telephone follow up reminders (Oregon DOT Motor Carrier Transportation Division truck registration database, response rate of 33%)

- Type 9 — mail out/mail back questionnaire with follow up reminders (Oregon DOT Driver and Motor Vehicle Services Division Commercial Driver's License (CDL) Database, response rate of 12%)

In every case, the respondents were given information on the availability of the survey via e-mail or the website, or both. However, little evidence was found that the option to use the web site or to communicate via e-mail was of interest to the survey participants. In addition to the infrastructure problems, various other issues such as regulations, taxation, and enforcement were covered in the survey. The survey response rates from telephone surveys were highest among all the methods. The use of postcard invitation before a mail out survey resulted in very low response rates. Telephone invitation with a mail out survey yielded a 19% response rate, while a mail out survey with follow up phone calls produced a 33% response rate. Freight firms said that a written survey is the most preferred method, but proved to yield a lower response rate than phone surveys.

Prior to carrying out the Oregon State-wide Freight Shipper and Carrier Survey, 34 previous freight surveys already implemented were reviewed by Loudon (2000). Considerations for conducting surveys of the freight movement community, and lessons learned from previous freight research in Oregon are summarized. The options to be determined according to the purpose of the surveys are:

- One company questionnaire versus separate company questionnaires for shippers and carriers.
- Survey transportation managers only versus survey managers and drivers.
- Direct driver contact versus distribution to drivers by managers.
- Focus on truck movements only versus focus on all modes of freight.
- Explore problems through open-ended questions versus structured list of possible problems.
- Ask the respondent to rank problems versus list problems only.

- Ask about problem and practices for inbound and outbound freight movements or outbound only.
- Use a written (self-completing) questionnaire versus interviewing.
- Use cold mailing of written questionnaire versus pre-arranged participation.

Lessons learned from previous freight research in Oregon are:

- Freight movement logistics are complex. So, special considerations for flexibility should be made to design each issue (shipment size, timing of shipments, etc).
- Methods of shipping freight are changing rapidly. For example, more inventories are maintained in trucks on the highway rather than in manufacturing plants, warehouses, or stores. The survey questionnaires must allow sufficient flexibility to pick up on the current changes.
- It is not easy to get participation from private businesses.
- Limit the number of issues covered in the survey so that sufficient depth of understanding on those issues can be achieved.
- Survey the right person. A transportation manager will generally know the most about decisions about how goods are shipped and received, while an accountant of the company will be able to say something about impact of congestion on costs and profitability.
- Explore the reasons why transportation bottlenecks are a problem and how they affect the business
- Nonrecurring congestion is a significant problem, and access to the major highways was as important as level of service on the major highways.

The feasibility and an estimation of the potential for using Urban Distribution Centres (UDCs) in the city of Dublin were studied using two surveys (Finnegan, et al., 2004 and Finnegan, et al., 2005). UDCs can fulfill a number of functions including warehousing, transshipment, consolidation of loads, efficient dispatch and collection of goods. Several associations or groups including Dublin City Centre Business Association have participated consultation meeting to indicate freight transportation issues in Dublin City Centre prior to the surveys. The fist survey was deployed on a weeklong survey of deliveries to Trinity College Dublin. The intercept survey method was used at the gate of the campus, resulting in an 82%

response rate (299 participated out of 365 requested). The second survey was distributed to several trade association members, capturing 906 individual deliveries with a 10% response rate. Many aspects of freight movement in the Dublin City Centre (time of delivery arrival and departure, types of goods, how packaged, quantity of packages, types of delivery vehicles, who supplied the goods, location of supplier, loading and unloading places) were yielded by the surveys to discover the use and location of a UDC. Some conclusions were made at this point; Food related deliveries are expected to be improved by the use of a UDC in Dublin, a UDC could assists in the process of backhauling, the operation of a delivery platform in the city centre was suggested. But, no definite recommendations for the use, location, and impact of UDC were presented.

The Southwestern Pennsylvania Regional Planning Commission (SPRPC) conducted a broad mail survey of freight transportation users and service providers about various issues in freight transportation (SPRPC, 1996). The surveys were drafted under the guidance of the Freight Forum and distributed to the 700 freight service providers from SPRPC's Freight Transportation Database, and 800 area manufacturers listed in the Southwestern Pennsylvania Regional Development Council's Computer Assisted Product Search database (CAPS). The postage-paid surveys were sent to them by mail. The original response rate was 4%, but the final response rate was 9% after follow up phone call efforts. With various types of freight service providers, and manufacturers answering the survey, 22% of manufacturers indicated that they utilize intermodal transportation, and 42% of service providers said that they do. Specific impediments to the respondents with locations and comments were also identified with their percent frequencies; traffic congestion (46%), rush hour deliveries (32%), roadway turning radius (25.5%), turning at traffic lights (24%), poor bridge or tunnel clearance (18%), curfews on high or wide roads (17%), merge lanes (16.5%), at-grade railroad crossings (14%), lack of receiving areas at malls (13%), lack of trailer drop-off and pick-up (12%), poor truck access to airport air cargo area (11%), lack of adequate warehousing (8%), delays or other problems at customs (5%), poor truck access to river terminals (4.5%), poor truck access to intermodal facilities (4.5%), lack of rail to highway access (3.5%), poor signage (3%), highway interference with railroad (2%). Women's compensation and other labor costs, regulations, and taxation were also introduced to be pressing issues affecting the freight transportation industry.

In 1998, Regan and Golob (1999) studied the perceptions of motor carriers about traffic congestion, congestion-relief policies, usefulness of information technologies, and efficiency of intermodal facilities in California through computer-aided telephone interviews (CATI). A total of 5258 freight operators, including California-based for-hire trucking companies, private fleets, and for-hire large national carriers were chosen from the databases maintained by Transportation Technical Services, Inc, producing an overall response rate of 22.4% (1177 responses). Most responding operators believe that traffic congestion will get worse over the next five years. Over half the respondents indicated significant or major problems of increased fuel and maintenance costs due to stop and go traffic, high numbers of accidents and insurance costs, driver frustrations and morale, and scheduling problems due to unreliable travel times. Similarly, more than half indicated that stop and go driving, speeders and other traffic violators, and poor road surface quality are important causes of loss of equipment, damaged goods, or even injury to drivers. Almost 90% of the freight operators also replied that at least sometimes schedules are missed, drivers are re-routed due to congestion, or customer time-windows force drivers to work in congestion. Preferred congestion relief policies included adding more freeway lanes, truck only lanes on freeways or arterials, better traffic signal coordination along the arterials, and so forth. The surveyed operators perceive that dedicated highway advisory radio, traffic reports on commercial radio stations, and face-to-face reports among drivers at truck stops and terminals are somewhat useful by drivers on the road, while traffic reports on television and computer traffic maps on the Internet are very useful to dispatchers. With respect to intermodal operations, about 45% of the operators pointed out that operations of carriers are often or very often impacted by congestion or other problems at maritime ports, while only 25% of them indicated this for airports or rail terminals.

The American Trucking Association (ATA) surveyed 470 stratified, randomly selected private and for-hire motor carriers based in the Baltimore region (ATA, 1997). It yielded a response rate of 13.1% (62 returned surveys) after two times mailing and follow-up calls. The ATA worked with the Baltimore Metropolitan Council and the Maryland Motor Transportation Association for the survey questions to check out various needs of transportation users in Baltimore region. The survey questions included company characteristics, major routes of travel, impediments in freight flows, infrastructure improvements needed, downtown freight pick up and delivery, time of day travel, freight origins and destinations, intermodal freight activity, company future plans. The survey results describe facts and motor carriers' perceptions about freight transportation in the Baltimore region. Especially, traffic congestion was thought to be one major structural impediment to freight movement. Intersection design/function, ramp design, tools, constructions projects were listed by some motor carriers as well.

In 2001, two surveys were conducted to obtain the opinions of the public and large truck drivers on road safety issues (Center for Public Policy, 2001). A computer-assisted telephone surveys produced 2415 samples of randomly selected adult residents from Virginia (n=602), Maryland (n=600), North Carolina (n=610), and West Virginia (n=603) with a cooperation rate of 52%. For truck drivers, an intercept survey was used at three truck stops (Lee Hi Truck Stop (n=206), Truck Stops of America (n=318), and White's Truck Stop (n=102) on interstate 81 and 95, producing 618 samples. The surveys discovered some overall aspects of truck drivers and difference in perspectives on safety issues from truckers and public respondents. The main findings from the surveys are as follows:

- More than 70% of truckers in the survey were company drivers opposed to owner-operators.
- Most truck drivers (about 70%) get paid based on miles driven.
- More than 90% of truckers in the survey are driving tractor-semi trailers.
- More than 80% of truckers spend 3–7 days away from home every week.
- Most truckers take time for a sleep break at private truck stops or public rest areas rather than motels or roadside.
- Both truckers and public respondents perceived the highways driven on most often by them to be somewhat safe.
- Truck drivers and public respondents tend to attribute conflicts or crashes between cars and trucks to each other.
- Both truckers and public respondents agreed that the driving habits of large bus drivers are considered to be the most safe and least aggressive around cars.
- Both truckers and public respondents agreed that drivers of large trucks drive somewhat aggressively around cars.
- Truck drivers get information of crashes between cars and trucks mostly from other truck drivers or citizen band (CB) radio, while public respondents get it from television or newspaper mostly.

Truck drivers' and motorists' opinions of such restrictions at three sites (I-5 Southcenter Hill, SR-520, and I-5 Southbound to Tacoma Mall) in the Puget Sound region of Washington State were obtained through surveys in 1992 (Koehne, et al., 1997). The trucker survey was performed at two truck stop locations (one day at each location), slightly more than four months after the last restrictions were put into place on I-5 Southcenter Hill, yielding 129 completed surveys. A mail-back survey was distributed to motorists who traveled each of the three restricted sections of highway more than three months after the last restrictions. About 400 license plate numbers were collected from each site for this purpose. The survey produced 153 completed responses (response rate of about 16%). The major findings are as follows:

- A relatively high 31.4 percent of truckers indicated that they had disobeyed the lane restrictions, while about 78 percent of motorists indicated that they have seen truckers disobey them.
- Only about 32 percent of the truckers are in favor of keeping Puget Sound lane restrictions, while 91 percent of the motorists are in favor of them. The negative view of most truckers toward restrictions could also be simply because they believe they are not necessary since trucks rarely use the leftmost lanes on ascending grades.
- About 65 percent of truckers and motorists indicated that it is not clear which vehicles or which lanes are subject to the lane restrictions.
- Only about 30 percent of the truckers believe that lane restrictions improve freeway operations, while 86 percent of the motorists do.
- Only about 31 percent of the truckers believe that lane restrictions improve safety, while 82 percent of the motorists do.
- About 66 percent of the truckers believe that lane restrictions should include buses, and 74 percent of the motorists do.
- Only about 21 percent of the truckers believe that lane restrictions should be expanded to more freeway sections, while 83 percent of the motorists do.

Three logit models were also developed for exploring truckers' and motorists' favorability and awareness of truck restrictions. There is a profile of a trucker who is least likely to favor truck restrictions, one who admits to violating restrictions, frequently changes lanes to avoid rough pavement, typically carries nonperishable cargo, is between 20 and 40 years old, and has been licensed for many years. Motorists most likely to favor restrictions also fit a definite profile; one who frequently changes lanes to avoid being followed by trucks, typically drives a passenger car, is between 30 and 45 years old, and has been a long-time licensed driver. The motorists most likely to be aware of Puget Sound truck lane restrictions are male passenger car operators who have been licensed relatively few years. Efforts to improve motorist awareness should focus on those motorists who do not fit this profile.

A study by Golob and Regan (2002) investigated the perceptions of truck company managers on usefulness of different source of traffic information to trucking operations. Managers from 1177 trucking companies including 34% private carriers and 66% for-hire carriers were asked how useful they consider different sources of traffic information are to the dispatchers and to their drivers. The surveys were distributed to 5258 companies containing 804 California-based for-hire companies, 2129 California-based private carriers, and for-hire large national carriers based outside of California, overall response rate of 22.4%. The relationships between 6 characteristics of the companies (load type, carrier type, primary service, location of logistics manager, intermodal operations, and average length of load moves) and manager-perceived usefulness of different source of traffic information to dispatchers or drivers, are discovered through canonical correlation analysis. The respondents were asked to evaluate the sources in one of the three categories (i.e., very useful, somewhat useful, and not useful).

With respect to the overall usefulness to dispatchers, “reports from the drivers on the road” are judged to be most useful followed by “traffic reports on the radio.” Least useful was “traffic reports on television”, followed by “internet traffic maps.” “Reports from their own drivers” are valued most highly by carriers with either rail or multiple intermodal operations, and “traffic reports on commercial radio stations” are useful to general LTL carriers and operations based in the Greater Los Angeles Area. “Traffic reports on television” are thought to be useful to movers, and intermodal operations. “Internet traffic information” is judged to be useful to operators with long moves, and “phone calls to Caltrans” are considered to be useful to operations based in California, but outside of the two largest metropolitan areas.

Concerning overall usefulness to drivers, “changeable message signs (CMS)” was thought to be most useful, followed by “CBR (Citizen Band Radio) or other radio reports from other drivers.” “Traffic reports on commercial radio station” were considered as useful as “face-to-face reports among drivers”, while “Dedicated highway advisory radio (HAR)” was rated to be least useful for drivers. “Face-to-face reports among drivers at truck stops and terminals” are useful with rail intermodal operations, and “CMS” was useful to common carriers and operations from outside of CA carriers with long load moves. “CBR reports from other drivers” are deemed to be useful exclusively to truckload carriers, and “HAR” is judged to be useful to common carriers or carriers with long load moves.

As far as future traffic information sources are concerned, “HAR and CMS” are considered to be most useful followed by “in-vehicle navigation system.” “In-vehicle navigation”, “computer traffic map”, “CMS”, and “traffic information kiosk” are expected to be useful to operations from outside of CA, and carriers with long moves, while “HAR” is thought to be useful for carriers with both truckload and LTL in the future.

Crum, et al. (2001) developed a conceptual level of commercial motor vehicle (CMV) driver fatigue model by reviews of the 55 literature and focus group meetings with industry professionals. It was later used for developing a survey for truck drivers to explore driving environment effects on driver fatigue and crash rates. The model categorized three factors influencing driver fatigue and crashes; CMV driving environments, economic pressures, and carrier support for driving safety. The CMV driving environments were subcategorized into three issues as regularity of time, quality of rest, and trip control, under which a total of 25 individual measures fall, while fatigue and crash outcome measures included 15 items. The data for analysis were collected at five truck stops each in different states, yielding 502 usable surveys. A $10 cash inducement was offered to participants in 1999 with the assistance of the National Association of Truck Stop Operators (NATSO). Twelve driving environment indicators were found to be meaningfully related to 15 fatigue and crash outcome measures; two regularity of time items, six measures of trip control, and four items for quality of rest. Factor analysis identified three constructs underlying the 15 fatigue and crash measures; close call due to fatigue, the perception of fatigue as a problem for self and other drivers, and crashes. From the regression analysis, “long load time” and “start workweek tired” is found to be significant in increasing frequency of close calls due to fatigue, while the frequency of the use of “6-hour time zone” was negatively related to “close calls” unexpectedly. “Long load time” and “start workweek tired” also were associated with more fatigue, while more “uninterrupted hours of sleep”, more use of “regular routes”, and more times “driving the same hours” were associated with less fatigue. More “average stops per day” and “start workweek tired” were found to significantly increase the number of crashes.

At the front part of this study, it was decided to use focus group and survey methods in obtaining the perceptions and opinions of the trucking community. Thus, some previous studies relevant to this issue were reviewed in this section to search for an effective way to conduct focus group and survey studies for the objective of this study. The authors of the studies provide their experiences and recommendations about focus group preparation, survey data collection and perceptions of the trucking community on various trucking-related issues as results. For the sake of this study, potential Florida trucking community focus group and survey participant recruitment sources, and advantages and disadvantages of various trucking community survey methods are summarized in the following three sections, based on the findings from this section.

2.4 Florida Trucking Community Focus Group Participant Recruitment Sources

It is generally difficult to invite truck drivers to a meeting at one place and time. They usually spend a significant portion of their time driving on the road, and their schedules are apt to change for time-variant demand for deliveries. One survey on truck safety issues at three truck stops (Center for Public Policy, 2001) showed that more than 80 percent of the total of 618 surveyed truck drivers spends 3 to 7 days away from home every week for deliveries. Given these constraints, following potential recruitment sources were found for truck driver focus groups:

- Florida Trucking Association (FTA) Road Team members
- Florida Truck Driving Championship (FTDC) participants
- Florida-based National Truckers Association (NTA) members
- Truck drivers from one or two trucking companies

Many previous trucking-related studies have benefited from the cooperation of national or state trucking associations. The American Trucking Association (ATA) is a major national association for United States trucking industry, which often provides assistance to the researchers, even conducting research studies by itself (ATA, 1997). Most states have either the state trucking association or motor vehicle carrier association, which is the state division of ATA. The Florida Trucking Association (FTA) is in that category.

A focus group study was conducted in Toronto at the annual convention of the Ontario Trucking Association (OTA) with its Road Knight Team members, which consist of 10 professional truck drivers (Hostovsky and Hall, 2004). FTA Road Team is the equivalent of the OTA Road Knight Team. The FTA Road Team includes 8 professional drivers from 6 different companies. They are highly informed professionals (each with more than 15 years of truck driving experience) and care about their industry and profession enough to take time from their daily jobs to speak at any public gatherings and give safety demonstration to the general public.

The Florida Truck Driving Championship (FTDC) is an annual competition of truck drivers' driving skills and knowledge on how to operate trucks safely and efficiently. Each participant competes for the championship in one of eight classes of trucks (i.e., single truck, three-axle, four-axle, five-axle, tank truck, flat bed, sleeper berth, and twins). The champions of this event represent Florida truck drivers in the annual National Truck Driving Championship (NTDC). Florida-licensed truck drivers, who performed regular duties of a full-time professional truck driver with no accident history for at least a year and no criminal record in the past 5 years, are eligible to participate in the competition.

The National Truckers Association (NTA) is an organization designed to protect and support the trucking business of independent (owner-operator) truck drivers. For the reason, most NTA members are independent truck drivers.

One or two big-sized trucking companies may help get their drivers together for a focus group meeting. The following potential sources of trucking company contacts were found:

- FTA membership directory
- Center for Economic Development Research (CEDR) Data Center (ES202)
- Florida Department of Highway Safety & Motor Vehicles (FDHSMV)
- Transportation Technical Services, Inc (TTS)

A total of 180 Florida-based trucking companies are listed in the FTA membership directory. They are categorized by 5 chapters (geographical locations), or 6 conferences (carrier types). One study (Lawson, et al., 2002) utilized the Oregon Employment Department database (ES202), Oregon Department of Transportation (ODOT) Motor Carrier Transportation Division truck registration database, and ODOT Driver and Motor Vehicle Services Division Commercial Driver's License (CDL) database to survey freight shippers and carriers. Likewise, ES202 database from CEDR Data Center or FDHSMV database can be used to contact the trucking companies in Florida. The information by TTS was used in the Golob and Regan (2002) study.

It includes national motor carrier directory, private fleet directory, and owner-operator directory database. FDOT personnel also recommended the following companies as potential sources of truck driver participant recruitment:

- Watkins Motor Lines, Inc (one of the nation's largest LTL carriers)
- Landstar Systems, Inc (a big logistics and transportation provider)
- Roundtree Transport & Rigging, Inc

It seems to be also difficult to recruit manager-level participants for focus group meetings. A study by Morris, et al. (1998) performed 13 industry sector focus groups, but with only 2–4 participants per group. Some of them also used a conference call. They seem to be tight in their time schedules. The following potential recruitment sources were found for truck company manager focus groups.

- FTA Leadership Conference participants
- FTA Safety Management Council (SMC) members
- Truck company managers from two or more trucking companies

In 2004, Veras, et al. (2005) conducted 2 focus groups with truck dispatchers as a part of the Evaluation Study of the Port Authority of New York and New Jersey's Value Pricing Initiative. FTA Leadership Conference is held annually to support and enhance trucking business for Florida trucking community. Florida-based Truck company owners and managers are the main attendees in this event. SMC members consist of professional safety managers from FTA member companies. Their primary goal is to make trucking in Florida as safe as possible. It is also possible to contact some of the trucking companies by using the same sources presented earlier to recruit truck company managers.

2.5 Trucking Community Survey Methods

In-field survey methods have often been used by other researchers to collect truck driver surveys. The perceptions of truck drivers on roadway safety issues (Center for Public Policy,

2001) were surveyed at three truck stops (Lee Hi Truck Stop, Truck Stops of America, and White's Truck Stop on interstate 81 and 95), producing a total of 618 surveys. A truck driver survey by Koehne, et al. (1997) was performed at two truck stop locations (one day at each location), yielding 129 completed surveys. Another study about truck driver fatigue and crash rates (Crum, et al., 2001) conducted surveys at 5 truck stop locations: Maryland, Georgia, California, Iowa, and Colorado. The National Association of Truck Stop Operators (NATSO) assisted with the study, producing a total of 502 usable surveys (overall effective response rate was 97.3% with $10 cash incentives). A week-long survey of deliveries to Trinity College Dublin (TCD) was also conducted with an intercept survey method at the gate of the campus, resulting in an 82% response rate (Finnegan et al., 2004). Surveying truck drivers at rest stops or truck stops have following benefits:

- It usually shows good overall productivity with some types of incentives. The completed surveys are colleted promptly on site.
- It asks for the perceptions of truck drivers on truck operation issues while they are on a trip, so their experiences are fresh.
- It enables face-to-face interactions between the participants and surveying staff. This helps yield more completed surveys and reduce the risk of the participants' misunderstanding of the questions.

However, it is required for the surveying staff to spend a fair amount of time and effort in the field.

Considering the irregular working hours and job characteristics of the truck drivers, it would be effective to distribute the surveys directly to them. It may be possible that written surveys are filled out by truck drivers where they can take time to fill them out. At places where truck drivers stay for a short time, written postage-paid surveys could be distributed to them so that they can return them later by mail. Otherwise, written postage-paid surveys may be sent to a number of trucking companies that can distribute the surveys to their drivers. The sources of contacting trucking companies are listed in the previous section.

Different survey methods can be considered for surveying truck company managers. Two studies by Lawson and Riis, and Lawson, et al. (2001 and 2002) compared several methods to survey the freight community (i.e., shippers and carriers) by a literature review and a pilot study. It was found that the most effective survey method in terms of response rates is a phone-based survey although a written survey is preferred by the freight firms. In the pilot study, the highest response rate (60–64%) was achieved by a telephone interview survey (with five callbacks). The other study (Regan and Golob, 1999) obtained a response rate of 35% with a phone survey. However, the response rates for previous written surveys of the trucking community only ranged from 8–24% (Lawson and Riis, 2001).

General characteristics of the survey methods are described in Table 2-1. Mail-based surveys are less costly and time-consuming while producing relatively low response rate. It would be helpful to contact the potential respondents in person or by phone to improve the response rate. In one study (SPRPC, 1996), follow-up phone calls resulted in an 5% increase of the response rate (from 4% to 9 %). The other study (ATA, 1997) showed a response rate of 13.1% by mailing twice with follow-up phone calls. The surveys were personally distributed to the potential respondents to improve the response rate in another study (Finnegan, et al., 2005). This approach also enabled to obtain helpful feedback and comments about the survey issues directly from them. The survey questions should be clear and simple to reduce the possibility that the respondents misunderstand them. A postage-paid survey format is typically used to reduce the respondents' efforts to return the surveys.

Phone-based surveys usually require more money and effort while yielding relatively high response rate. The two studies (Lawson and Riis, 2001 and Lawson, et al., 2002) indicated that a traditional structured phone survey is useful in obtaining detailed information about specific issues, but is not suitable for a sample size large enough to represent the views of a big population. The Computer-Aided Telephone Interview (CATI) allows for a large sample size while reducing the opportunity to fully explore a certain aspect of any given topic. The CATI is typically conducted by survey companies because it requires trained interviewers and interactive CATI computer systems. The participants' responses are keyed directly into a computer and administration of the interview is managed by a specifically designed software program. The program does not accept invalid surveys. In a survey study of freight operators (Regan and Golob, 1999 and Golob and Regan, 2002), the CATI was conducted by Strategic Consulting and Research, an Irvine, California-based survey company, yielding a response rate of 35%.

The Web-based survey method is less costly and easy to administer, but the response rate from this method may greatly depend on publicity and advertisement of the surveys. Some types of contacts (e.g., phone, email, mail) with potential respondents are highly encouraged to increase the response rate. Little is known about the use of this method for surveying the trucking community. The Idaho Technology Transfer Center, in conjunction with the ATA, is conducting a web-based study about the perceptions of truck drivers or fleet managers on the benefits of anti-icing chemicals and reductions of potential vehicle corrosion (Alexander and Moore, 2006).

Regardless of the survey method(s), a clear indication of the contribution(s) of a survey study to the trucking community or industry may encourage the potential respondents to participate in the survey. The sponsorships of trucking-related associations or institutes (e.g., FTA, ATA, or FDOT, etc.) may help reinforce the importance of the survey study, resulting in an improvement of the response rate as well.

Table 2-1. Comparison of Survey Methods

Characteristics	Survey Methods: Mail-based Survey	Phone-based Survey	Web-based Survey
Advantages	• Less costly and time-consuming • Interviewer bias is not introduced • Uniform survey method • Provide respondents with enough time to give thoughtful answers • Suitable for obtaining larger and more representative sample	• Relatively high response rate • Chance to correct misunderstandings • Chance to get more detailed information • No respondents' efforts required to return surveys	• Less costly, easy to administer • Fast results • Provide respondents with enough time to give thoughtful answers • No respondents' efforts required to return surveys
Disadvantages	▪ Relatively low response rate ▪ Potential long time delay ▪ Hard to ensure that the right person will complete the survey ▪ Potential misunderstanding of the questionnaires by the respondents ▪ Respondents' efforts required to return surveys	o More costly and time-consuming o Dependent on respondent availability o Not suitable for large sample size o Can not be used for non-audio information o May present lack of uniformity	▪ Response rates may greatly depend on publicity/advertisement of the surveys ▪ Hard to ensure that the right person will complete the survey
Typical Range of Response Rates	8–24%	35–64%	Highly variable
Studies in which used	Lawson and Riis (2001) Lawson, et al. (2002) Finnegan, et al. (2005) SPRPC (1996) ATA (1997)	Lawson and Riis (2001) Lawson, et al. (2002) Regan and Golob (1999) Golob and Regan (2002)	Alexander and Moore (2003)

CHAPTER 3
RESEARCH APPROACH

This exploratory study was aimed at discovering the factors important to estimate LOS on existing roadway systems, as perceived by truck mode users. This was intended to provide the FDOT with the information about the determinants of truck LOS and the levels of their significance with which it can develop methods to effectively evaluate LOS provided for trucks on various roadway facilities. To accomplish this, it was necessary to obtain the perceptions and opinions of the trucking community on what factors are important for the quality of a truck trip on various transportation facilities and the relative significance of each of those factors. Focus group and survey studies were conducted to satisfy this requirement.

Truck drivers and truck company managers are the two major stakeholder groups for the LOS provided for trucks. Truck drivers deliver goods by driving trucks while truck company managers operate the trucks and drivers to make a profit. Truck drivers are the most important group concerning truck LOS, in that they are the ones who actually drive the trucks on the road, so their performance and satisfaction is directly affected by the LOS provided by various transportation facilities. Their performance levels also have major effects on trucking business in such aspects as on-time performance, operating cost, etc. Truck company managers are primarily concerned with those trucking business concerns, but in most cases they need to manage their fleet on existing roadway facilities based on the perceptions and opinions of their drivers due to the lack of regular truck driving experience. Thus, the focus was on the perceptions of truck drivers, while the perceptions of truck company managers were also sought to be compared with those of truck drivers.

Initially, very limited knowledge was present on the factors determining LOS perceived by the trucking community. This required a small number of observations to be obtained through some type of qualitative study to get enough information to develop a more formal survey, which would then be used to obtain the perceptions of a larger sample to represent the trucking community. Typically, there are two types of qualitative study methods; personal interviews and focus group studies. Individual interviews can require a considerable amount of time and effort. A respondent is also apt to be unwittingly influenced by an interviewer, or, often not able to come up with his/her opinions about various aspects of the subjects during the interview. Homogeneous and information-rich participants in a focus group study can boost the diverse conversation about the subjects with little guidance from a moderator. Thus, focus group studies were performed for this study.

Focus group studies do not provide enough observations for quantitative analysis. Thus, a follow-on survey study was conducted to confirm the focus group findings with a broader audience and measure the relative importance of each factor quantitatively. The surveys focused only on potentially relevant and important items.

Based on the focus group and survey studies, the guidelines for developing truck LOS estimation methodologies were developed to provide the FDOT with potential service measures for truck LOS and/or a list of factors that should be considered to develop truck LOS estimation models on various roadway facilities. The overall description of the research approach of this study is presented in Figure 3-1.

To develop actual truck LOS estimation models in future studies, experimental data should be collected to quantitatively measure the correlations between the service measures and/or the list of factors identified in this study and the perceptions of a representative sample of truck drivers on trip quality. This often requires some experimental efforts with in-field driving, video simulation, or driving simulator methods.

3.1 Focus Group Sessions

The primary objective of this focus group study was to identify the roadway, traffic, and control factors that are important to the trucking community for truck trip quality on various transportation facilities and to explore the perceptional differences between truck drivers and truck company managers on the relative importance of each factor.

Ultimately, this study sought to inform transportation service providers of what should be focused on to better accommodate truck traffic on existing roadway facilities. Thus, the factors that cannot be controlled by the transportation service providers were of less interest in the discussions, although the discussions were open to any factor important to the quality of a complete truck trip from origin to destination. The focus was on the operational and design policies and issues relative to truck operations on various roadway facilities (e.g., lane widths, traveler information systems, etc.) as opposed to truck industry regulation issues such as number of continuous hours of driving, maximum non-permit weight loads, etc. Weather-related factors were also less of a concern.

Three focus group interviews were conducted to elicit the factors affecting LOS on various transportation facilities perceived by truck mode users (truck drivers and truck company managers). The participants for each focus group session were recruited by the cooperation of the Florida Trucking Association (FTA). Several discussion topics were selected carefully for the overall objective of this study, which is to find out what should be focused on to better accommodate truck traffic on the existing roadway system. During each focus group session, the topics were introduced to the participants with several open-ended questions so that they discuss each topic amongst themselves with only a little guidance from the moderator. The focus group discussions were transcribed and summarized to be used as inputs to a follow-on survey.

3.1.1 Participant Recruitment

Based on the review and considerations of focus group participant recruitment presented in Chapter 2, it was decided that the most effective and efficient approach to recruiting candidates for the focus group sessions would be with the cooperation of the FTA. With the FTA's contacts and presence in the industry, they would be much more capable of identifying willing participants for this study. Thus, assistance from the FTA was solicited (Appendix A for a cooperation request letter), and they were happy to assist. FTA staff were pleased to hear that the FDOT was conducting a research project targeted at the LOS needs of the trucking community.

For the focus group participant recruitment, several documents were provided to the FTA to inform them of preferred participant characteristics, what questions would be asked throughout the sessions, and how the sessions would be conducted. The documents included focus group instructions (Appendix B), guidelines for participant selection (Appendix C), and a focus group moderator's guide (Appendix D). For the truck drivers' focus group sessions, the FTA recruited members from its Road Team. Two other truck driver candidates were also recruited. Once they provided a list of these candidates, a follow-up recruitment letter was emailed to them to ask for confirmation. Focus group instructions and a map to the meeting place were attached to the email as well. Two focus group sessions were held with the truck drivers as follows:

- 5 people including 4 FTA Road Team members, 2.5 hours of discussion, on November 15th, 2005
- 4 people including 3 FTA Road Team members, 2.5 hours of discussion, on December 8th, 2005

It was initially planned to also hold two focus group sessions with truck managers, but the FTA found the recruitment of these individuals to be much more difficult. Ultimately, just one 2-hour focus group session was held with three managers on November 17th, 2005.

3.1.2 Participant Selection

When the FTA agreed to help recruit the participants for the focus group meetings, the guidelines for selecting the participants were developed and provided to the FTA (Appendix C). This was intended to ask the FTA to consider the guidelines to obtain a representative sample of the Florida trucking community. They describe characteristics of eligible participants and the desirable participant composition for each focus group. This section explains the reasoning behind the development of the guidelines.

Initially, a total of four focus group interviews were proposed (two with drivers and two with managers), balancing the scope and resources available for this study. The two distinct groups of participants were separately invited to different meetings because they were expected to have different perspectives with regard to the discussion topics. Truck drivers may show more concerns about the traffic, roadway, and/or control factors affecting truck driving comfort and amount of earning while truck company managers may be more concerned with the factors contributing to their trucking businesses. The separation of the two groups not only made the participants comfortable to share their opinions, but also helped the research team to clearly identify the perceptions of each group. The desired number of participants in each focus group was originally 8–10. However, it proved challenging for the FTA to obtain this number of participants. Thus, about half this number of participants for each focus group was obtained. Nonetheless, these group sizes worked out well given the depth and breadth of the participants in each session, and that each of the participants had much to contribute to the discussions.

There are several major socio-economic or working characteristics of the trucking community that may be highly correlated with their perceptions on the factors affecting LOS on transportation facilities. It is not realistic to take into account all the characteristics of the focus group participants with the several focus group meetings, but consideration would help recruit a more representative sample of the Florida trucking community. The following characteristics of the trucking community were considered in the guidelines:

Hauling distance: Long-haul trucking with frequent travel on the Florida's SIS facilities was of main interest in this exploratory study as opposed to local or short-haul trucking, which only use small portion of the Florida's SIS facilities.

Carrier type: It was desired to include the participants from both for-hire and private truck companies. Private trucks moved 32.7 percent, and for-hire trucks transported 43.3 percent of the total freight value originating in Florida in 2002 (BTS, 2004). The rest of the percent (24 percent) was delivered by other modes such as train, ship, plane, or multiple modes. One survey study (Golob and Regan, 2002) verified the perceptional difference between private and for-hire truck companies about various sources of traffic information.

Load type: It was desired to include truck drivers from both Truckload (TL) and Less-than-Truckload (LTL) carriers. It is likely that the perceptions of TL drivers on truck trip quality issues are different from those of LTL driver due to the weight of the equipment and goods. The TL and LTL operations are defined as follows:

- TruckLoad (TL): The quantity of freight required to fill a truck. Usually in excess of 10,000 pounds. When used in connection with freight rates, the quantities of freight necessary to qualify a shipment for a truckload rate.
- Less-than-TruckLoad (LTL): A quantity of freight less than that required for the application of a truckload rate. Usually less than 10,000 pounds and generally involves the use of terminal facilities to break and consolidate shipments.

Truck type: It is likely that perceptional difference among the drivers operating different types of trucks exists due to their discrete size and operational characteristics. The majority of the trucks on the roads were categorized into the following three types of trucks in terms of truck configurations:

- Straight Truck (single unit truck)
- Truck-Trailer (truck-trailer, truck-double trailer)
- Tractor-Trailer (tractor-semitrailer, twin-trailer, rocky mountain double, turnpike double)

It was desired that each truck driver focus group include at least three truck drivers, each operating different three types of the trucks.

Fleet size: It was desired to include truck drivers that represented companies with a variety of fleet sizes. About 87 percent of the carriers in the U.S. operated 6 or fewer trucks, 9 percent operated the fleet size between 7 and 20, and 4 percent operated more than 20 trucks in 2004 (ATA, 2005).

Others: ATA (2005) showed that 29.4% of the total drivers in the U.S. were minorities in 2003 and the percentage has been going up gradually from the year 1996. Only 4.6 % of the total truck drivers in the U.S. were women in 2003, but the percentage has been going down since 2001. So, inclusion of the minority or woman truck drivers in focus group sessions was desired, but this was obviously difficult to attain, given their limited proportions.

Overall, a good composition of participants was recruited for the two truck driver focus groups in terms of carrier type and primary load type. The participants were all from major trucking companies with at least 16 years of truck driving job experience. The truck types they operate include various tractor-trailers. However, no straight truck driver, truck trailer driver, female driver, or minority driver was present on the meetings. Only one truck company manager focus group was conducted with three managers. They were all from the TL carriers with at least

5 years of truck company manager experiences. One was from private company while the other two were from for-hire companies. A detailed description of the focus group participants' backgrounds is provided in Appendix E.

3.1.3 Focus Group Questionnaires

For each focus group interview, several discussion topics were introduced to the participants by the moderator through several open-ended questions. Then, the participants talked about the topics amongst each other with a little guidance of the moderator. An identical set of questions was presented for each meeting to compare and contrast the perceptions of truck drivers with those of truck company managers. The issues to be covered were selected according to the overall objectives of this focus group study, which is to investigate which factors transportation service providers should focus on to better accommodate truck traffic. Following four topics were considered as most relevant to this study, therefore were covered during each focus group meeting.

Truck travel route and departure time selection:

- Who is responsible for selecting a truck travel route and departure time for a delivery?
- When selecting a travel route and departure time for a delivery, what factor are considered and what is their relative significance?

Truck trip quality on various transportation facilities:

- When you drive a truck on Florida's roadway facilities (i.e., freeways, arterials, and two-lane highways) for a delivery, what factors affect the quality of a truck trip and how significant is each of those factors for it? (for truck driver groups)
- When you consider truck operations on Florida's roadway facilities (i.e., freeways, arterials, and two-lane highways), what factors affect the quality of a truck trip and how significant is each of those factors for it? (for truck company manager groups)

Transportation service improvement priority for trucking industry:

- What types of transportation facilities (e.g., freeways, urban arterials) would you emphasize most for improving truck operations in Florida?

- What are your top priorities for improving trip quality/travel condition for commercial trucks?

Truck delivery schedule reliability:

- What factors affect the truck drivers' ability to reach a destination on time?
- How often does a late delivery take place?
- What are the typical consequences for you/your company of a late delivery?

The most important contributors to quality of a truck trip perceived by the trucking community were thought to be the factors that they consider for truck route and departure time decision, so they were asked in the first place. The participants provided their valuable insight about in what respect certain routes and times of day are preferred or avoided by them and which specific factors contributes to each of those aspects. The performance levels of those factors have most significant impacts on their trucking business and truck trip quality perceived by them.

Secondly, the participants were directly asked to list the factors affecting quality of a truck trip. The topic was introduced by each roadway type, in that it was generally admitted in the first focus group meeting that the importance of a factor on truck trip quality vary by which type of a roadway it is on. For example, it was discussed that the importance of shoulder width and condition on truck trip quality for two-lane highways was considered to be much bigger than that on freeways. The participants also indicated how and how much each factor influences truck trip quality based on their direct or indirect experiences.

Improvement priorities among various transportation issues and facilities were asked next. It was intended to search for the facilities or specific factors which are getting relatively less attention by transportation service providers compared to their relative importance on truck trip quality. The participants' comments on this issue will be a good reference for prioritizing transportation improvement plans.

As the truck volume and the demand for just-in-time deliveries have increased in Florida, the importance of truck delivery schedule reliability has become critical. Thus, at the last part of the discussion, the participants were asked to list the factors contributing to the issue and indicate their level of impact on it. Truck company manager participants explicitly mentioned that their customers assess the performance level of their truck companies based primarily upon on-time delivery performance. The factors affecting on-time performance, frequency and consequences of a late delivery were explored within this topic.

The factors identified as important to any of the topics covered in the focus group discussion were used as a primary input for a follow-on survey so that the importance of each of those factors could be verified by a larger audience and the relative significance among the factors on truck trip quality could be quantitatively investigated.

3.1.4 Conducting Interviews

The focus group meetings were held at the Civil Engineering Conference Room or Transportation Research Center Conference Room at the University of Florida. All the meetings were moderated by a researcher who is knowledgeable to direct the discussions for the purpose of this study. Upon the arrival of the participants, they were asked to fill out an informed consent form and a two-page participant background survey (Appendix F and G). During the main session, the moderator introduced the selected topics to the participants with several general open-ended questions (Appendix D). Each question was displayed on a big screen to help keep the participants focused on the issue being discussed. The participants discussed each topic amongst each other with just a little guidance from the moderator. Although all the issues were planned to be covered within the two hours, it turned out to not be enough time because they had so much to say about each topic. The truck driver focus groups were extended by about

30 minutes with the permission of the participants. Participation in the focus group meetings was voluntary.

The audio from the focus group meetings was recorded on a laptop computer through external microphones and a specialized software product that enabled every comment to be associated with the corresponding speaker. The recorded audio files (.wav files) were transcribed into an electronic text format. The transcriptions were reviewed in detail by the research team to ensure their accuracy. After the transcriptions were complete and accurate, the focus group discussions were summarized and used as guidance in the development of the follow-on surveys.

3.1.5 Summary of Discussions

The results of the focus group studies were summarized by each issue covered in the discussions. The participants did not always focus on the issue being discussed. They sometimes jumped onto the previously discussed issues or the issues to be discussed later. As long as the discussions remained on relevant topics, the moderator did not redirect the conversation. Thus, it was required to collect participants' comments about each issue spread over the transcriptions. Some of the comments were paraphrased for clarity and brevity, but care was taken not to place any personal perceptions on the summary. The factors perceived to affect truck trip quality were categorized by each transportation facility type (e.g., freeways). Each of the factors was listed and described with the participants' comments about its contribution to the truck trip quality and their direct or indirect experiences with it. The perceptions of truck company managers were separately summarized to be compared with those of truck drivers.

The focus group meetings covered many issues in a limited amount of time. The discussions were directed by the moderator to draw out a list of the factors important to truck trip quality, not spending too much time on one or two specific factors. Thus, it was not appropriate to make quantitative implications of the discussions on the relative importance of each factor. It was investigated quantitatively in a follow-on survey, which was developed based on the focus group discussion summary.

3.2 Survey Studies

The primary objective of this survey study was to verify the importance of each factor identified in the previous focus group study with a larger audience and to quantitatively measure the relative significance of each of those factors on truck trip quality on Florida's roadway system. Preference of the respondents on truck driving time of day was also investigated to explore how quality of truck driving environment varies by time of day. The background characteristics of the respondents that were correlated with their perceptions on truck trip quality or preference on truck driving time of day were identified.

The survey included following three parts: working and socio-economic backgrounds of the respondents; their perceptions on the relative importance of each factor on truck trip quality; and their opinions about the importance of each hypothetical truck LOS performance measure. Two sets of survey forms were distributed; one for truck drivers and the other for truck company managers. Some questions about the backgrounds of the respondents differed in the two survey forms, but identical sets of factors and hypothetical performance measures were evaluated in both surveys. They were carefully selected based on the previous focus group study results. Only truck trip quality determinants on the following three roadway types were investigated considering the lengths and complexity of the surveys: freeways; urban arterials; and two-lane highways.

A total of 459 truck drivers and 38 truck company managers responded to the written surveys collected at Florida Truck Driving Championship (FTDC) event or the postage-paid mail-back surveys distributed at four agricultural inspection stations. The survey responses were analyzed with various statistical methods such as descriptive statistics, Exploratory Factor Analysis (EFA), multiple comparisons of the means, non-parametric tests, and chi-squared tests of independence.

3.2.1 Question Types

When the issues to be questioned in the survey were selected, a questions type for each of those issues was carefully determined to effectively carry out the study. It involved such various considerations as applicability of statistical analyses, respondent burden, respondent error (or complexity level), measurement accuracy, etc. Following five question types were utilized in this survey study: interval-rating questions; ratio-scale questions; forced-ranking questions; discrete-choice questions; and fixed-sum questions. This sections describes characteristics (advantages and disadvantages) of those question types based on which the question types for each survey issue of this study were determined.

3.2.1.1 Interval-rating questions

This question type is often used to ask for the perceptions of the respondents. Respondents are asked to present their perceptions on the level of importance, satisfaction, or agreement for each item on an interval-rating scale (e.g., 1 = Not at all Important, 7 = Extremely Important). The accuracy of the participants' opinions may be improved as the number of selectable points in a rating scale increases. However, more points require the respondent to think about the differentiation along the extended scale, increasing response burden and time to complete the survey. It is typical to have at least five points on the scale, since fewer than five points generally do not generate normally distributed data which are usually obtained when the data are truly interval in nature. Seven-and ten-point scales are most common. Even-numbered scale may be used when there is a need to force the respondents to commit to one side or the other, but it typically creates a downward bias as they tend to choose five as a neutral point in a ten-point scale.

A critical differentiator between interval-rating and ordinal scale questions is that equal intervals exist between each adjoining pair of response options. If all response options are literally presented (e.g., 1 = Not At All Important, 2 = Little Important, 3 = Important, 4 = Very Important, 5 = Extremely Important), the difference between each adjoining pair of response options are not the same, resulting in ordinal scale data. Thus, the response values from an ordinal scale question do not have numerical meaning, and categorical or nonparametric statistical analyses can only be applicable to the data. It is also true for a forced-ranking question, which is one type of the ordinal scale questions. The responses from an interval-rating scale question are appropriate for the numerical interpretation (although not perfectly), enabling further statistical analyses (e.g., parametric statistical analyses). However, an interval-rating scale question allows respondents to indicate that everything is almost equally important/satisfied, making the distinction among the factors difficult, while a forced-ranking question require them to make clear distinctions among the factors.

3.2.1.2 Ratio-scale questions

Respondents are asked to provide their answer as a ratio to a basic unit of measurement (e.g., year, dollar, hour, etc.) assigned to each question. The ratio scale of measurement is the most informative scale and widely used to obtain participants' background data (e.g., age, number of children, how long their phone call was on hold, etc.). It has zero position indicating the absence of the quantity being measured and is an open-ended interval-rating scale, in that there is no designated upper-end point.

The use of a ratio-scale question for respondents' perceptions or opinions (e.g., perceived importance or satisfaction levels) may not be a good idea. It may decrease a response rate, increase respondent error, and bring about unreasonably large variances among the responses or participants, rather than increase level of precision in their responses with numerous numbers of points in the scale.

3.2.1.3 Forced-ranking questions

Respondents are given a number of factors and asked to place them in order based on a certain criterion (e.g., importance level). For example, six factors might be presented and the respondent is asked to place a "1" next to the most important factor, a "2" next to the second most important factor, and so on. Again, the response values from this scale do not have a meaning numerically, so the data should be analyzed categorically or nonparametrically. These data are often analyzed with a cumulative frequency distribution for each factor. For example, "90 percent of the respondents perceived that factor A is at least secondly important among the listed factors." This approach forces them to clearly distinguish one factor from others, usually producing a larger variance among the responses than an interval-rating scale question.

A forced ranking question is heavily prone to respondent error. Respondents might interpret it as an interval-rating question, use the top and bottom rankings more than once, or rank the top and bottom items skipping the middle ones. In a telephone survey, you could train the interviewers to prompt the respondent for full and correct answers. For a web-based survey, you could insert an error feedback system, not letting the respondents move through the survey without completing the question correctly. These practices are as likely to annoy the respondent as to get real answers. It could also require the respondents to make a considerable effort to complete the survey as the number of factors to be ranked increases. Rank ordering of 10 factors is, in fact, extremely difficult.

3.2.1.4 Discrete-choice questions

Respondents are given a list of items and asked to choose one answer that best applies, or specific number of answers that best applies, or all the choices that apply. A survey developer decides which type of discrete-choice question is appropriate for a survey issue, considering the characteristics of the issue, study purpose, and respondents' burden accompanied by the question. This question type is widely used in a survey to ask for the respondents' background characteristics as well as their perceptions on certain issues. The responses are nominal (or categorical), so it is easier for the respondents to reply to the question than other question types. The discrete-choice data are often presented by (cumulative) frequency distributions of each option category. If the respondents' perceptions are asked with a discrete-choice question, logit modeling technique can be applied where the responses data are used as a response variable and other background characteristic data as explanatory variables. Relationships between the perceptions and background characteristics of the respondents are identified by the logit modeling technique, which provides an equation to predict the response once a set of background characteristics are given. This question type is often used to ask about the topics that may be potentially sensitive to the respondents (e.g., income level) because it is less personally obtrusive than a ratio-scale question to the respondents. In that case, the response data can be used in logit modeling process as a potential explanatory variable.

Multiple choices, multiple responses: Respondents are given multiple response categories and asked to select either all the response choices that apply, or specific number of response options that apply. The former question type is usually used for some background characteristics (e.g., choose all the types of foods you can cook) and the latter is often used to investigate the perceptions of the respondents (e.g., select 2 types of foods you like the most). The response data are often analyzed by (cumulative) frequency distributions. When the former question type is used, the data are often converted to binary data for each response category and used as potential explanatory variables for various statistical modeling (e.g., logit, probit, or regression modeling). The latter question type requires less respondent burden than other question types for respondents' perceptions. The respondents only have to choose a certain number of factors (e.g., 2, 3, or 5 factors) from a list of factors according to their perceptions. Two or three factors are most commonly asked to be selected, but the number of factors to be selected basically should be determined based on the purposes of a study. One study by Washburn, et al. (2004) used this question type to identify most important user-perceived trip quality determinants on rural freeways. The respondents were asked to select 3 factors most important to their perception of trip quality among 16 listed factors. The importance of each factor was presented by the percent of the respondents who selected the factor in their top 3 most important factors.

Multiple choices, single response: Respondents are asked to select only one most appropriate response out of multiple response options. A survey designer should be careful to direct the respondents to select only one most appropriate response, not just any responses that may apply. If the perceptions of the respondents are asked with this question type, the relationships between their perceptions and background characteristics can be modeled by multi-category logit or probit modeling technique, which provides a means of predicting response probability, given a set of background characteristics. This question type can also be used to ask for some background characteristics of the respondents (e.g., race). In that case, the responses are often converted to a set of binary data to be used as explanatory variables for other models.

Binary choice: The respondent is asked to select one out of two choices. Typically, these choices are true or false, or yes or no (e.g., existence of any dependent). If the perceptions of the respondents are asked with this question type, the relationships between their perceptions and background characteristics can be modeled by binary logit or probit modeling technique, which provides a means of predicting response probability, given a set of background characteristics. This question type can also be used to ask for some background characteristics of the respondents (e.g., gender) and defined as an explanatory variable for other models. In all cases, the data can be easily represented by frequency distributions.

3.2.1.5 Fixed-sum questions

Fixed-sum or fixed-allocation questions are combination of the interval-rating scale and the forced-ranking questions. Respondents are given a set of factors and asked to allocate a total of 100 points to the factors for a certain aspect (e.g., importance level). They are encouraged not only to consider rankings of all the listed factors before the allocations, but also to present level of each factor for the aspect by a number. This question type is also used to obtain some background characteristics of the respondents (e.g., percent of your trip purposes: business; leisure; social). The block of points to allot is typically 100 since most people are comfortable thinking in percentages, but allocated scores often tend not to add up to 100 as the number of factors in question increases. Time-consuming data cleansing is required for the responses not summing to 100. For this reason, it is common to present not more than 10 factors and state what an equal weighting would be. Typically, 4, 5, or 10 factors are listed to be evaluated because the equal weighting (i.e., 25, 20, and 10) is easily recognized by the respondents. The response data are often presented with descriptive statistics and can be considered as a response variable or an explanatory variable for various statistical analyses.

3.2.2 Survey Development

The survey issues covered in this study were selected for the ultimate objective of this study which is to find out what should be focused on by transportation service providers to better accommodate truck traffic on current roadway systems. They are presented in Table 3-1 with their corresponding question types and analysis methods utilized in the survey to address those issues. Two different survey forms were prepared (Appendix H for truck driver survey and Appendix I for truck company manager survey). Identical sets of factors were evaluated in the two surveys to compare the perceptions of the two groups, but most questions regarding respondents' background characteristics necessarily differed between the two surveys.

Participant's background: Background characteristics of each participant were asked in the first part of the survey. It was intended to discover the relationships between their backgrounds and perceptions on truck trip quality. Thus, the characteristics suspected to explain the potential variances in their perceptions were included in the first place.

The background survey section includes the questions about socio-economic status and working characteristics of the respondents. Various question types were used for this section according to the characteristics of the selected issues. Discrete-choice questions were used to ask for socio-economic backgrounds (e.g., age, annual income) to be less personally intrusive to the respondents than ratio-scale questions. All the response options for working characteristics questions (e.g., types of goods hauled, truck types used, duties of truck company managers, etc.) were determined through extensive literature search and discussions with members of Florida trucking industry to reflect the current state of Florida trucking industry.

Preference on truck driving time of day: Truck driver respondents were asked to present current and preferred truck driving times of day, while only preferred truck driving times of day could be asked in the manager survey. It was intended to investigate how quality of truck driving condition varies by time of day. This offered valuable information about the preference of the trucking community on night-time delivery and how the preference of truck drivers on truck driving time of day is different by their background characteristics. Time of day was divided into 6 time periods and preference on each of the periods was asked with a binary choice question to reduce respondent burden.

Relative importance/satisfaction of each factor on truck trip quality: Relative importance of each factor on truck trip quality was asked simultaneously with relative satisfaction of each factor on overall Florida roadway facilities. Importance-satisfaction (or importance-performance) analysis approach is often used in the field of marketing research to prioritize attributes of a product for improvement (Martilla and James, 1977). That is, manufacturers should firstly focus on improving the attributes of a product that are perceived to be important, or are unsatisfied by the customers. In this study, this approach provided transportation service providers with valuable insights about what should be firstly focused on to improve LOS for trucks (i.e., the factors that are perceived to be important, but are not well satisfied by truck drivers).

Basically, the factors identified in the previous focus group studies were presented in the survey to be evaluated, but a couple of other factors that the research team considered to be important were also included (e.g., frequency of faster vehicles following your truck). Weather factors (e.g., thunder storms, heavy rain falls) were excluded from this survey study even though they were perceived to be fairly important in the focus group studies, because they cannot be controlled by transportation service providers. The relative significance/satisfaction of each factor on following three roadway facilities was evaluated: freeways; urban arterials; two-lane highways. Truck trip quality issues on multilane highways were not covered in this study to keep the proper length of the surveys. It was indicated in the focus group studies that the trucking community was least concerned about truck trip quality on multilane highways among those on various roadway facilities (i.e., freeways, urban arterials, two-lane highways, and multilane highways).

The importance/satisfaction of each factor was asked on a 7-point relative interval rating scale (−3 = Least Important (or Satisfied), 0 = As Important (or Satisfied) As Others, +3 = Most Important (or satisfied)). It was not appropriate to use typical interval-rating scale, ordinal scale, or ranking scale types of questions. As mentioned in a previous section, a typical interval-rating scale question allows respondents to indicate that everything is almost equally important, making the distinction among the factors difficult. An ordinal scale or forced-ranking questions do not allow mathematical interpretation of the survey responses, restricting the applicability of various statistical analyses. The number of factors to be evaluated ranged from 18 to 19 by roadway type, so the use of a forced-ranking scale question was strongly discouraged because it would significantly increase respondents' burden and error, or decrease the response rate. Bubble-shaped option boxes were displayed for participants to reply to this survey question easily. A 7-point scale was used for this question, balancing the precision in measuring respondents' perceptions and the respondent burden. A small number of points in scale decrease level of measurement precision, while a large number of scale increase the respondent burden.

Improvement Priority Score (*IPS*): Although not asked directly in the survey, improvement priority of each of the listed factors could be assessed through a combination of Relative Importance Score (*RIS*) and Relative Satisfaction Score (*RSS*). Improvement priority is proportional to *RIS* and inversely proportional to *RSS*. That is, the more important or the less satisfied a factor was, the more the factor is in need of improvement. Based on this reasoning, Equation 3.1 was devised to calculate the Improvement Priority Score (*IPS*) for each factor.

$$IPS = \left(\frac{RIS}{RSS} \right)^{a} \times (RIS - RSS) \tag{3.1}$$

where,

IPS = Improvement Priority Score (−42 – +42)

RIS = Relative Importance Score (1 – 7)

RSS = Relative Satisfaction Score (1 – 7)

a = +1 if *RIS* >= *RSS*, otherwise −1

RIS and *RSS* of each factor collected on an interval-rating scale of −3 to +3 were converted to a scale of 1 to 7 for calculating *IPS* for each factor. The greater the *IPS* of a factor is, the more improvement on the factor is anticipated. When the importance level of a certain factor is equal to the satisfaction level, *IPS* will be zero. A total of 49 (7 *RIS* × 7 *RSS*) possible responses and their corresponding *IPS* are tabulated in Appendix J. One survey response presents one *IPS* for each factor. An average IPS of each factor from all the responses is used to estimate its relative need of improvement.

Relative importance of each factor on overall trucking business: Relative importance of each factor on Operating Cost (*OC*), On-time Performance (*OP*), and truck drivers' Trip Satisfaction (*TS*) was asked individually on a 7-point relative interval rating scale (−3 = Least Important, 0 = As Important As Others, +3 = Most Important) in the manager survey. The percent allocation of the managers' concerns on each of these issues was also asked with a fixed-sum question. *OC*, *OP*, and *TS* values were converted to a scale of 1 to 7 and relative importance of each factor on Overall Trucking Business (*OTB*) was calculated by summing the *OC*, *OP*, and *TS* values weighted by their corresponding portion of the managers' concerns.

Relative importance of each category of factors on truck trip quality: All the listed factors for each roadway type were divided into four categories for each roadway type and the relative importance of each of the categories on truck trip quality was evaluated with a forced-ranking question (1–4, 1 = Most Important, 4 = Least Important). This was intended to investigate which types of transportation service are relatively important to LOS perceived by truck mode users for each roadway type and how this importance priority varies for various roadway facilities. The relative importance of four identical categories were evaluated for freeway and two-lane highway facilities (i.e., physical roadway condition, traffic condition, traveler information systems, and other drivers' behavior), but 'signal condition' replaced 'traveler information systems' category to be evaluated for urban arterial facilities. A forced-ranking question was used for this issue to focus on the distinctions among the importance of the categories of factors. The use of an interval-rating scale question was not appropriate because there is much chance that most respondents simply state that every category is equally extremely important.

Applicability of single hypothetical performance measure to estimate truck trip quality: Based on the focus group studies, several hypothetical truck LOS performance measure were developed by the research team for each roadway facility (e.g., Ease of Driving at or above the Speed Limit for freeways). This was intended to investigate whether it is possible to use only one or two performance measures to adequately evaluate truck trip quality on each roadway type. The hypothetical performance measures for each roadway type were selected in a way they are independent one another. That is, each performance measure presents different aspect of truck driving condition. Each performance measure can be considered as a function of multiple specific factors that were evaluated in a former part of the survey. The applicability of each hypothetical performance measure solely to evaluate truck LOS was asked on a typical 7-point interval-rating scale (1 = Not at all Applicable, 7 = Perfectly Applicable). It was expected to obtain large enough variances for the distinction amongst the factors since it is not reasonable for the respondents to indicate that most of the different performance measures are perfectly applicable solely to assess truck LOS. Again, a 7-point scale was used for this question, balancing the precision in measuring respondents' perceptions and the respondent burden.

Relative improvement priority for each roadway type: The relative improvement priority among various roadway types was asked at the last part of the survey. It was intended to find out which roadway facility types are more in need of improvement for the trucking community among the four roadway facility types (i.e., freeways, urban arterials, two-lane highways, and multilane highways). A forced-ranking question was used for this issue to focus on the distinctions among the roadway facility types while keeping the respondent burden at a reasonable level (1–4, 1 = Most in Need of Improvement, 4 = Least in Need of Improvement). The survey data is beneficial for prioritizing the improvement needs of various roadway facility types for truck traffic.

3.2.3 Data Collection

Truck drivers and truck company managers, as the major truck mode users on the Florida's SIS facilities, are the target population in this study. A truly random sample is impossible to obtain considering expected difficulties with recruitment, time, and budget. However, an effort has been made to get a reasonably representative sample for this study.

Based on the review and considerations of truck driver survey methods discussed in Chapter 2, two different approaches were used for survey data collection of the truck drivers. The first method involved the distribution of the written surveys at the Florida Truck Driving

Championship (FTDC) event. The second method consisted of distributing the postage-paid surveys at several agricultural inspection stations.

The first truck driver survey was conducted at the FTDC event (on June 1–3, 2006 in Tampa). This event is co-sponsored by the FTA and they assisted the research team with the distribution of the surveys. They were given to the drivers while they were in a session where they were required to fill out other paper work as well.

There were some concerns expressed by the research team about the original length (six pages) of the survey, and the research team discussed this with the FDOT and the FTA. However, the FTA representatives felt that the length would not be a problem because they would require the drivers to fill them out as part of their participation in the event, so it was decided to leave it at that length.

The first two pages of the survey included the questions regarding the socio-economic and working characteristics of the respondents. The relative importance/satisfaction of each factor on truck trip quality on freeways, urban arterials, and two-lane highways were asked on pages 3, 4, and 5 of the survey, respectively. The last page was used to ask about the applicability of several different performance measures being suitable as a single performance measure to estimate truck trip quality on each roadway type (Appendix H for the truck driver survey form).

As FTA recommended, a total of 220 truck driver survey forms were provided for distribution at the driving competition. This number was based on the number of registered participants in the event. Of this total, 148 surveys were returned to the researchers. Unfortunately, only 38 respondents out of the total of 148 respondents (25.7%) completed all sections of the survey as directed. Most participants chose to not fill out the survey in its entirety, even though they were instructed to do so. Most respondents may have not taken the surveys seriously, or they might have thought that the survey was a bit long or hard for them to complete, especially the survey sections for relative importance/satisfaction of each factor on each roadway type.

Given these results, it was decided to also conduct an in-field survey data collection effort. With the assistance of FDOT personnel, postage-paid mail-back surveys were distributed at several agricultural inspection stations. For this survey effort, a reduced version of the surveys was prepared in hopes of obtaining a good response rate and a higher level of completion of the surveys. The response rate statistic from the FTDC survey data indicated that the survey sections for relative importance/satisfaction of each factor required the most amount of respondent burden among all the sections in the survey. Most survey participants did not have problems or difficulties filling out the last page on applicability of a single performance measure. Thus, the survey was reduced to three pages in length; the first page for background information, the second page for relative importance/satisfaction of each factor on one of the 3 roadway types (freeways, arterials, or two-lane highways), and the last for applicability of a single performance measure. This survey (one with freeway related factors on the second page) is included in Appendix K. A total of 4000 postage-paid surveys were supplied to the FDOT for distribution at the inspection stations. A total of 1000 surveys were distributed at each of four inspection stations.

The four stations were located at northern border locations, and included:

- Pensacola station on I-10 (West)
- Suwannee station on I-10 (near Live Oak)
- Hamilton station on I-75
- Yulee station on I-95

The previous focus groups indicated that most truck drivers' concerns are on freeways or two-lane highways as alternatives to freeways. A significant portion of their trips are also on freeways, distance-wise as well as time-wise. Thus, of the 1000 surveys distributed at each site, 500 surveys were freeway related (i.e., the second page asked questions about relative importance and satisfaction of factors affecting freeway quality of service), 250 surveys were two-lane highway related, and 250 were arterial related. The research team was informed by FDOT that only about 3 percent of all the truck drivers traveling on the Interstates could bypass the agriculture stations. These vehicles generally include pre-pass users, car haulers, and empty flat beds. The surveys were distributed during the week of August 14–20, 2006. A return date of September 1st was put on the surveys. Most surveys were returned by that date, but some were still received up to a month later. Surveys received after October 1st were not included in the data set because data reduction was complete at that point and analysis had started. A total of 311 surveys were returned by October 1st, yielding a response rate of 7.8%. As shown in Table 3-2, the response rate for the freeway-related surveys was much higher than those for arterials or two-lane highways. It implies that this particular population of truck drivers was more concerned or interested about transportation services on freeways. The completion rate of these surveys was much higher than those from the FTDC. It is likely that the reduced length and greater flexibility of when they could fill them out contributed to this.

According to the advantages and disadvantages of the various survey methods reviewed and discussed in Chapter 2, the phone-based survey method was considered as the most efficient way to survey truck company managers. However, this method was not well suited for this study because it does not allow the respondents to complete the second section of the survey without bias. This section requires the respondents to present their perceptions on the relative importance/satisfaction of each factor among a total of ~18–19 factors. It would be possible only when the respondents can skim through all the factors simultaneously.

With these considerations, truck company managers were surveyed with two different approaches. One method was the in-field survey during the FTDC event. The other method was the postage-paid mail-back survey with a number of trucking companies listed in the FTA membership directory.

A survey data collection effort for truck company managers was made on June 1, 2006 at the Fairgrounds in Tampa, where the truck driving championship was taking place (Figure 3-2). There was a modest crowd present on this day, with a mix of company managers, other truck company employees, as well as family and friends. The research team set up a table with several chairs, covered by a large umbrella. A survey poster describing the purpose and background of this research project was placed on the table to solicit participation of truck company managers (Figure 3-3). The announcers for the driving competition also made several announcements throughout the day about our effort. Eleven truck company managers filled out the surveys, with seven of them answering most of the survey questions as directed (Appendix I for the truck company manager survey form).

For the second survey data collection effort of truck company managers, potential recipients were identified from the FTA membership directory, which contains a list of all carrier and allied members with their affiliation and contact information. All the Florida-based carriers in the directory (a total of 180 trucking companies) were considered as potential survey participating trucking companies. All the allied members were removed from consideration because they do not operate trucks. They support trucking companies by offering various services such as accident investigation, insurance, truck driver training, truck sales or rentals, etc. In the FTA directory, the carriers can be divided into 5 chapters (geographical locations), or 6 conferences (carrier types). A total of 50 Florida-based carriers were selected for the survey using the stratified random sampling procedure that preserves the proportional composition of all the Florid-based carriers in terms of conference and chapter (a total of 30 strata).

A reduced version of the manager survey (one with freeway related factors on the second page) was used (Appendix L). The background section of the manager survey is different from that of the driver survey. For the rest of the sections, the same sets of roadway, traffic, and/or control factors are presented, but questioned differently. For instance, the relative importance of each factor on operating cost, on-time performance, and truck drivers' trip quality were asked respectively in the manager survey, while the importance and satisfaction of each factor on truck trip quality were asked in the driver survey.

Five postage-paid surveys were mailed to each of the 50 FTA carrier members ($5 \times 50 =$ 250 surveys) with a cover letter asking them to distribute the surveys to the managers (transportation, safety, dispatch, logistics, etc.) at their companies (Appendix M for the cover letter). As can be seen in the cover letter, it was mentioned that this study was being conducted with the cooperation of the FTA. It was hoped that this would encourage managers to respond to the survey. Follow-up phone contacts were made to each of the companies to whom surveys were mailed (about one week later) to confirm that they received them and ask for their support in filling them out. Initially, a total of 300 surveys were prepared in case some the 50 carriers do not receive the surveys. Of 50 additional surveys, 5 surveys were resent to one carrier that did not receive the survey and 45 surveys were mailed to 9 different newly-selected carriers. As a result, 27 surveys were obtained from all the Florida regions except for West Florida. Nineteen surveys were from common (for-hire) carriers, 6 from private carriers, and 2 from tank carriers. Table 3-3 shows the number of carriers that participated in the survey from each conference by each chapter, out of the total of 59 carriers. Table 3-4 indicates the number of surveys received from each conference by each chapter, out of the total of 300 surveys.

3.2.4 Data Reduction

It turned out that most respondents completed only parts of the surveys and there was also some evidence that some of the respondents did not pay enough attention to fill out the surveys as directed. The length, or the perceived complexity, of the survey may have kept the participants from completing them correctly. Considering that the purpose of this survey is to potentially identify ways of improving the working environments of the participants, there is no other source of non-response bias expected in this study. Thus, given an overall low response rate, it was decided that in addition to complete surveys, partially completed surveys would be utilized for data analyses once surveys with unreliable responses were screened out according to certain criteria. The usability of survey responses for data analysis was determined for each survey question. Survey data filtering criteria were developed to assess the validity of the survey responses (Appendix N). However, for a few surveys, it was still difficult to determine their validity with the filtering criteria. The research team had to make decisions in those cases through discussions. In that process, the researchers were stricter on the validity of survey responses collected during FTDC than of the postage-paid surveys due to the larger respondent burden to complete the surveys distributed at the FTDC event. Tables 3-5, 3-6, and 3-7 illustrate the number of valid surveys out of total number of returned truck driver surveys from the FTDC event, the postage-paid surveys, and both combined. Table 3-8 describes the number of valid surveys out of the total number of returned manager surveys from all the survey data collection sources.

3.2.5 Data Analysis

A variety of statistical methods were used to analyze the survey data to satisfy the objectives of this study. All the variables observed in the survey were first summarized by descriptive statistics and/or (cumulative) frequency distribution to investigate overall distributions of the responses. The following five statistical methods were applied to the survey data for further analyses: Exploratory Factor Analysis (EFA); Games-Howell multiple comparison test; Kruskal-Wallis test; Mann-Whitney test; and chi-squared test. Exploratory Factor Analysis (EFA) was performed with Relative Importance Score (*RIS*) of all the factors to look for common latent factors that are important to truck trip quality. Each pair of the mean importance of hypothetical truck LOS performance measures for each roadway type was compared with Games-Howell tests to find out which performance measure is more important than others statistically. Potential relationship between each background characteristics of the respondents and their perceptions on each potential truck LOS performance measure was investigated through nonparametric tests such as Kruskal-Wallis test and Mann-Whitney test. Chi-squared test, in particular, was performed to discover potential relationship between each background characteristics of the respondents and their preference on each truck driving time of day.

3.2.5.1 Descriptive statistics

Two most important descriptive statistics were calculated for all the interval-rating and ratio-scale questions; mean and standard deviation. A central tendency of each variable was presented by its mean, while its standard deviation was presented to measure a typical degree of spread of the variable. For nominal (categorical) data, (cumulative) frequency distributions were presented to describe overall distribution of the survey responses. Histograms and scatter plots were used to display the results.

3.2.5.2 Exploratory factor analysis (EFA)

Exploratory Factor Analysis (EFA) is a statistical method to explain a large number of metric variables in terms of their common, underlying dimensions, that is, latent factors. Latent factors are unobserved entities that influence a set of measures (variables) and are extracted from the correlations among the variables. EFA results provide how the variables are grouped into a small number of latent factors from the respondents' perspectives and how much each latent factor is correlated with each of the variables. Factor analysis is a multivariate interdependence technique with which all the variables are simultaneously considered, rather than multiple regression, discriminate or canonical analyses, in which one or more variables are explicitly considered as dependent variables (Hair, et al., 2005). This technique is often used in social science research to summarize the data by identifying a set of latent factors that influence each set of variables, which correlate highly amongst each other. The following seven steps are typically taken to perform EFA (Field, 2005).

Calculation of correlation matrix: The starting point of factor analysis is to create a correlation matrix, in which the inter-correlations between each pair of observed variables are presented. A basic assumption of a factor analytic procedure is that a group of variables that significantly correlate with each other do so because they are measuring the same common, underlying dimension. Thus, if a group of variables seem to correlate highly with each other within the group, but correlate very badly with variables outside of that group, they are considered to well measure a common, underlying dimension, which is called a 'latent factor'. The ultimate objective of the EFA procedure is to reduce the correlation matrix to a factor matrix, which provides the correlations between the latent factors and each of the observed variables (i.e., factor loadings). This can be done by various factor extraction methods that are introduced later in this section.

Factorability investigation: To identify common underlying dimensions that explain the patterns of collinearity among the variables, the observed variables have to be inter-correlated enough to be factorable, but they should not correlate too highly. It is important to avoid multicollinearity (i.e., variables that are very highly correlated) and singularity (i.e., variables that are perfectly correlated) as these would cause difficulty in determining the unique contribution of the variables to a factor.

The communality of a variable is the sum of the loadings of the variable on all extracted factors. This represents the proportion of the variance in that variable that can be accounted for by all extracted factors. Thus, if the communality of a variable is high, the extracted factors account for a large proportion of the variables' variance. This means that this particular variable is reflected well via the extracted factors, and hence the factor analysis is reliable. When the communalities are not high, the sample size has to be large enough to compensate for this. To examine whether the sample is large enough to elicit a meaningful factor solution, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is used. The KMO statistic varies between 0 and 1. A value of 0 represents that the sum of partial correlations is large relative to the sum of correlations, indicating that factor analysis is likely to be inappropriate. A value close to 1 represents that patterns of correlations are relatively compact, so factor analysis should yield distinct and reliable factors. Typically, a KMO statistic value of greater than 0.5 is acceptable to perform factor analysis.

Bartlett's test of spherity tests the null hypothesis that the original correlation matrix is an identity matrix. When the correlation matrix is an identity matrix, there would be no correlations between the variables, eliminating the need for a factor analytic procedure. Thus, this test has to be significant. A significance value (p value) less than 0.05 is usually necessary to justify the factor analytic procedure.

Multicollinearity and singularity problems can be detected by investigating the determinant of the correlation matrix. Usually, it is considered to not be a problem if the determinant is greater than 0.00001.

Extraction of factors: A variety of statistical methods have been developed to extract latent factors from an inter-correlation matrix of the observed variables. They include the principal component extraction method, the principle axis extraction method, the maximum likelihood extraction method, the unweighted least-squares extraction method, the generalized least squares extraction method, the alpha extraction method, and the image factoring extraction method.

The two most commonly used extraction methods are the principle component and principle axis methods. There are three types of variance in the variables: common, specific, and error. Common variance is the variance in a variable which is shared with all other variables in the analysis. Specific (unique) variance is the variance associated with only a specific variable. Error variance is the inherently unreliable random variation. The principle component method finds latent factors that maximize the amount of total variance (i.e., sum of common, specific, and error variances) that is explained, while the principle axis method finds latent factors that maximize the amount of common variance that is explained. The main difference between the two types of methods lies in the way the communalities are used. Communality of a given variable is the proportion of its variance that can be accounted for by extracted factors. In the principle component method, it is assumed that all the communalities are initially one (unities are inserted in the diagonal of the correlation matrix). That is, the total variance of the variables can be accounted for by the extracted factors. On the other hand, with the principle axis method the initial communalities are not assumed to be one (it does assume error variance). They are usually estimated by taking the squared multiple correlations of the variables with other variables. These estimated communalities are then represented on the diagonal of the correlation matrix, from which the eigenvalues are determined and factors are extracted.

Theoretically, when the analyst is primarily concerned about determining the minimum number of factors needed to account for the maximum portion of the variance represented in the original set of variables, and has prior knowledge suggesting that specific and error variance represent a relatively small portion of the total variance, the principle component method is appropriate. In contrast, when the primary objective is to identify the latent dimensions or constructs represented in the original variables, and the analyst has little knowledge about the amount of specific and error variance and therefore wishes to eliminate these variances, the principle axis method is appropriate. Practically, however, both methods are widely used and the solutions generated by each usually do not differ significantly.

Figure 3-4 shows an example of a path diagram for an exploratory factor analytic model by the principle component extraction method. As discussed, this method finds latent factors that maximize the amount of total variance (of the observed variables) that is explained, and it is assumed that there is no error variance. An EFA model is constructed in the way that series of regression equations are set up to summarize its configuration. Equation 3.2 describes an EFA model by the principle component extraction method. Each of the variables is defined as a linear combination of the factors (i.e., sum of the products of each latent factor variable and the factor loading of each observed variable on the corresponding factor). Results from the EFA include derived loadings of each variable on each factor and calculated factor scores for each subject on each factor. The factor scores are a composite measure that can be used for subsequent analyses. When an orthogonal rotation method is used, the scores of the factors can be considered to be independent of each other, and thus can be used as explanatory variables in a multiple regression analysis.

$$V_i = \sum_{j=1}^{k} (A_{ij} \times F_j) \tag{3.2}$$

where,

V_i = i^{th} observed variable (i = 1 to k, k = number of observed variables). These correspond to V1, V2, …, V10 in Figure 3-4.

A_{ij} = a factor loading of the i^{th} variable on the j^{th} latent factor

F_j = j^{th} latent factor variable (a common, underlying dimension, j = 1 to k, k = number of observed variables). These correspond to F1, F2, and F3 in Figure 3-4.

Determination of number of factors to be retained: The maximum number of factors that can be extracted is equal to the number of observed variables. However, the purpose of an EFA is to adequately explain a relatively large number of variables with a small number of factors. Thus, the analyst seeks to identify the smallest number of factors that explain a considerably large amount of variance in the observed variables.

There are several criteria for the number of factors to be extracted, but these are just empirical guidelines rather than an exact quantitative solution. In practice, most factor analysts seldom use a single criterion to decide on the number of factors to extract. Some of the most commonly used guidelines are latent root, percentage of variance, and scree test criteria. With the latent root (eigenvalue) criterion, only the factors having an eigenvalue greater than one are retained. It should be noted that the total sum of eigenvalues from the data is equal to the total number of variables and the variance of a single variable is considered as the eigenvalue of one. Thus, the rationale for the eigenvalue criteria is that any individual factor should account for at least the variance of a single variable if it is to be retained for interpretation. The percentage of variance criterion is a different approach. Using this method, the cumulative percentages of the variance extracted by successive factors is the criterion. It is common in social science research to consider a solution that accounts for at least 60% of the total variance as a satisfactory solution. Another common approach is the scree test criterion. The scree test is derived by plotting the latent roots (eigenvalues) against the number of factors in their order of extraction. The scree plot illustrates the rate of change in the magnitude of the eigenvalues for the factors. The rate of decline tends to be fast for the first few factors, but then levels off. The “elbow”, or the point at which the curve bends, is considered to indicate the maximum number of factors to extract.

Rotation of factors: Once the number of factors to be retained is decided, the next logical step is to determine the method of rotation. The fundamental theorem of factor analysis is invariant within rotations. That is, the initial factor matrix is not unique. There are an infinite number of solutions, which produce the same correlation matrix, by rotating the reference axes of the factor solution. A primary objective of the rotation is to make each variable load highly on only one factor and have nearly zero loadings on the other factors. This simplifies the factor structure and helps to achieve a more meaningful and interpretable solution. The simplest case of rotation is an orthogonal rotation in which the angles between the reference axes of factors are maintained at 90 degrees. Thus, there is no correlation between the extracted factors. A more complicated form of rotation allows the angle between the reference axes to be other than a right angle and is referred to as an oblique rotation. The factors are allowed to be correlated with each other in this type of rotation. Orthogonal rotation procedures are more commonly used than oblique rotation procedures because researchers often try to obtain an independent set of factors to clarify the meaning of each factor. Three major orthogonal approaches are varimax, quartimax, and equamax rotation methods, and two major oblique approaches are direct oblimin and promax rotation methods.

Criteria for the significance of factor loadings: If there are variables that load highly on two or more factors, or do not load highly on any factor, they are excluded from a factor solution because it is not clear which factor(s) has an influence on the variables and this ambiguous relationship between the factors and the variables blur the interpretation of a factor solution. Whether a factor loading of a variable is significant or not depends on the sample size, the total number of observed variables, and the total number of extracted factors. The larger the sample size, the smaller the loading is considered to be significant. The larger the total number of variables, the smaller the loading is considered to be significant. The larger the number of factors, the larger the size of the loading on latent factors is considered to be significant. As a rule of thumb, factor loadings greater than ± 0.5 are considered to be significant when the sample size is 120 or more, and factor loadings greater than ± 0.65 are considered to be significant when the sample size is 70 or more.

Naming of factors: Once the latent factors to be retained, and the variables associated with each of those factors are identified, the analyst attempts to assign some meaning to the factors based on the patterns of the factor loadings. It should be noted that the factor loadings represent the correlation, or linear association, between a variable and the latent factors. Thus, the analyst makes a determination as to what an underlying factor may represent, investigating all the variables' loadings on the factor in terms of their size and sign. The larger the absolute magnitude of the factor loading for a variable, the more important the variable is in interpreting the factor. The sign of the loadings also need to be considered in labeling the factors. It may be important to reverse the scoring of the negatively worded items in Likert-type instruments to prevent ambiguity. That is, in Likert-type instruments some items are often negatively worded so that high scores on these items actually reflect low degrees of the attitude or construct being measured.

As the importance level of each traffic, roadway, and/or control variable was evaluated on a 7-point interval-rating scale, EFA was applied to search for a set of latent factors that accounts for the patterns of collinearity among the variables. The extracted factors and their correlations with observed variables reflect in what respect each variable contributes to truck trip quality and the degree to which the importance of each variable is explained by the underlying latent factors. The principle component extraction method was used to find the set of latent factors that accounts for the maximum amount of variance of the observed variables. The results of the EFA presented a set of extracted latent factors, the percent of trace, that is, the portion of the total variance (of the observed variables) that is explained by each latent factor, and the correlations between each observed variable and latent factor (i.e., factor loadings). It was not possible to apply Confirmatory Factor Analysis (CFA) or Structural Equation Modeling (SEM) statistical techniques to the survey data because no previous hypothetical model construct exists for the truck trip quality issue.

3.2.5.3 Multiple comparison test

When an Analysis of Variance (ANOVA) test verifies that the means of multiple variables (i.e., more than two) are statistically different, multiple comparison procedures are widely used to determine which means are different from one another. Fisher's Least Significance Difference (LSD), Tukey's W, Student-Newman-Keuls (S-N-K), and Duncan's tests are often used (Ott and

Longnecker, 2006), assuming each sample from the groups is selected from a normal population with an equal variance. However, if it is not reasonable to assume equal variance, pair-wise multiple comparison procedures such as Tamhane's T2, Dunnett's T3, Games-Howell, or Dunnett's C tests can be used (Dunnett, 1980).

As the importance of each hypothetical performance measure was evaluated in a 7-point interval rating scale, the Games-Howell pair-wise multiple comparison test was performed to investigate if the differences among the mean importance levels of the performance measures are statistically significant. Normal Quantile-Quantile (Q-Q) plots showed that each sample was approximately normally distributed (Figure 3-5), but the equal variance assumption did not hold according to Levene's tests (Levene, 1960).

Thus, it was necessary to perform the multiple comparison tests with methods that do not rely on the equal variance assumption. The Games-Howell test was performed among the multiple comparison tests with unequal variances to investigate every possible statistical difference in the pair-wise mean comparisons among the groups. The Games-Howell test is the most liberal, meaning that differences between group means are identified as being significant more readily with this test than the other tests. The Games-Howell test is a modification of S-N-K procedure, using the *q* test statistic (i.e., studentized range statistic). Equation 3.3 is used to calculate the test statistic, reflecting heterogeneous variances and sample sizes in the error term in the denominator.

$$q = \frac{\overline{\mu_i} - \overline{\mu_j}}{\sqrt{\dfrac{\dfrac{s_i^2}{n_i} + \dfrac{s_j^2}{n_j}}{2}}} \tag{3.3}$$

where,

q = studentized range test statistic

$\overline{\mu_i}$ = calculated mean of the group *i*

s_i = calculated standard deviation of the group *i*

n_i = sample size of the group *i*

Equation 3.4 is also used to calculate the degrees of freedom for each pair-wise comparison to adjust the error term. The calculated test statistics are compared with critical *q* values with the corresponding degrees of freedom found in the studentized range tables.

$$df = \frac{\left(\frac{s_i^2}{n_i} + \frac{s_j^2}{n_j}\right)^2}{\frac{\left(\frac{s_i^2}{n_i}\right)^2}{n_i - 1} + \frac{\left(\frac{s_j^2}{n_j}\right)^2}{n_j - 1}} \qquad (3.4)$$

where,

df = degrees of freedom for each pair-wise comparison

3.2.5.4 Non-parametric test

The survey respondents' backgrounds were collected from various question types (i.e., ratio-scale, discrete choice, forced ranking, etc.) and their perceptions on the importance of each hypothetical performance measure were evaluated on a 7-point interval rating scale. Thus, ordered probit modeling technique (Greene, 2000) was first applied in an attempt to explore respondents' backgrounds that may explain the variance in their perceptions. However, with the ordered probit modeling, only a small number of potential explanatory variables were found to be statistically significant, resulting in generally poor model fits. The Kruskal-Wallis test and Mann-Whitney test (non-parametric version of Analysis of Variance (ANOVA) and *t*-test) were applied to the data. The use of parametric ANOVA and the *t*-test was not appropriate even though it is more powerful, because it was not reasonable to assume normality and equal variances with the data.

The Kruskal-Wallis test (Conover, 2001) is a non-parametric one-way ANOVA by ranks. It is used with *k* independent groups, where *k* is equal to or greater than 3, and measurement is at least ordinal. The sample sizes across the groups can vary because the samples are independent. The null hypothesis is that the *k* samples come from the same population. The alternative hypothesis states that at least one sample comes from a different population. Following *H* test statistic is used to test the hypothesis.

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3 \times (N+1) \tag{3.5}$$

where,

H = Kruskal-Wallis test statistic

N = total sample size

k = number of independent samples

R_i = sum of the ranks of group i

n_i = sample size of group i

The calculated H test statistic approximately follows a Chi-Squared distribution (χ^2) with $k-1$ degrees of freedom. Thus, for a specified value of α, the null hypothesis is rejected when calculated H value exceeds the critical value of χ^2 for $k-1$ degrees of freedom.

The Mann-Whitney test (Conover, 2001) is a non-parametric *t*-test by ranks. It is used specifically with two independent groups, and measurement is also at least ordinal. The sample sizes between the two groups can vary because the samples are independent. The null hypothesis is that the two samples come from the same population. Following *z* test statistic is used to test the hypothesis.

$$z = \frac{U_{\min} - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (N+1)}{12}}} \tag{3.6}$$

where,

z = Mann-Whitney test statistic

$U_i = U_{\min}$ number of independent samples

$U_{\min}$ = minimum of U_1 and U_2 (U_i = sum of the ranks of group *i*)

n_1 = sample size of group 1

n_2 = sample size of group 2

N = total sample size (= $n_1 + n_2$)

The calculated *z* test statistic follows a normal distribution. The null hypothesis is rejected when the calculated *z* value exceeds the critical value of *z* for a specified value of α.

3.2.5.5 Chi-squared test

The perceptions of the respondents on the preferred truck driving times of day were investigated with a binary choice question type. Binary logit modeling technique was first tried to explore respondents' backgrounds that are correlated with the perceptions on their preferred truck driving times of day. However, only a small number of potential explanatory variables were statistically significant, again yielding poor model fits. A chi-squared test (Ott and Longnecker, 2006) was performed for each individual background characteristic to investigate whether their perceptions are dependent on it. The null hypothesis is that the respondents' background and their perceptions are independent. The alternative hypothesis is that they are dependent; that is, the perceptions of the respondents on truck driving time of day preference vary by their specific background. The two variables are categorized in a two-way frequency table, and then the χ^2 test statistic is calculated to test the hypothesis as shown in Equations 3.7, 3.8, and 3.9.

$$\chi^2 = \sum_{i,j}\left[\frac{\left(n_{ij} - E_{ij}\right)^2}{E_{ij}}\right] \tag{3.7}$$

where,

n_{ij} = observed number of measurement in the cell for the i^{th} row and the j^{th} column

E_{ij} = expected number of measurement in the cell for the i^{th} row and the j^{th} column

$$df = (r-1)\times(c-1) \tag{3.8}$$

where,

df = degrees of freedom

r = number of rows in the two-way table

c = number of columns in the two-way table

$$E_{ij} = \frac{R_i \times C_j}{N} \tag{3.9}$$

where,

R_i = total sum of the number of measurements in the cells of the i^{th} row

C_j = total sum of the number of measurements in the cells of the j^{th} column

N = total sum of the number of measurements in the two-way table

The null hypothesis is rejected when the calculated χ^2 value exceeds the critical value of χ^2 for a specified value of α.

3.3 Truck LOS Measurement

The ultimate objective of this study is to recommend effective methodologies to develop a mathematical model to estimate LOS for trucks on Florida roadways. This section describes what steps are required to satisfy the objective and how each step could be performed to complete the study. The first step is to determine one or two performance measures, or multiple factors, upon which truck LOS on a specific roadway type can be adequately assessed. It is preferable to specify just one or two performance measures to simplify truck LOS estimation methodologies, but if it is not possible, diverse important factors should be simultaneously factored into the development of the methodologies. The focus group and survey studies of this study were conducted for this purpose. Once the truck LOS determinants are identified for each roadway facility type, some experimental data are required to develop mathematical truck LOS estimation models through appropriate statistical analysis methods. Several different approaches can be considered to for the data collection. Given the data, the correlations between the truck LOS determinants and the truck drivers' perceptions of LOS could be measured by appropriate statistical modeling techniques to develop truck LOS estimation models, which will then be used to predict truck LOS on a specific route.

The final truck LOS estimation models should reflect perceptions of most truck drivers working in Florida and be easily applicable to most Florida roadways. It is preferable to select explanatory variables, which are simply measurable with the data obtained from the performance monitoring system of FDOT.

3.3.1 Truck LOS Service Measures

It was indicated in the focus group studies that what is important for LOS perceived by the trucking community varies by different roadway types. This means that truck LOS service measures (or truck LOS determinants) should differ according to the type of roadway that truck drivers travel on as current HCM represents (Table 3-9). This study identified the truck LOS service measures (or truck LOS determinants) for each roadway type from the focus group and survey study results. The two different approaches were considered to perform this task.

3.3.1.1 Single performance measure approach

It may be possible to represent overall perceptions of truck drivers on truck trip quality only by one or two important truck driving or traffic condition effectively. As shown in Table 3-9, the current HCM uses one or two performance measures to determine LOS on a specific roadway type for all the vehicles in a traffic stream. Several important truck driving conditions for each roadway type were postulated from the previous focus group studies and evaluated in the survey study as to how each of these conditions is solely applicable to assess truck trip quality. It was intended to investigate if there are any one or two performance measure(s) that may be used as truck LOS service measure(s) on a specific roadway type. Such performance measures may be measured from the field directly, or derived from data obtained by the performance monitoring system of FDOT.

3.3.1.2 Multiple variable approach

If the perceptions of truck mode users on truck trip quality have multidimensional characteristics; that is, it is not appropriate to represent them with just one or two performance measures, the truck LOS estimation model should reflect various natures of truck operations. The model may be expressed as a function that yields an LOS index value based upon a number of independent variables (e.g., flow, speed, number of lanes, pavement condition, etc.) and their corresponding coefficients. The experimental data to calibrate truck LOS estimation model should include the factors identified as important in the focus group and survey studies as well as LOS perceptions of a sample of truck drivers. The final model may use only the variables showing significant effects on truck LOS in the experimental data.

3.3.2 Truck LOS Estimation Model

Once the truck LOS performance measure(s) (or truck LOS determinants) are identified, experimental data are required to calibrate truck LOS estimation model for each roadway type. The following four different approaches can be considered to collect the experimental data: video simulation; vehicle simulator; in-field driving experiment; and truck operational data from a trucking company. In the experiments, various scenarios with different levels of the factors should be tested with a representative sample of truck drivers in Florida. The selected truck drivers experience maneuvering a truck directly or indirectly in each of the scenarios, and then rate it in terms of their trip quality. The results of the experiments should be analyzed with appropriate statistical modeling techniques to develop truck LOS estimation models, which will be used to predict LOS on a specific route for trucks.

3.3.2.1 Data collection

Experimental data to calibrate truck LOS estimation models can be collected by video simulation, vehicle simulator, in-field driving experiment, or truck operational data from a trucking company. In a video simulation experiment, a truck driver' views are video-recorded while he/she is actually experiencing various driving conditions in the field. It is required to prepare enough number of video clips reflecting various traffic and roadway conditions for the experimental purposes. The collected videos are displayed to a sample of truck drivers so that they rate each video clip in terms of their trip quality. It may be impossible for the drivers to experience the pavement quality of a road with this method. A driving simulator may also be used for the same purpose, but it is not known whether any truck driving simulator exists. Most driving simulators are designed to mimic passenger car driving environment. If available, it may reflect more realistic driving environments in that the participants are able to manipulate their vehicle speed and directions, but programming enough number of scenarios to be displayed may pose a challenge and a pavement quality is difficult to be simulated. The in-field driving approach probably provides a best set of data because participants are exposed to the actual truck driving environment before evaluating LOS on the transportation facility. However, replicating field conditions is very difficult, and it is dangerous to be in the field. Huge recruiting efforts are required as well. It was indicated from the focus group discussion that some truck companies collect truck operational data (e.g., travel time) from a GPS system equipped in their trucks. The data are regularly updated and used to reflect current truck driving condition for future truck route and departure time selection. If possible, the data supplemented by other traffic and roadway field data may be used to calibrate truck LOS estimation model. In this case, the perceptions of the truck drivers on LOS of their trip should be asked at their arrival. Advantages and disadvantages of the four experimental data collection methods are summarized as follows.

Video simulation: This approach has shown promise in other studies. However, it may be more difficult to implement from a truck drivers' perspective. This approach also has limitations with regard to accurately reflecting pavement condition, which is a major concern for truck drivers.

Vehicle simulator, using truck cab:

- Pavement quality could be simulated.
- Motion sickness a significant issue for participant recruiting.
- Programming the required number of scenarios to be displayed may be very costly.

In-field driving experiment:

- May provide most accurate feedback from participants.
- Difficult to replicate desired traffic conditions for each participant at each location
- It can be difficult to find all the various experimental conditions in the field.
- Huge recruiting effort is required.

- Having a truck company allow researchers to travel along on previously planned trips, and ask questions during the trip, may be a potential data source.

Truck operational data from a truck company:

- It was indicated from focus group discussions that some truck companies use an onboard recording system for speed data to regularly update expected travel time on the routes.
- Truck driver focus group participants stated that most trucks are equipped with GPS and controlled by computers.
- It may be possible that some truck operational data required to develop LOS models can be obtained while truck drivers make real deliveries.
- However, some supplemental data will probably still need to be collected along the specific truck routes, such as general traffic stream variables (e.g., speed, volume).

3.3.2.2 Statistical modeling

The contemporary transportation community has widely adopted LOS estimation procedures provided by HCM as the primary means of measuring system performance of each type of facility. The six LOS values defined through the procedures range from ‘A’ to ‘F’, with ‘A’ representing ‘very good operating conditions’ and ‘F’ representing ‘very poor operating conditions’. To be consistent with this representation, truck drivers participating in the experiment should be asked to rate their trip quality with one letter designation from ‘A’ to ‘F’ (or an equivalent numerical scale, such as 1–6). Statistical modeling involves correlating the response variables (i.e., LOS values) with multiple factors contributing to truck trip quality. Given the fact that the values of the response variables are ordered, and discrete, ordered discrete choice modeling techniques (i.e., ordered logit or ordered probit modeling) may be appropriate to develop the truck LOS estimation models. Washburn and Kirschner (2006) used ordered probit modeling technique to develop rural freeway LOS estimation models. The final models should provide truck LOS predictions on various roadways as single letter designations, given all the necessary explanatory variables.

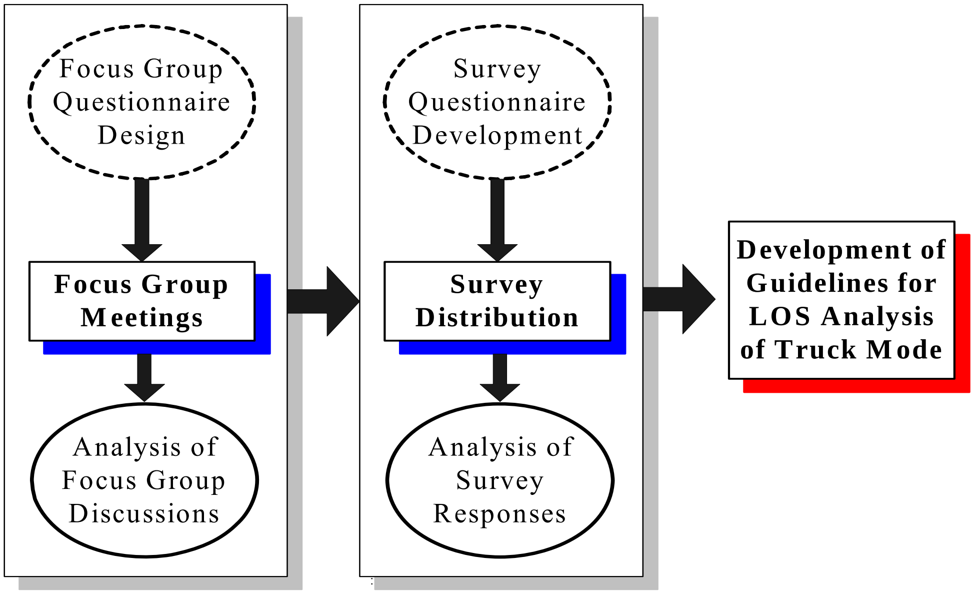


Figure 3-1. Research Approach

Table 3-1. Survey Development

Survey Issues	Question Types	Analysis Methods
Background Characteristics	Various Question Types	Descriptive Statistics, Frequency Distributions
Preference on Truck Driving Times of Day	Discrete Choice	Frequency Distributions, Chi-squared Tests
Relative Importance/Satisfaction of Each Factor on Truck Trip Quality	Relative Interval Rating	Descriptive Statistics, Exploratory Factor Analysis (EFA)
Relative Importance of Each Category of Factors on Truck Trip Quality	Forced Ranking	Descriptive Statistics, (Cumulative) Frequency Distributions
Applicability of Single Hypothetical Performance Measure to Estimate Truck Trip Quality	Interval Rating	Descriptive Statistics, Multiple Comparisons of the Means, Non-parametric Tests
Relative Improvement Priority for Each Type of Roadway Facility	Forced Ranking	Descriptive Statistics, Frequency Distributions

Table 3-2. Postage-Paid Truck Driver Survey Response Rates (number of surveys returned/number of surveys distributed)

	Roadway Types		
Issues on the Second Page of the Survey	Freeways	Urban Arterials	Two-lane Highways
Response Rate for Each Type of Survey	187/2000 (9.35%)	66/1000 (6.6%)	58/1000 (5.8%)
Overall Response Rate	311/4000 (7.78%)		

Figure 3-2. Truck Driving Competition Course

Figure 3-3. Survey Table Setup at Truck Driving Competition

Table 3-3. Survey Participation of the Selected Carriers by Each Conference and Chapter (number of carriers from whom the surveys were received/number of carriers to whom the surveys were distributed)

	Chapter					
Conference	Central West	North Florida	South Florida	Central East	West Florida	Total
Dump Truck Carriers	0/0	0/1	0/1	0/1	0/0	0/3
Common Carriers	5/8	3/7	1/5	2/3	0/2	11/25
Household Goods Carriers	0/0	0/1	0/0	0/0	0/0	0/1
Private Carriers	2/9	1/5	2/2	1/3	0/3	6/22
Special Riggers	0/0	0/1	0/1	0/1	0/0	0/3
Tank Carriers	1/2	0/1	1/1	0/1	0/0	2/5
Total	8/19	4/16	4/10	3/9	0/5	19/59

Table 3-4. Survey Collection by Each Conference and Chapter (number of surveys received/number of surveys distributed)

	Chapter					
Conference	Central West	North Florida	South Florida	Central East	West Florida	Total
Dump Truck Carriers	0/0	0/5	0/5	0/5	0/0	0/15
Common Carriers	9/40	5/35	2/25	3/15	0/10	19/125
Household Goods Carriers	0/0	0/5	0/0	0/0	0/0	0/5
Private Carriers	2/50	1/25	2/10	1/15	0/15	6/115
Special Riggers	0/0	0/5	0/5	0/5	0/0	0/15
Tank Carriers	1/10	0/5	1/5	0/5	0/0	2/25
Total	12/100	6/80	5/50	4/45	0/25	27/300

Table 3-5. FTDC Truck Driver Survey Data Usability (number of valid surveys / total number of surveys received)

	Roadway Types		
Issues	Freeways	Urban Arterials	Two-lane Highways
Relative Importance of Each Factor	58/148	43/148	36/148
Relative Satisfaction of Each Factor	66/148	56/148	43/148
Relative Importance & Satisfaction of Each Factor	54/148	39/148	33/148
Relative Importance of Each Factor Category	40/148	34/148	37/148
Applicability of Hypothetical Single Performance Measure	116/148	115/148	116/148
Relative Transportation Service Improvement Priority		25/148	

Table 3-6. Postage-Paid Truck Driver Survey Data Usability (number of valid surveys / total number of surveys received)

	Roadway Types		
Issues	Freeways	Urban Arterials	Two-lane Highways
Relative Importance of Each Factor	108/187	33/66	33/58
Relative Satisfaction of Each Factor	121/187	41/66	35/58
Relative Importance & Satisfaction of Each Factor	105/187	29/66	31/58
Applicability of Hypothetical Single Performance Measure	273/311	272/311	269/311

Table 3-7. Overall Truck Driver Survey Data Usability (number of valid surveys / total number of surveys received)

Issues	Roadway Types: Freeways	Roadway Types: Urban Arterials	Roadway Types: Two-lane Highways
Relative Importance of Each Factor	167/335	76/214	69/206
Relative Satisfaction of Each Factor	187335	97/214	78/206
Relative Importance & Satisfaction of Each Factor	159/335	68/214	64/206
Relative Importance of Each Factor Category	40/148	34/148	37/148
Applicability of Hypothetical Single Performance Measure	389/459	387/459	385/459
Relative Transportation Service Improvement Priority		25/148	

Table 3-8. Overall Truck Company Manager Survey Data Usability (number of valid surveys / total number of surveys received)

Issues	Roadway Types: Freeways	Roadway Types: Urban Arterials	Roadway Types: Two-lane Highways
Relative Importance of Each Factor on Operating Cost	33/38	7/11	7/11
Relative Importance of Each Factor on On-Time Performance	34/38	8/11	8/11
Relative Importance of Each Factor on Truck Drivers' Trip Satisfaction	36/38	9/11	8/11
Relative Importance of Each Factor Category	7/11	6/11	5/11
Relative Importance of Each Aspect of Truck Driving Condition	35/38	33/38	34/38
Relative Transportation Service Improvement Priority		5/11	

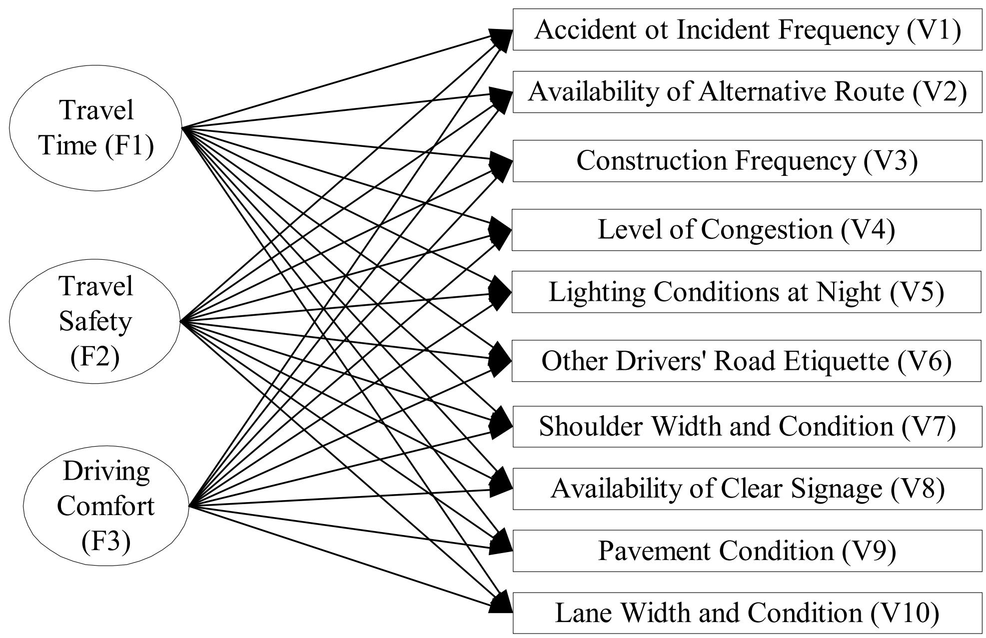


Figure 3-4. Example of a Path Diagram for an EFA Model by Principle Component Extraction Method

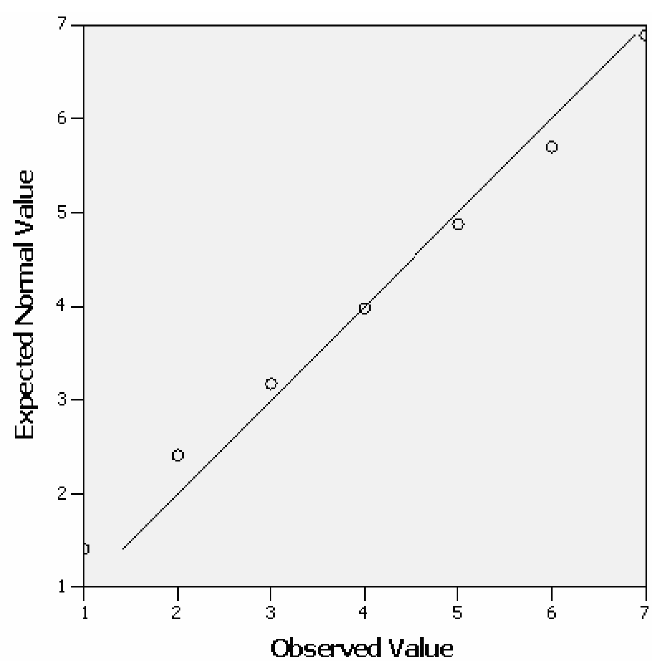


Figure 3-5. Normal Q-Q Plot of the Importance of 'Ease of Obtaining Useful Traveler Information' on Freeways

Table 3-9. Current HCM Service Measures used for LOS Determination

Roadway Types	Service Measure for all the vehicles in a traffic stream
Freeway (Basic Segment)	Density
Multilane highway	Density
Two-lane highway	Average Speed, Percent-Time-Spent-Following
Urban arterial	Average Speed

CHAPTER 4
FOCUS GROUP STUDY RESULTS

This chapter summarizes the findings from the three focus group meetings held for this study. The perceptions of drivers and managers are presented separately to be compared to each other. The factors important to the following four issues are listed and discussed in order: truck route and departure time selection, truck trip quality, improvement priority of transportation services and truck delivery schedule reliability. The factors contributing to quality of a truck trip are clustered by each type of transportation facility.

4.1 Perceptions of Truck Drivers

The following section describes the study results from the two focus group meetings with truck drivers. A total of nine drivers participated in the meetings; one with five drivers and the other with four. Seven drivers were from the for-hire Less-than-Truck Load (LTL) carriers delivering various types of goods, while the other two were from private Truck Load (TL) operators carrying mainly foods. They all have truck driving experience of more than 15 years, with their ages ranging from 40 to 59 years. Seven of the participants were FTA Road Team members. The Road Team members, in particular, were very concerned with safety issues, as one of their important duties is to give safety demonstrations to the public. The socio-economic and working characteristics of the participants were collected through a background survey (Appendix E for the survey results). The text presented in this section only includes summaries and paraphrasing of the comments made by the focus group participants. Thus, all the statements are a reflection of the focus group participants' perceptions, not the personal opinions of the author.

4.1.1 Truck Route and Departure Time Selection

For most truck drivers, truck route and departure time decisions are made by the managers at their trucking companies, based primarily on travel safety, time, and distance. However, when truck drivers run into adverse weather or abnormal traffic or roadway conditions (e.g., severe congestion, low overpasses) on designated routes, they may call the central dispatch office to obtain permission to change routes. Some drivers select their own routes to meet the delivery times set up by their trucking companies. They choose what they believe to be the best route for the times. City drivers, especially P&D (Pick-up and Delivery) drivers pick the routes by themselves for the most efficient delivery. They try to minimize back tracking situations by coordinating the order in which their trailers are loaded with the delivery times appointed for each customer. Some owner-operators (independent truck drivers) have designated routes by which they get paid. They need permission to deviate from the designated routes in order to still get paid for those different routes.

Truck company managers typically use a routing software program to find the shortest route with respect to either time or distance. They also consider overall truck operating cost, travel time variability, driver comfort, etc. to ultimately choose the most efficient route for their trucking business. That is, the shortest routes may not be selected if significant chances of safety problems (e.g., narrow lane or shoulder widths, pedestrians or wildlife crossing) or excessive cost (e.g., fuel, toll) are involved in traveling the routes. Truck drivers usually are not allowed to change designated routes to travel on toll roads unless they have a really important shipment, or the designated routes are completely blocked at the time of delivery (e.g., I-4 shut down due to crash investigation activities). It may be more important for LTL drivers than for TL drivers to stay on the designated routes. They have other potential destinations along the routes that their trucking companies may want them to reach during the deliveries. The new reduced hours of service (amounts of time truck drivers can travel per day) also discourage the LTL drivers from changing routes. Drivers that decide on their own to change routes can be held responsible if they were not able to make deliveries and come back to the base within the hours of service. Truck company managers also like to keep their drivers on routes that keep them within cell phone communication range.

Most truck drivers prefer to travel on freeways as much as possible because of their shorter travel times and better perceived safety level. They try to stay off "back roads" (e.g., two-lane highways, arterials), unless they happen to be much shorter in traveling distance. From hub to hub, most trucking facilities are located on or near the interstates, reducing the need of truck drivers to travel on the back roads. A lot of back roads are not well suited for accommodating large, heavy trucks, especially double trailers. Truck drivers can get stuck on those back roads when they have to back up or turn around. They sometimes get a little nervous with low bridges, small towns (e.g., short turning radii), animals, frequent stop lights, or unexpected pedestrians. Nevertheless, they will definitely utilize the back roads when there is an accident or other unexpected event on the freeway that brings about considerable delay. Back roads serve a vital role today in the transportation system due to the increasing delays caused by the ever growing traffic volume and construction activities on Florida's interstates. Of the back roads, most truck drivers prefer traveling on multilane highways rather than two-lane highways due to a perceived higher level of safety.

Trucking companies set up the loads to be delivered at a specific time or within a time window. Truck company managers typically use an average speed of 47 mph in their calculations for travel time. This speed takes into account the various stops (e.g., fuel) that a driver may make during their trip, as well as occasional slow downs due to traffic congestion. If traffic conditions are not severe, use of this speed value usually results in ample time for the drivers to reach their destination on time.

4.1.2 Factors Affecting Truck Trip Quality

The three most important concerns of truck drivers for evaluating the quality of a truck trip are the perceived safety level, driving comfort, and total travel time. The factors contributing to those concerns vary by which type of roadways truck drivers travel on (e.g., freeways, 2-lane highways, etc.). Truck lane restrictions, speed differential between trucks and cars, motoring public's attitudes, level of congestion, and construction activities affect their perception of truck trip quality on freeways the most, while physical roadway conditions such as shoulder widths and condition, curb radii, lane widths, pavement condition are the most important determinants on their perceived truck trip quality on arterials or two-lane highways. The motoring public's knowledge and attitude about trucks and truck drivers are important to truck drivers regardless of the roadway type, but their effects on the perceived quality of a truck trip is greater on freeways than on the other facilities. Truck drivers are also sensitive to the potential presence of pedestrians, wildlife, or farming equipment on two-lane highways for safety reasons.

4.1.2.1 Factors affecting truck trip quality on freeways

Consistently good traffic flow and safety are the two major factors considered to determine truck trip quality on freeways. Truck lane restrictions, speed differential between trucks and automobiles, the motoring publics' attitude and knowledge of truck driving, etc. influence the traffic flow and safety condition of a freeway. Most truck drivers are very satisfied with the lighting conditions on Florida's freeways, especially at the interchange areas. The frequency and timing of construction activities are other major concerns of truck drivers.

Truck lane restrictions: No trucks are allowed in the left-most lane on some interstate highways in Florida. Truck drivers feel that the truck lane restriction makes the overall traffic flow worse and is also an unfair policy for truck traffic. Truck drivers have difficulty in consistently maintaining a desired speed in the right-side lanes. They often have to drive in a traffic stream where some passenger cars travel much slower than other cars or others cut in their way to merge into or diverge from the freeway. It is difficult for drivers of large trucks with low acceleration and deceleration capabilities to travel comfortably within the traffic flow with all the slow vehicles and merging or diverging traffic, especially with the maneuverability of passenger cars being much better. In addition, much of the motoring public does not know how to drive around trucks safely. Truck drivers need to always be attentive to their often abrupt behaviors. On the other hand, large trucks traveling in the right-side lanes make it more difficult for the passenger car drivers to find a safe gap to merge on to or off of the freeway. When a line of large trucks are formed behind slow vehicles, maneuverability of the passenger cars is limited to a great degree. During the peak hours, traffic in the right-side lanes is extremely congested with a considerable amount of on- and off-ramp traffic. Some independent truck drivers get really impatient and go around the right-side lanes by using the left-most lane to maintain their high desired speed even though it is not allowed. They usually get paid by every mile and/or for a drop. Shortening travel time and distance would be more important for them than for other truck drivers. Those drivers run right behind other truck drivers, flashing their lights to get them move out of their way.

Speed differential between trucks and autos: The major truck companies restrict the maximum speed of their trucks for safety and fuel economy through the use of engine governors. This maximum speed is usually around 65 mi/h. Independent truck drivers typically do not use speed governors; thus, their maximum speed is usually much higher than 65 mi/h. Additionally, some states, though not Florida, have implemented a lower posted speed limit on the freeways for trucks than passenger vehicles. This truck speed limit is usually 5 or 10 mi/h lower than the passenger vehicle speed limit. Whether by engine governing or speed limit posting, truck drivers strongly oppose these speed differentials. They feel that a safe and efficient traffic flow is greatly hampered by the speed differential between trucks and other vehicles. It is hard for truck drivers to consistently maintain a safe following distance with the restricted speed limit. They often get tailgated or meet other drivers cutting in front of them.

Motoring public's attitudes: The motoring public often has a negative impression of trucks and truck drivers even though they are carrying goods necessary for the public's lives. Courteous driving behavior by the motoring public is important to the quality of a truck trip. Passenger vehicle drivers often get aggressive around large trucks, not knowing or ignoring the characteristics and limitations of truck driving. They should be cautious and knowledgeable enough to mingle with large trucks in a traffic stream safely. In this respect, it is important to publicize the importance of the trucking industry to our society and educate the motoring public about how to safely drive around large trucks in the traffic stream. Many passenger car drivers just want to go faster than everybody else. A big crash often occurs with their unpredictable aggressive driving behavior around trucks.

Truck-only lanes: The designation of truck-only lanes is a good idea only if they are in the left-hand lanes. When truck-only lanes are designated to the right-hand lanes on freeways, it may just result in restricting the truck drivers' use of all the other lanes on the left side. Other types of vehicles still have to use the right-hand lanes for getting on and off the freeways, and this weaving activity around the trucks can pose a significant safety hazard.

A couple of drivers provided a specific example in Chicago on I-94. Along this freeway is 5 or 6 lanes in each direction. The right two lanes are for trucks only. Truck drivers cannot use the 3 or 4 lanes on the left side (the penalty for using them is $250 and 3 points). Truck drivers travel at a low speed of about 30–35 miles per hour constantly in the right two lanes on the freeway because of the number of merging and diverging drivers and their aggressive driving behavior, and increased truck density. They try to maintain a safe following distance. As a result, many truck drivers try to avoid this section of the freeway if possible.

Truck drivers would like to have more alternative routes, preferably some that only allow trucks on them. The truck-only routes could relieve the congestion on the freeways, improving traffic flow to a great degree by separating trucks from other vehicle types.

Frequency of rest areas: Long-haul drivers often need to take a rest or get some sleep at rest areas or truck plazas. However, there are generally not enough rest areas or truck parking spaces along the freeways. In South Florida, the nearest place for drivers to park is at a mile marker 130. There is no truck parking facility south of this mile marker.

Frequency and timing of construction activities: More and more construction activities are being planned and conducted on major Interstates in Florida. Truck drivers choose to save travel time by taking back roads rather than traveling on the freeways with frequent construction activities. This makes the transportation service improvements on the other facilities (e.g., two-lane highways, multilane highways, or arterials) more important. They also want construction activities to be scheduled to avoid holidays or major activities like racing days in Daytona.

Traveler Information Systems (TIS): Truck drivers appreciate the availability of TIS such as Variable Message Signs (VMS), Highway Advisory Radio (HAR), Citizen Band Radio (CBR), XM radio (a satellite radio service), 511 (America’s traveler information phone number), etc. However, they would like to hear more than just current traffic and roadway conditions or expected travel time on their route or greeting messages. They want to be informed of better ways to reach their destination when the driving condition on their traveling route is expected to be poor, considering travel time and/or safety. The extensive use of XM radio for TIS is recommended in that a significant portion of truck drivers listen to the traffic channels on the radio. Additionally, truck drivers look forward to using the 511 service all over the state of Florida, not just in the Tampa region.

4.1.2.2 Factors affecting truck trip quality on urban arterials

The perceived quality of a truck trip on arterials primarily depends on physical roadway conditions, in terms of safe and efficient through or turning movements of trucks. These factors generally include curb radii, lane and shoulder widths, locations of trees, poles, street hardware, and utility lines. The roadway infrastructure in some old towns was not designed to accommodate many of the larger trucks on the road today. Truck drivers also want to minimize stops and delays while traveling along an arterial. The control factors such as traffic signal spacing, yellow interval signal timing, traffic signal responsiveness and coordination were all mentioned by the drivers as influencing their perception of the quality of their trip. Availability and condition of signage and marking are important for guidance to their destination. Other drivers' behavior is also considered to have an impact on truck trip quality on arterials.

Ease of turning maneuvers: The main concern of truck drivers on arterials is the difficulty in making turning movements. Inadequate curb radii, misplaced trees and poles on corners, improper locations of stop lines at intersections, and the motoring public's poor attitudes about trucks and truck drivers are the primary factors affecting this concern. The new areas of a town usually have wide enough roads and intersections for P&D (Pick-up and Delivery) drivers to make a turning maneuver, but most old parts of a town are not physically suitable to accommodate truck traffic. It is easier for truck drivers to make a left turn with a protected left turn traffic signal than to make several right turns to go left. If a left turn signal phase operates as permitted only, it is hard for truck drivers to find a large enough gap to clear the intersection. When there is a very wide median along an arterial, they could do a two-stage maneuver to make a left turn instead of waiting long for both ways to be cleared. Inexperienced drivers are much more likely to have an accident making a left turn than a right turn because they are naturally inclined to thinking that left turns are not difficult. They are relatively easier than right turns, but still not easy. At many intersections, there is not enough room on the right side of a truck for a safe right turn to be made. It is also hard for truck drivers to notice bicyclists or pedestrians crossing on the right side of a truck. Truck drivers will not attempt to make a U turn unless it is absolutely necessary. It is considered to be a very high-risk maneuver. Truck drivers are generally opposed to closing medians for access management purposes, as this usually increases the odds of having to make a U-turn. They would much rather have access to and from their destination driveway through a traffic signal.

Level of congestion: The congestion level of an arterial is closely related to the quality of a truck trip. As the roads get crowded with cars, bikes, or pedestrians, truck drivers have more difficulty driving safely at a desired speed. They experience more delay and stop-and-go conditions. It also gets hard for them to change lanes or make turns. As the congestion level of a road goes up, the more concerned truck drivers become with the safety conditions of the arterial.

Number of stop-and-go conditions: It requires a lot more attention and effort to stop and re-maneuver a truck than any other vehicle on the road. Thus, truck drivers are reluctant to travel on an arterial with heavy traffic or short intersection spacing.

Familiarity of the roads: Truck drivers are more likely to run into problems when they travel on arterials they have never been on. They might encounter such physical constraints as inadequate curb radii, low overhanging trees, misplaced poles and trees at the corner, etc, or may have difficulty locating their delivery destination.

Signage conditions: Missing or poorly maintained street name or truck route signs are a source of concern for truck drivers. Also, sign positioning can restrict sight distance in some instances. One driver gave a specific example of being stopped at the end of an exit ramp and a street sign blocking their view of oncoming traffic from the left. If the ramp is not signalized, they are forced to pull further in front of the sign and put their bumper out into traffic.

Motoring public's attitudes: The general motoring public are either unaware of the characteristics of truck driving or just ignore them when they are driving on arterials. The majority of them do not know that there is a blind spot on the right side of trucks when truck drivers are making a right-turn maneuver. They just try to sneak in every space they can find around the trucks in order to get by them as fast as possible. The motoring public sometimes stops beyond the stop lines at intersection approaches, either through ignorance or indifference, and thus making it very difficulty for trucks to make a turning maneuver from an adjacent approach. In these cases, a truck driver will often find themselves needing to back up at some point during the turning maneuver. However, it is very dangerous for truck drivers to back up and many drivers will not do it, instead opting to just wait for the other vehicle drivers to make space, even if their truck is blocking the intersection. The motoring public should understand the limitations of truck driving and give trucks plenty of room, but they often try to use all the space around the trucks to go faster. Educating the motoring public to understand and support truck operations on arterials is essential as the volume of truck traffic continues to grow in Florida.

Trees, electrical lines: Truck drivers need to be more alert for overhead and side objects, such as low hanging trees, power lines, TV lines, telephone lines, and street furniture, on arterials than on the open highway. Trees seem to be becoming a more popular arterial roadside feature, but are just problematic for truck drivers, as they often damage their trailers by colliding with branches. Truck drivers are especially not fond of tree canopy roads.

Length of yellow interval signal timing: Truck drivers prefer to have longer yellow intervals for clearing the signalized intersections safely. They are apt to be in a predicament if they decide to run through the intersections at the moment when the light changes to yellow. Stopping before entering the intersection is difficult with the poor braking capabilities of the truck, and clearing the intersection with the large size of their vehicles before the conflicting movements begin takes several seconds. Additionally, very short green intervals (of just a few seconds) are very undesirable. Unless they are first in queue, there is little chance for them to accelerate in time to clear intersection. At signalized intersections near highway-railroad grade crossings, truck drivers often have to run the red light to avoid stopping on the tracks. The loop detectors are usually located at the clear storage distance areas that can only accommodate passenger cars. Thus, trucks cannot be in the right position to trigger a green signal.

Traffic signal responsiveness: During the late night hours, drivers sometimes have to wait a long time at an intersection approach for the green signal even when there is no other traffic on the other approaches. The traffic signals need to respond to the approaching vehicles to eliminate unnecessary delay. It is also important to assign green signals fairly to all the vehicles approaching an intersection. Truck drivers are likely to get more impatient when the green signal assignment seems unfair to them.

Truck lane restrictions: Trucks are restricted to the right-hand lanes at many towns in Florida. When traffic is backed up and trucks are lined up in the right hand lane at a signalized intersection, only 2 or 3 trucks can get through the intersection within one traffic signal cycle due to their low acceleration capabilities. The passenger car drivers behind the trucks probably get frustrated, especially the right turners.

4.1.2.3 Factors affecting truck trip quality on two-lane highways

Truck drivers generally do not like to travel on two-lane highways. It usually exposes them to additional safety hazards, while not saving them any travel time relative to the freeways. However, they do often use two-lane highways when there are accidents or construction activities on the freeways. They also use them to go around some routinely congested stretches of freeways. Sometimes, they are the only route to their destination. The importance of two-lane highways is increasing with the increase of growth and interstate traffic in Florida. Truck drivers are most concerned with the physical roadway conditions for the quality of a truck trip on two-lane highways. The lane and/or shoulder widths are often too narrow to provide truck drivers with much room for error. Even 12-feet of lane width (the standard lane width) are considered narrow for these roadways. And if they should encounter a problem and need to pull off the road, many two-lane highways have either no shoulder or a narrow shoulder. Even for locations with a shoulder, it is often not paved, and in wet weather, will be too soft to support the weight of a loaded truck and trailer. Some truck drivers routinely encounter pedestrians, bicyclists, farming equipment, or wildlife crossing on two-lane highways that pose a safety hazard. Additionally, when a low speed vehicle is encountered, the only way to pass is usually in the oncoming lane, which truck drivers are very reluctant to do. Thus, their perceived trip quality deteriorates rapidly in this situation.

Shoulder width and condition: Many stretches of two-lane highway contain no shoulder at all. For other locations that include a shoulder, it is often not wide enough to park a truck on (in case of emergency) without partially blocking the travel lane. This can be a very dangerous situation for both the truck driver and passing passenger vehicles. Additionally, paved shoulders are strongly preferred. Some drivers recalled stories of when they pulled their truck off onto an unpaved, wet shoulder. In some instances, the shoulder was so soft that their truck tipped over, and thus two trucks were needed to remove it; one to stand it up and the other to pull it out. Many two-lane highways also have large drainage ditches on the side of the road. Truck drivers feel it is less risky to travel on multilane highways than on two-lane highways because the shoulders on most multilane highways are wider and better paved.

Crowning condition: Some roads are reverse crowned or have a significant side slope, which makes it more challenging for the driver to keep the truck from steering onto the shoulder or into the opposing lane.

Pavement condition: Some roads are grooved and not maintained properly. There is only a little pavement or patches along the roads. The poor pavement condition makes the tires wear out faster and inhibits the safe delivery of fragile goods or hazardous materials.

Lane widths: Most roadway lanes are tight for truck movements. Even though a significant portion of them have the standard lane width of 12 feet, it does not allow truck drivers much room for error. This problem gets bigger on roads with construction activities, where travel lanes are often narrowed.

Unexpected pedestrians, wildlife, or others: Pedestrians, wildlife, or others in close proximity to two-lane highways can pose a safety hazard. For some truck drivers, it is a major deterrent to traveling on two-lane highways. It is not rare to encounter some folks out there on the roads that are sleepy, tired, or drunk in the very early morning, late evening, or in the summer. Wildlife such as deer, opossums, or raccoons often shows up on two-lane highways. On a two-lane highway in a farming community, truck drivers need to be careful not to conflict with farm trucks, peanut wagons, cotton hoppers, or the like.

Passing maneuvers on two-lane highways: When truck drivers encounter somebody who is going at a considerably lower speed than the roadway speed limit, most of them usually try to pass him/her even though they have to take significant risks due to the large size and low acceleration capability of their truck. If a passing lane is upcoming, they will usually wait for that, but many two-lane highways do not provide passing lanes. If a leading vehicle is only going a little slower than the truck drivers' desired speed, they usually will not try to pass. However, their trip quality is definitely negatively affected.

4.1.2.4 Factors affecting truck trip quality on hub facilities

The perceived safety level and operation of access to a hub facility are the two major concerns of the truck drivers using hub facilities. There are some access highways that are routinely congested. Those roads need traffic signals or wide medians for truck drivers to get in and out of the traffic streams easily. It is good to have hub facilities at some locations where the access of truck traffic is easy. Truck drivers sometimes have to wait for a long time for their freight to be unloaded at some hub facilities because of overbooked appointments. Some receivers or receiving departments at retail stores are not supportive to get their shipments from truck drivers at a scheduled time. It is a significant problem for trucking companies and truck drivers, especially the drivers who get paid by the miles because they are not paid for waiting there. Some trucking companies stipulate how to compensate for the delay into the contracts with their customers. The old and deteriorated pavement condition at some old hub facilities is another problem.

4.1.3 Improvement Priority of Transportation Services

It was inferred from the focus group discussions that the order of roadway types in which more improvements are needed, are two-lane highways, freeways, multilane highways, and urban arterial facilities, from the truck drivers' perspective. The increasing traffic volume and construction activities on freeways lead truck drivers to take two-lane or multilane highways more often than ever. The main subjects of improvement on those facilities are narrow lane and shoulder widths and deteriorated pavement condition, which mostly do not provide them adequate room for error. Although the participants were mostly satisfied with freeway conditions in Florida, they are still very important for truck drivers as they spend most of their time on them. Truck drivers do not want the left lane restricted from truck use or a lower speed limit only applied to truck traffic. They also indicated that educating the motoring public, in addition to truck drivers, would be one of the key factors for improving driving conditions on freeways. Given the fact that much less of truck drivers' travel mileage occurs on arterials, they were thought to be least in need of improvement among the listed facility types. However, truck driving environment on arterials are important exclusively to LTL or short-haul drivers. Some arterial facilities, especially in old towns, were considered to be in need of renovation in terms of physical roadway conditions (e.g., curb radii, placement of trees or light poles, etc.) to accommodate trucks whose sizes are larger than they used to be many years ago.

The participants indicated that the best measures for better truck operations would be constructing more alternative routes, preferably truck-only routes. They believe that designated truck routes would not only help them cope with the ever increasing number of cars in Florida, but also eliminate possible safety hazards caused by inconsistent traffic flow with all the vehicles having different operating characteristics (e.g., acceleration or deceleration capability, braking distance, etc.).

4.1.4 Truck Delivery Schedule Reliability

Unexpected traffic congestion incurred by accidents, construction, etc. is the major cause of a late delivery. The impact of road construction activities on on-time delivery performance is greater for the long-haul drivers than for the short-haul drivers in that they usually do not travel on regular routes, so they often have no idea where the construction zones are. Long-haul drivers are more likely to jeopardize themselves by speeding up to meet the arranged time for a delivery. If they are late for a delivery, there is a possibility that they are not paid for the long trip and also fail to pick up other loads for back-hauling on their way back. Independent truck drivers also are sensitive to on-time performance. They often try to set up more delivery appointments to earn more money, and then they have to speed up on roadways to meet their tightened delivery schedules. They may also need some time to change the loading sequence of the goods by themselves according to the newly set up delivery appointments. Owner-operator truck drivers have difficulty delivering the goods as scheduled if their trucks are not ready. They cannot start their trip until their trucks are fixed. That is not the case for company-hired drivers whom their companies provide with a wide collection of trucks. Most long-haul truck drivers in Florida are rarely late for their deliveries (almost 100% early or on-time delivery). It is mainly because they are given enough time to make on-time deliveries. An average speed of 47 mi/h is typically used by truck company managers to calculate the total delivery travel time. Managers often use an average speed less than 47 mi/h to allow more travel time for the drivers that have to travel through some routinely congested areas.

Some impatient drivers try to save a significant amount of time by driving fast. Also, new drivers will often not admit that they are sleepy and pull over, as they want to make a good impression to their employers. Thus, they would have a higher likelihood of being involved in an accident than others. On-time delivery performance is important, especially at the seaport facilities. Some receivers there will not take the freight even if it is only 5 minutes late.

4.2 Perceptions of Truck Company Managers

The following section describes the results from a focus group session held with three truck company managers. They were all from the major Truck Load (TL) carriers operating more than 400 trucks. One manager was from a private company primarily carrying groceries. The other two were working for for-hire companies delivering various types of goods. One of these two was involved in a company dealing with hazardous materials, mostly using multilane or two-lane highways. The information on the socio-economic and working characteristics of the participants is summarized in Appendix E. It was noted by the participants that some portion of their perceptions was formed by the communications with the truck drivers working for their trucking business. Again, the text presented in this section only contains summaries and paraphrasing of the comments made by the focus group participants. It is not necessarily the opinions of the researchers.

4.2.1 Truck Route and Departure Time Selection

Typically, dispatch managers or driver managers at the trucking companies decide on a truck travel route and departure time. They usually use routing software to choose a shortest or quickest route. However, they are also open to the suggestions (e.g., traffic or clearance conditions on a route) their drivers make. When the problems of a route are thought to negatively affect their trucking business (in terms of overall operating cost, on-time performance, or drivers' trip satisfaction), they occasionally change the route or manipulate the routing software to reflect those problems. Sometimes, truck drivers try to take alternative routes instead of the routes designated by their managers. Managers normally allow them to do it as long as they are legal routes, but they get paid by the dispatched routes. Commercial for-hire carriers discuss with customers to figure out what time is the best for delivery, while private carriers operate various delivery windows for their own goods. Once a freight arrival time is set up, truck departure time is normally calculated with a 45–55 mi/h average truck speed (47 mi/h is most often used) considering DOT hours of service, time to rest, and all the possible situations truck drivers may encounter.

Truck travel route and departure time are selected primarily based on shortest travel time or distance, using routing software. Although the software saves much time for managers, it does not always make the best decisions. Thus, managers also take into account perceived safety risks, time of day congestion, construction activities, pavement conditions, operating cost, etc. of potential routes. Driving on two-lane highways may be considered dangerous due to the intermittent unexpected presence of pedestrians and no amount of room for error (e.g., no shoulder, narrow lane width). School zones, in particular, are avoided by hazardous material carriers and it is also often noted in the delivery contracts with their customers. Some routes are avoided at certain times of a day (e.g., AM peak hours) due to routinely congested traffic conditions. Construction activities sometimes cause unexpected delays, so are considered in the decision. Pavement conditions are important to the truck drivers hauling fragile goods such as glass bottles. Managers sometimes also try to avoid roadways requiring high tolls, unless the travel time savings is relatively very large.

Although some truck drivers would prefer to travel on freeways for time savings, there are some other drivers, who would rather drive on multilane highways because of the congestion and safety hazards on freeways. The major cause of congestion is frequent construction activities currently in place on many freeways in Florida. Most trucks in major carriers are governed at certain speeds lower than the speed limits on freeways for travel safety and fuel economy. Some truck drivers prefer to drive on multilane highways to avoid the speed differential between trucks and passenger cars caused by the governed truck speeds. The motoring public generally does not have much respect for trucks and are also not knowledgeable about how to drive around trucks safely. Many truck drivers hate driving on some two-lane highways with a lot of tourists and people passing. On the other hand, they are more comfortable on some other two-lane highways with double solid yellow lines for good stretches, even though there may be many traffic lights along the highway.

4.2.2 Factors Affecting Truck Trip Quality

Managers generally believe that travel time and safety are the two most important issues for determining truck trip quality perceived by truck drivers. On-time delivery performance is considered to be significantly affected by traffic volume, construction activities, and traffic signal controls on various transportation facilities. Driving safety is thought to be mostly affected by the motoring public's negative attitudes about trucks and truck drivers and their lack of knowledge about truck driving characteristics. Physical roadway conditions are also considered to be important for accommodating trucks with their large sizes and low acceleration and deceleration capabilities.

4.2.2.1 Factors affecting truck trip quality on freeways

Truck company managers prefer to route their drivers to freeways for continuous and fast traffic flow. However, this advantage has been diminished with the significant increase in traffic volume and construction activities on freeways in Florida. Truck drivers consistently complain about the motoring public's unfavorable attitudes about trucks and the speed differential between trucks and other vehicles on freeways. Those issues negatively affect the perceptions by truck drivers of the quality of a truck trip with respect to driving safety and comfort. Some drivers often try to travel on multilane highways instead of freeways for these reasons. Ideally, truck-only routes would be provided to separate truck traffic from others and reduce the congestion level.

Speed differential between trucks and autos: Many truck drivers are restricted to travel at a maximum speed ~5–10 miles lower than the posted speed limit of a freeway by the engine speed governors. The speed differential between speed-governed trucks and other vehicles deteriorates the overall traffic flow on freeways. However, it is required to support safe driving behavior by the truck drivers. Ability of the driver to cope with a dangerous moment drops significantly as the truck speed increases above a certain level. For many truck companies, this level is 65 mi/h. According to one manager, his drivers believed that the safety level would be enhanced if they could travel as fast as the others in a traffic stream, but it was disproved statistically with the safety records of their company. On the other hand, the slow trucks are the main obstacle for the motoring public. They keep the other drivers from consistently maintaining a desired travel speed. In addition, truck drivers often travel next to each other to talk while driving, sometimes blocking more than three lanes simultaneously.

Motoring public's attitudes: The motoring public is a significant deterrent to the safe driving performance of truck drivers in a traffic stream. They generally have little respect for trucks and truck drivers, and also are not knowledgeable about how to drive around large trucks safely. The motoring public does not usually maintain a safe following distance and they often cut off in front of trucks or pass by them with a high speed while their movements are unexpected or sometimes even unnoticeable by the truck drivers. Many managers would route their truck drivers to multilane highways rather than freeways if it took a similar amount of time to reach the destination.

Level of congestion: The main benefit of using freeways is a lower travel time. However, the traffic volume on Florida's freeways has increased significantly in the past several years, while the roadway capacities have not changed much. This increases the travel time of the users and aggravates the safety level on freeways. There are not many alternative routes in Florida to avoid the traffic congestion. Thus, truck company managers always try to schedule a delivery during non-peak hours. Most truck drivers and managers prefer a night-time delivery. The trucking community often utilizes multilane highways in case of congestion, accidents, or construction activities on freeways. However, two-lane highways are hardly considered as alternatives due to their longer travel time, potential safety hazards, inadequate shoulders, etc.

Frequency and duration of construction activities: Construction activities on Florida interstates have significantly increased over the past few years. They have become so frequent and long in duration as to have a significant negative impact on trucking business with respect to on-time delivery performance and truck operating cost. Poor temporary pavement surface during construction periods is another concern for keeping the freight in good condition.

Truck lane restrictions: It was thought by all three managers that left-lane truck restrictions (i.e., trucks are not allowed to travel in the left-most lane) are not a big concern to truck drivers as long as more than two travel lanes are provided to them in each direction. This was based on the reasoning that there is almost no possibility of truck drivers passing other vehicles through the left-most lane because the maximum speed of most trucks is restricted under the posted speed limit by the engine speed governors of their truck companies. However, they felt that truck drivers need to be allowed in the left-most lane on a roadway with only two lanes in each direction.

Traveler Information Systems (TIS): Truck drivers and truck company mangers are always welcomed to use the TIS. However, it is not really beneficial to the trucking community due to the lack of alternative routes in Florida. Its value will be much higher if more alternative routes are provided. It is best to have truck-only routes with at least two travel lanes in each direction.

Weigh stations: The passage of truck drivers through weigh stations is not much of a concern for the Truck Load (TL) trucking community. Nearly all weigh stations in Florida allow most truck drivers to pass by the stations without being weighed at all, once the safety records of their truck companies verify their good performance regularly. Only one out of seven passing trucks gets stopped for a weight inspection. It is very rare that total weight (the sum of weights of vehicle, equipment, and freight) is over the maximum limit allowed by law (80,000 pounds). The only situation that truck companies are eligible to carry above the limit is when they deliver necessities (e.g., frozen foods) to areas of impact during a state of emergency declared by the governor. Truck company managers sometimes encounter some customers at ports with international containers weighing more than 80,000 pounds coming from overseas. They need a permit before delivering the freight from the port to the destination. Thus, they try to have the permit obtained by who is responsible for it. The weigh stations at the state borders investigate the axle distribution as well as the total weight. For this reason, the truck drivers frequently crossing the state lines may have some different concerns about the weigh station facilities.

One manager complained about the location of a weigh station in Florida. The weigh station is located in the median area on highway 60. The speed limit of the roadway is 65 mi/h and the acceleration lane is only 100 yards long. Truck drivers have difficulty accelerating their trucks to safely merge into the left-most lane (the fastest travel lane). There were some rear-end accidents at this site.

4.2.2.2 Factors affecting truck trip quality on urban arterials

Managers mainly talked about physical roadways and traffic conditions not suitable for trucks' turning movements. The influencing factors are curb radius, stop line position, existence of protected turning phases, motoring publics' knowledge and attitudes about trucks' turning maneuvers. They mentioned that length of yellow signal timing and traffic signal coordination along an arterial would also affect truck trip quality perceived by truck drivers. Level of congestion on Florida arterials has gone up to a great degree by a consistently increasing number of cars and traffic signals. The increased congestion level has a direct negative impact on efficiency in truck operations. Thus, managers always take into account time-of-day congestion (at AM or PM peak) when selecting truck routes and departure times for deliveries.

Ease of turning maneuvers: Truck drivers sometimes have difficulty making turning movements. A considerable number of intersections do not provide adequate space and appropriate traffic signal control for the turning movements of trucks. The turning path of a truck is often partially blocked by the curbs with small radii at intersection corners. The vehicles waiting for a green signal at an intersection sometimes obstruct the turning movement of a truck. Many drivers stop beyond the stop line in a turn lane on an adjacent approach, which reduces the available turning area. Thus, shaving off a section of a corner to make an angled corner or placing the stop lines further back would be beneficial. When truck drivers get stuck in the middle of turning at an intersection, managers advise them to not back up and re-maneuver, as there are great risks of them conflicting with other drivers, bicyclists, or pedestrians. They want the driver to wait until the potentially obstructing traffic clear their way. Additionally, light poles, and electrical wires at the edge of the curbs were not relocated for truck turning movements in some renovations for old downtown areas. This should be always considered for the development of a new town as well as the future renovation of an old town.

Most commercial carriers have a company policy against U-turning movement because it has been one of the major causes of accidents. Safety managers regularly remind their drivers of the danger of making a U-turn and demonstrate to them how to reach destinations without a U-turn when they miss a left- or right-turn. Some carriers use a routing database to eliminate the need of their drivers for U-turn maneuvers by guiding them to other routes on which no U-turn maneuver is necessary. Many carriers prohibit a U-turn maneuver exclusively in residential areas because of the possibility of trucks colliding with pedestrians, electrical lines, or something else.

The managers felt that trucks need much more time and space for turning maneuvers than other vehicle types. It is preferable to turn at controlled intersections with enough curb radii and shoulder width. Truck drivers prefer the existence of exclusive turning signals (e.g., left turn arrow signals) with no permitted vehicle movements (e.g., no right turn on red signs) during turning maneuvers due to the difficulty in finding an adequate traffic gap and space.

McCord (2006) reported that UPS now has an official policy that instruct their drivers to avoid making left turns as often as possible. Steve Goodrich, UPS Community Relations Manager, indicated that UPS cannot eliminate left turns entirely, but the idea is to reduce the number as much as possible. He stated that its benefits are three-fold. First, it saves travel time by not having to wait for a large traffic gap and space. Second, it also saves fuels as truck drivers idle waiting the left turn opportunity. Third, left turns are not as safe to make as right turns.

Level of congestion: Congestion levels on Florida arterials have been increased significantly over the past a few years. Additional traffic lights are added to the existing roadway infrastructure to control the increased number of cars, motorcyclists, bicyclists, and pedestrians on many arterials. This makes it harder than ever for truck drivers to travel along arterials or through intersections. The increased levels of congestion just lead to poor on-time performance, upward truck operating cost, and unhappy truck drivers and customers. During AM or PM peak hours, driving through an urban arterial is often an ordeal. Thus, truck drivers are directed to travel during non-peak hours in every possible case.

Number of stops versus overall delays through signalized intersections: It is difficult to discern which one of the two aspects is more important to the quality of a truck trip. However, the importance of number of stops is certainly greater for truck drivers than for the passenger car drivers, in that it takes much more time and effort for truck drivers to decelerate and accelerate their vehicles. They also need to pay special attention to keep all the equipment and goods safe, so it is a big concern especially for fragile or hazardous material carriers.

Motoring public's attitudes: Automobile drivers need more etiquette or knowledge about the characteristics of truck turning movements. They often pull their cars beyond the stop lines, or drive around a truck making a turning movement at intersections, ignoring its wide turning radius. When a truck driver gets stuck at an intersection in the middle of a turning maneuver, the cooperative attitude (i.e., yielding behavior) of other drivers is sometimes crucial for the truck driver to get out of the predicament safely.

Length of yellow interval signal timing: The lengths of yellow signal timings at signalized intersections are somewhat short for trucks to clear the intersections safely before conflicting traffic signals turn green. This is because the long length, heavy weight, and poor acceleration and deceleration capabilities of trucks. At a signalized intersection, drivers are often placed in a dilemma zone where they can neither stop before the stop line nor clear the intersection. In this situation, they are forced to choose between abruptly stopping and running the red light. Length of the dilemma zone is usually much longer for large trucks than for passenger cars. There are even some signalized intersections where the dilemma zones only exist for trucks, not for passenger cars. The dilemma zones for trucks may be eliminated if traffic signal clearance intervals (yellow and red intervals) are timed properly. Expansion of yellow interval signal timing may contribute to this issue.

Traffic signal coordination: Truck drivers are well aware that even when there is some congestion, they can still go through an arterial without having to stop too much if traffic signals are properly coordinated. Again, it takes much more time and effort for truck drivers to stop and re-maneuver than it does for passenger car drivers. It is important for truck drivers to stop as little as possible along their delivery routes.

4.2.2.3 Factors affecting truck trip quality on two-lane highways

As noted at the truck driver focus group meetings, shoulder width and condition are exclusively important for truck drivers to deal with potentially unexpected situations such as breakdowns, flat tires, etc. Another important concern is routinely encountered pedestrians along two-lane highways, causing safety hazards. Managers have very negative opinions about passing maneuvers of trucks (safety concerns), considering their acceleration and deceleration capabilities inferior to other vehicles and much longer length.

Shoulder width and condition: A wide and firm shoulder is essential for truck drivers in a case of emergency. Long continuous shoulders placed at least every 3–5 miles may be required for the drivers to deal with emergency situations without disturbing the two-way, two-lane traffic flow and get back on the road later safely. Moreover, widths of travel lanes on many two-lane highways are not enough for truck drivers to maneuver comfortably. Their travel path is not in the center of travel lanes, but often skewed to the right. Truck drivers tend to travel on some parts of shoulder. Thus, use of rumble strips on the boarder of travel lane and shoulder may be beneficial for bicyclists or pedestrians, but can disturb truck driving.

Passing maneuvers: Managers generally discourage their drivers from passing other vehicles in any case due to the significant risks accompanied by it. However, many truck drivers still try to do it. One manager commented that his truck drivers would pass a vehicle running at 40 mi/h if they were traveling at 55 mi/h or more. The safety departments at most truck companies use such educational programs as "Value-Driven" or "Ethics and Techniques" by Smith Systems, to make them realize the importance of safe driving. The potential hazards of passing and U-turn maneuvers are well demonstrated by those programs.

Frequency of pedestrians: Managers prefer to not route their drivers to pedestrian-crowded areas for safety reasons. It usually increases travel time and asks the drivers for an additional effort to pay attention to those pedestrians. A truck-pedestrian collision is apt to lead to severe pedestrian injury or fatality, soaring recovery and insurance fee, and potentially loss of sales. Traveling on two-lane highways around many tourist spots in Florida is often avoided.

4.2.2.4 Factors affecting truck trip quality on hub facilities

Post 9/11, port facilities statewide reinforced their security levels, increasing time and cost for truck operations. Truck drivers are required to pass background and security checks for every visit. The truck companies are charged for their use of the port facilities. Additional cost is imposed to the companies on updating the background information of their drivers. The port facilities in Florida have grown consistently, but access roads from FIHS (Florida Intrastate Highway System) to the facilities have not been accordingly upgraded with respect to roadway capacity and safety level.

4.2.3 Truck Delivery Schedule Reliability

A primary determinant of on-time delivery performance is the existence of unexpected congestion along the route. In this respect, accidents, incidents, construction activities, or bad weathers are the main causes of late deliveries. Construction activities and bad weathers on delivery routes may be predictable in a short term to some degree. However, it is always difficult for long-haul drivers or independent drivers to obtain and update reliable information about construction and bad weather conditions along their long routes. Even though they are properly informed of the conditions, they are not rare and there is often no alternative route as efficient (primarily time-wise) as their originally designated route. In many cases, they have no choice but to go through the conditions.

Travel time through some routinely congested areas is hard to predict. That is, the more congested a delivery route is, the more difficult it is to estimate accurate freight arrival time. Variability of on-time delivery performance (the percent of the expected travel time by which the actual arrival time is different from the scheduled arrival time) largely depends on the expected level of congestion along the traveling areas. For example, in the Sarasota region, variability of on-time performance is within 2 percent, while it is about 30 percent in Atlanta. Other than the congestion issues, delivery is sometimes late because of problems with shippers' facilities. This occurs when they are not ready for the goods to be carried. Managers consider roadway capacity increases for trucks as the most efficient way to improve on-time delivery service. This capacity increases may be accomplished by constructing alternative routes or designating truck only routes. The managers at the meeting agreed that late delivery rarely occurs, so it is not a major concern for now. However, the importance of on-time performance is on the rise with an increasing demand for just-in-time deliveries and low inventory controls. Managers generally prefer night-time deliveries because truck drivers can run more efficiently without much congestion. However, the night-time truck deliveries are uncommon for now. Some shippers only operate Monday through Friday, 6 AM to 6 PM. It is also usually difficult for truck companies to save enough money for receivers to employ night crews by delivering just a few truck loads. One manager from a for-hire company stated that truck companies may be able to offer discounts to the receivers for the night crews by making a profit by operating each of their trucks day and night by different drivers (day shift and night shift). The other manager from a private company actually considered night-time delivery as the only way to remain competitive for its trucking business. Early deliveries also cause problems for both for-hire and private trucking companies. Customers often do not accept early deliveries and for-hire truck companies still pay for the truck drivers' waiting time. There is a lot more flexibility for private companies than for-hire companies in terms of early deliveries because they can reallocate labor to pick up their own goods delivered earlier than scheduled. However, it is sometimes difficult to do that especially when unloading crews are busy performing other tasks at the time of early delivery.

On-time delivery performance is critical in the trucking business because it is the primary determinant of the delivery service performance level of a truck company. Some customers evaluate the trucking service based totally on it. Some other customers rate it primarily on on-time delivery and include billing errors, load condition, claims, etc. to evaluate the overall service performance. Impact of late deliveries on trucking business should not be underestimated since they aggravate service level of a truck company, which may lead to penalties and loss of sales, not to mention unhappy customers.

4.3 Perceptional Difference between Truck Drivers and Truck Company Managers

Truck drivers and truck company managers both believe that quality of a truck trip largely depends on three factors such as travel safety, travel time, and driving comfort. The travel safety aspect of a truck trip is very important for the two groups, given the fact that truck drivers are mostly graded by their accident history and frequency of accidents has a great effect on trucking business operated by truck company managers. Travel time aspect of a truck trip is more important for truck company managers than for truck drivers. Truck company managers always have to focus on the on-time delivery performance of their drivers, which is a primary measure for customers to evaluate the overall performance level of their truck company. On the other hand, most truck drivers are given enough time to make a delivery on time, and thus it is rare that they are late for a delivery. Even when a late delivery occurs, truck company managers are often responsible for it since they typically select the travel route and departure time for deliveries. Truck drivers have more concerns on driving comfort aspect of a truck trip than truck company managers. It is because they are the ones who spend most of their time driving their truck on the road as a job, and thus they are very sensitive to this aspect. Out of the factors perceived to be important to driving comfort by truck drivers, truck company managers are concerned mainly with the factors affecting their trucking business with respect to overall operating cost and on-time delivery performance.

Most of the factors perceived to be important to quality of a truck trip by the two groups were overlapped, but the perceptions of truck drivers on the relative importance of those factors were different from those of truck company managers. Truck lane restriction, in particular, was not perceived to be a problem by the manager group as long as there are at least two or more lanes in each direction allowed for truck traffic. However, it was perceived to be very important to quality of a truck trip by the truck drivers. It was considered to have a significantly negative effect on both safety and maneuverability aspects of their truck trip.

CHAPTER 5
SURVEY DATA ANALYSIS RESULTS

A total of 459 truck drivers and 38 truck company managers responded to the survey effort of this study. The survey responses were analyzed statistically to investigate their general perceptions on the importance of the traffic, roadway, and control factors on various transportation facilities. This chapter provides the findings from the survey data analysis. The relative importance, satisfaction, and improvement priority of each factor on truck trip quality was examined from the truck driver survey responses, while the relative importance of each factor on operating cost, on-time delivery performance, truck drivers' trip satisfaction, and overall trucking business was examined from the truck company manager survey responses. The perceptions of the both groups on the improvement priority of various roadway types and the preference on truck driving times of day were also explored.

5.1 Backgrounds of the Participants

This section describes the general background characteristics of the survey respondents. The background characteristics of the driver respondents from FTDC event and from postage-paid mail-back surveys are presented separately as well as in a combined form, while those of the managers are presented only in a combined form, given the small sample size.

5.1.1 Truck Driver Participants

The socio-economic and working characteristics of a total of 459 driver survey respondents are shown in Table 5-1. About 32 percent of the respondents (148/459) were from the FTDC event, while almost 68 percent of them (311/459) were postage-paid mail-back survey respondents. About five percent of all the respondents were women and most respondents (95%) were at the age of 30–59 years. The average truck driving job experience was more than 17 years and the number of respondents from for-hire carriers was more than three times that from private carriers. The ratio of the respondents from TL carriers to those from LTL carriers was 54:19. About one fourth of them were independent truck drivers. More than 75 percent of the respondents were long-haul drivers and more than 80 percent of the drivers operate trucks that are speed-governed. The average governed speed of the respondents was 68.4 mi/h.

More than half of the respondents from FTDC event were short-haul drivers, but a majority of the postage-paid mail-back survey respondents (92%) were long-haul drivers. It is because the surveys were distributed at the agricultural inspection stations on freeways which are mostly used by long-haul drivers. This explains the differences in several other background characteristics between the two respondent groups. The postage-paid survey respondents consisted of more percent of TL drivers, owner/operator drivers, and drivers getting paid by the mile than the respondents from the FTDC event. Their average one-way truck driving distance and average governed truck speed were also higher.

More background questions were asked only to the FTDC respondents. The summary of the additional backgrounds of the respondents is shown in Table 5-2. A majority of the respondents (70%) were caucasian and about 76 percent were educated up to the level of high school. More than half of the respondents earn between 50,000 and 69,000 dollars annually as truck drivers. Their truck company fleet sizes and type of goods they carry varied. The drivers use freeways most often among various roadway types. An average of 51 percent of their truck trips is made on freeways and they spend about 52 percent of their truck driving hours on freeways. They spend the average of 1.3 nights away from their home per week.

5.1.2 Truck Company Manager Participants

The backgrounds of a total of 38 manager survey respondents are shown in Table 5-3. Twenty seven of them were postage-paid survey respondents and the rest were the participants at the FTDC event. The participant background information from the two recruitment sources was combined and investigated as a whole due to the small sample size. Most respondents were male with their age ranging from 30 to 59 years. A higher percentage of them were for-hire and/or TL carriers than private and/or LTL carriers. They were mostly transportation/logistics or safety managers at truck companies and their main job duties included management of truck operation safety, truck travel route selection and scheduling for deliveries. The fleet sizes of their truck companies varied. An average of about 45 percent of their concerns was on the operating cost aspect of truck operation, while 30 percent of their concerns were for on-time delivery performance and 25 percent on truck drivers' trip quality.

Table 5-4 summarizes the additional backgrounds of the 11 respondents at the FTDC event. More than half of the respondents indicated that truck travel route and departure time decisions are made only by the managers at their companies. The income levels of the respondents varied with almost 30 percent of them earning 50,000–60,000 dollars annually as truck company managers. Thirty six percent of the respondents were educated at more than a high school level. The truck types their companies operate varied, but straight trucks, 4-axle and 5-axle tractor semi-trailers were more often used than other truck types. The type of goods carried by their companies also varied.

5.2 Perceptions on the Relative Importance of Each Factor on Freeways

The relative importance and satisfaction of each factor on the quality of a truck trip was asked in the driver survey, while the relative importance on operating cost, on-time performance, and truck drivers' trip satisfaction was asked in the manager survey. The relative improvement priority of the listed factors was elicited from the importance and satisfaction scores of each factor. The relative importance of each factor on the overall trucking industry was also postulated from the manager survey data. Exploratory Factor Analysis (EFA) was performed on the relative importance of each factor to determine if there are some common factors that adequately explain the variances of the items. The relative significance of each aspect of the truck driving environment is described at the end of this section. The analyses were performed for each of the three roadway facilities (i.e., freeways, urban arterials, and two-lane highways).

5.2.1 Relative Importance of Each Factor

The average Relative Importance, Satisfaction, and Improvement Priority Scores (*RIS*, *RSS*, and *IPS*) of each factor on the quality of a truck trip on freeways are presented in Table 5-5. As discussed in chapter 3, the Improvement Priority Score (*IPS*) is higher for the factors perceived to be relatively more important and/or less satisfied. The *IPS* was calculated for each factor for each respondent and the average *IPS* of each factor is also shown in Table 5-5. The rankings of each factor relative to *RIS*, *RSS*, and *IPS* are marked as superscripts with the five most important factors for each issue marked in bold.

Based on average *RIS*, *RSS*, and *IPS*, other drivers' behavior (i.e., 'Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways' and 'Passenger Car Drivers' Road Etiquette') were found to be most important and least satisfied, thus most in need of improvement. The factors relative to physical roadway conditions (e.g., 'Availability of Signage', 'Pavement Condition', 'Lane Widths', etc.) were perceived to be relatively fairly important, but the respondents were relatively well satisfied with the factors on freeways in Florida. 'Level of Congestion' ranked the fifth in relative importance and the fourth in relative satisfaction. Interestingly, the factors concerning truck traffic restrictions (i.e., 'Lane(s) Restricted from Truck Use', 'Lower Speed Limit Only Applied to Truck Traffic', and 'Governed Truck Speed Lower than Speed Limit') were perceived to be relatively less important. However, the respondents were definitely opposed to those restrictions, thus the factors were perceived to be in need of significant improvement. 'Availability/Publicity/Advertising of Traveler Information Systems (TIS)' was considered to be least important and least in need of improvement. It is probably partly because there are not many alternative routes the truck drivers can take to detour in Florida, or many truck drivers may be regular drivers, who are already familiar with time-dependent traffic and other conditions on their potential routes in Florida, not admitting the importance of TIS.

Table 5-6 shows the results of the truck company manager surveys. The average relative importance scores of each factor on Overall Trucking Business (*OTB*), Operating Cost (*OC*), On-time Performance (*OP*), and Truck drivers' trip Satisfaction (*TS*) are presented. As explained in chapter 3, the relative importance of each factor on *OTB* was calculated for each respondent by weighting the values of relative importance of *OC*, *OP*, and *TS* by their corresponding percents of the respondent's concern. Again, the five most important factors for each issue are marked in bold.

Based on average *OTB*, *OC*, *OP*, and *TS*, 'Level of congestion' was most important in all the aspects of trucking business. 'Frequency and Timing of Construction Activities' and 'Availability of alternative Routes' followed next. It implies that construction activities are a significant constraint to their trucking business (probably with respect to increased travel time) and availability of alternative routes is important to avoid congested sections of freeway. The two factors representing 'other drivers' behavior' ranked sixth and seventh for on-time performance, but they ranked between second and fifth for all other issues. 'Pavement Condition' was perceived to be relatively more important for truck drivers' trip satisfaction than for any other issues. 'Number of Lanes' and 'Availability and Condition of Signage' were perceived more important to on-time performance than 'other drivers' behavior'. The truck company managers may believe that many signs on freeways are misplaced or not appropriately designed or maintained; thus they often negatively affect the on-time performance of a delivery by keeping the drivers from finding their way easily. 'Availability/Publicity/Advertising of Traveler Information Systems (TIS)' was perceived to be least important for most of the issues in the managers' perspectives as well.

The *RIS* and *TS* were compared to discover the perceptional differences between drivers and managers on the relative importance of each factor on freeway truck trip quality. The factors concerning travel time (or traffic capacity) were perceived to be more important by the managers, while the factors regarding other drivers' behavior and physical roadway condition were perceived to be more important by the drivers. Both groups stated that TIS-related factors are least important.

An Exploratory Factor Analysis (EFA) was applied to find common factors that account for the patterns of collinearity among the variables. The analysis was executed with a total of 147 truck driver surveys by the principle component extraction method and varimax rotation in SPSS version 15 (SPSS Inc., 2006). The varimax rotation was specifically used to obtain a clear separation among the factors. Bartlett's test of sphericity was found to be significant (χ^2 = 867.8, *df* = 171, < 0.01) and the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.77, justifying application of the factor-analytic procedure. The five factors with latent roots (eigenvalues) greater than one were retained. A scree plot also supported the decision. Table 5-7 displays the latent factors and the rotated factor loadings and communalities of their allied items. A factor loading is the correlation between an item and a factor that has been extracted from the data and the communality of an item indicates how much of the variance in the item is accounted for by the five factors extracted. Considering the sample size of 147, the items with a loading at 0.5 or above on one factor and less than 0.35 on others were first identified (the loadings on the factor are in bold print). The three items ('Pavement Condition', 'Number of

Lanes', and 'Amount of Merge or Diverge Traffic') with a factor loading of 0.5 and above on one factor, but equal to or more than 0.35 on the other(s) were considered as loading highly on two or more factors. The other item ('Availability of Alternative Routes') without loadings at 0.5 or above was noted as not loading highly on any factor. In a conventional EFA procedure, those items are excluded from the analysis, but this survey study purported to evaluate the relative importance of all the items. Thus, it was not intended to exclude any item in the analysis. The four items were assigned to one of the factors with respect to the perceptional correlations between the items and factors, or the levels of the factor loadings. The communalities of most items were 0.5 or more, denoting that at least half of the variance in each of the items is explained by the factor solution.

For quality of a truck trip on freeways, 58.4% of the total variance of the observed variables was explained by five latent factors (17.6% by factor 1, 10.5% by factor 2, 10.4% by factor 3, 10.0% by factor 4, and 9.9% by factor 5), resulting in 41.6% unexplained or lost variance. The first five factors extracted, in order of proportion of variance explained, were labeled 'physical roadway components', 'passenger car drivers' behavior', 'traveler information usage', 'truck travel restrictions', and 'volume/capacity ratio' to reflect the meaning and context of the corresponding items.

Basic summated-scale descriptive statistics were calculated for each latent factor to assess its relative importance to the freeway truck trip quality. The mean *RIS* of each item was recalled to compare the relative importance of the items within each factor to the freeway truck trip quality. These results are presented in Table 5-8.

Factor 2 (Passenger Car Drivers' Behavior) included two items and was exclusively most important for freeway truck trip quality among all the factors. Factor 1 (Physical Roadway

Components) and its allied items were second most important. This factor was correlated with the most number of items, which generally ranked high in mean *RIS* score. The signage and pavement were most significant items within this factor. Factor 5 (Volume/Capacity Ratio) was third most important. Most items associated with this factor were also fairly correlated with the other factors. The primary items of this factor were construction and congestion. The two least important factors were Factors 3 (Traveler Information Usage) and Factor 4 (Truck Travel Restrictions), and the items relative to those factors were also least important among all the items. The other three factors were relatively much more important than the two factors, according to the factor summated means.

The EFA results indicate that the respondents did not give out one or two common factor(s) that can potentially be used as performance measure(s) by which truck trip quality on a freeway can be sufficiently evaluated. However, they suggest that potential freeway truck LOS performance measure(s) should be strongly correlated with 'Passenger Car Drivers' Behavior' and also be associated with 'Physical Roadway Components' and 'Volume/Capacity Ratio' to some degree.

5.2.2 Applicability of Single Hypothetical Performance Measure to Estimate Truck Trip Quality

The relative importance of each hypothetical performance measure on freeway truck trip quality was asked on the last page of both the truck driver and truck company manager surveys. A total of four performance measures were presented identically to the two distinct groups of participants, but were questioned differently. The drivers were asked to assess applicability of each performance measure solely to estimate their truck trip quality, while the managers were asked to evaluate the relative importance of each performance measure for their trucking business with respect to overall operating cost, on-time performance, and truck drivers' trip satisfaction.

The opinions of 389 driver respondents and 35 manager respondents are summarized in Table 5-9 and Table 5-10, respectively. The two most important measures for each group are marked in bold. 'A Consistently Good Ride Quality' ranked first by the drivers and third by the managers, based on the average scores. This factor description primarily corresponds to pavement quality and may also be correlated with other drivers' poor driving behavior to some degree. The effects of pavement condition on trip quality are not considered in the current HCM, but it is evident from this survey that this factor is very important to truck drivers' trip satisfaction. Poor pavement condition may result in an uncomfortable riding experience, damage to the equipment (e.g., tires), or condition of goods (e.g., fragile goods, hazardous materials). Unpleasant driving interactions between trucks and other vehicles may also negatively affect ride quality experienced by the truck drivers, by requiring them to accelerate or decelerate their truck more frequently. Given the heavy weight and large size of trucks, truck drivers are more sensitive to ride quality than the drivers of other types of vehicles. This factor, however, was not perceived to be that important to the trucking business by the managers.

'Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit' ranked second by the drivers and first by the managers. This factor description corresponds to what the researchers considered as speed or acceleration variance. That is, the longer a truck driver can travel at a constant speed without needing to accelerate or decelerate the truck, the more satisfied the driver will be. It requires more time and effort to accelerate or decelerate trucks than any other vehicle. The frequent or abrupt acceleration or deceleration activities may also increase the likelihood of an accident. This acceleration variance factor was perceived very important to both the drivers and managers. The specific elements contributing to the factor may include other drivers' driving behavior, congestion level, and frequency of construction activities, incidents, or accidents. This factor may be regarded as 'traffic flow' in a larger sense.

'Ease of Obtaining Useful Travel Condition Information' ranked third by the drivers and fourth by the managers. This factor was perceived relatively less important to both drivers and managers. As stated in the focus groups, Traveler Information System (TIS) may not be useful in Florida due to the lack of alternative routes. The congestion level of Florida's freeways may be not so serious that the trucking community does not need to use TIS much, or many truck drivers may be regular drivers, who think that they are highly informed about their potential routes enough to not recognize the need of TIS. Level of congestion, frequency of construction activities, and availability of alternative routes may be correlated with this factor.

'Ease of Driving at or above the Posted Speed Limit' ranked fourth by the drivers and second by the managers. This factor description corresponds to what the researchers considered as the 'percent of free-flow speed' factor. Free-flow speeds are typically higher than the posted speed limit, and thus truck drivers may be dissatisfied with a situation where they have to travel at a speed less than the posted speed limit. A considerable number of trucks on the roads are engine speed-governed to travel at a speed less than the posted speed limit. This factor may have been recognized as 'ability to travel at the highest possible speed' by the drivers of those trucks. An overall effect of this factor on the trucking community is best described as 'total travel time'. This factor was regarded as the least important by the drivers, but more important by the managers, who operate the trucks and their drivers to do the trucking business.

Pair-wise multiple comparisons were performed to investigate if there is a mean difference among the importance of each hypothetical freeway performance measure statistically from truck drivers' perspectives. Games-Howell Post Hoc test was used for this purpose because sample sizes and variances of the importance of the performance measures were not equal, even though Q-Q plots showed that the data are approximately normal. The Games-Howell Post Hoc test results for freeway performance measures are shown in Table 5-11. The mean difference between the importance levels of Factor A and B was not significant. However, the mean importance levels of Factor A and B was significantly different from (greater then) those of Factor C and D.

5.3 Perceptions on the Relative Importance of Each Factor on Urban Arterials

The same analysis procedure as in the previous section was performed to evaluate the relative importance of each factor on quality of a truck trip on urban arterials.

5.3.1 Relative Importance of Each Factor

The average Relative Importance, Satisfaction, and Improvement Priority Scores (*RIS*, *RSS*, and *IPS*) of each factor on the quality of a truck trip on urban arterials are presented in Table 5-12. Again, the rankings of each factor relative to *RIS*, *RSS*, and *IPS* are marked as superscripts with the five most important factors for each issue marked in bold.

Other drivers' behaviors (i.e., 'Passenger Car Drivers' Road Etiquette' and 'Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials') were found to be most important and least satisfied, thus most in need of improvement. 'Curb Radii for Right Turning at Intersections' was perceived to be next most important and fairly less satisfied by the drivers, indicating significant need of improvement. 'Pavement Condition' and 'Availability and Condition of Signage' were fourth and fifth most important, but the respondents' satisfaction levels over the factors were relatively high. Thus, those factors were at most moderately in need of improvement among all the factors. 'Level of Congestion' and 'Frequency and Timing of Construction Activities' ranked eighth and ninth with respect to mean *RIS*, respectively, but, the respondents were strongly dissatisfied with those factors. Therefore, the factors were perceived to be significantly in need of improvement. 'Traffic Signal Coordination' was perceived to be sixth most important, but fourth least satisfied, ranking fourth in the *IPS*. 'Level of Bicycle or Pedestrian Congestion' was least important and relatively very highly satisfied, being found to be least in the need for improvement.

Table 5-13 shows the results of the truck company manager surveys. The average relative importance scores of each factor on Overall Trucking Business (*OTB*), Operating Cost (*OC*), On-time Performance (*OP*), and Truck drivers' trip Satisfaction (*TS*) are presented. Again, the five most important factors for each issue are marked in bold.

'Frequency and Timing of Construction Activities' was most important in all the aspects of trucking business. 'Pavement Condition' was perceived second most important to overall trucking business, but not that important to on-time delivery performance. 'Level of Vehicle Congestion' and 'Existence of Left Turn Signal Phase at Intersections' ranked third and fourth, based on the average *OTB* scores. 'Roadway Striping Condition' ranked fifth. 'Curb Radii for Right Turning at Intersections' was perceived to be fairly important to operating cost and truck drivers' trip satisfaction, but almost least important to on-time performance. 'Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials' ranked fifth in average *OC* score and sixth in average *OP* score, but its importance levels to *OTB* and *TS* were found to be much less. 'Coordinated Traffic Signal Timings at Intersections along the Arterials' was fourth most important to on-time performance, but not that important to operating cost or truck drivers' trip satisfaction. It should be noted that the results presented here should be much less focused than the other parts of this document because they came from a small sample size (6–9). It was also not worth comparing the *RIS* with *TS*, given such a small sample size.

An Exploratory Factor Analysis (EFA) was applied to find common factors that account for the patterns of collinearity among the variables. The analysis was executed with a total of 64 truck driver surveys by the principle component extraction method and varimax rotation in SPSS version 15. Bartlett's test of sphericity was found to be significant (χ^2 = 554.7, *df* = 153, < 0.01) and the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.77, justifying application of the factor-analytic procedure. The four factors with latent roots (eigenvalues) greater than one were retained. A scree plot also supported the decision. Table 5-14 displays the latent factors and the rotated factor loadings and communalities of their allied items. Considering the sample size of 64, the items with a loading at 0.6 or above on one factor and less than 0.45 on others were first identified (the loadings on the factor are in bold print). The five items without any loading at 0.6 or above ('Availability and Condition of Signage', 'Frequency and Timing of Construction Activities', 'Roadway Striping Condition', 'Level of Vehicle Congestion', and 'Curb Radii for Right Turning at Intersections') were noted as not loading highly on any factor. They were assigned to one of the factors with respect to the perceptional correlations between the items and factors, or the levels of the factor loadings. The communalities of most items were above 0.5, denoting that more than half of the variance in each of the items is explained by the factor solution.

For quality of a truck trip on urban arterials, 62.5% of the total variance of the observed variables was explained by four latent factors (18.7% by factor 1, 17.2% by factor 2, 13.7% by factor 3, and 12.9% by factor 4), resulting in 37.5% unexplained or lost variance. The first four factors extracted, in order of proportion of variance explained, were labeled 'roadway and traffic components', 'intersection crossing constraints', 'passenger car drivers' behavior', and 'physical driving deterrents' to reflect the meaning and context of the corresponding items.

The basic summated-scale descriptive statistics were calculated for each latent factor to assess its relative importance to the arterial truck trip quality. The mean *RIS* of each item was recalled to compare the relative importance of the items within each factor to the arterial truck trip quality. These results are presented in Table 5-15.

Factor 3 (Passenger Car Drivers' Behavior) included two items and was exclusively most important for arterial truck trip quality among all the factors. Factor 1 (Roadway and Traffic Components) and its allied items were second most important. This factor was correlated with the most number of items, which ranked from fourth to twelfth in mean *RIS* scores. The pavement and signage were most significant items within this factor. The Factor 2 (Intersection Crossing Constraints) was third most important. The primary items of this factor were curb radii and coordinated traffic signal timings. The least important factor was Factors 4 (Physical Driving Deterrents) and the items associated with this factor were also least important among all the items. The importance of this factor was much less than the other three factors, according to the factor summated means.

The EFA results indicate that the respondents did not give out one or two common factor(s) that can potentially be used as performance measure(s) by which truck trip quality on an arterial can be sufficiently evaluated. However, they suggest that potential arterial truck LOS performance measure(s) should be strongly correlated with 'Passenger Car Drivers' Behavior' and also be associated with 'Roadway and Traffic Components' and 'Intersection Crossing Constraints' to some degree.

5.3.2 Applicability of Single Hypothetical Performance Measure to Estimate Truck Trip Quality

The relative importance of each hypothetical performance measure on arterial truck trip quality was asked on the last page of both the truck driver and truck company manager surveys. A total of seven performance measures were presented identically to the two distinct groups of participants, but were questioned differently. The drivers were asked to assess applicability of each performance measure solely to estimate their truck trip quality, while the managers were asked to evaluate the relative importance of each performance measure for their trucking business with respect to overall operating cost, on-time performance, and truck drivers' trip satisfaction. The opinions of 387 driver respondents and 33 manager respondents are summarized in Table 5-16 and Table 5-17, respectively. The two most important measures for each group are marked in bold.

'A Consistently Good Ride Quality' ranked first by the drivers and fourth by the managers, based on the average scores. Again, this factor description primarily corresponds to pavement quality and may also be somewhat correlated with other drivers' poor driving behavior. Similar to the freeway EFA results, this factor was perceived to be most important by the drivers (highest mean and lowest standard deviation), but not that important by the managers.

'Ease of Changing Lanes' ranked second by the drivers and third by the managers. This factor description corresponds to what the researchers considered as 'density' factor. As the traffic volume in a given section of a roadway increases, drivers' ability to change lanes is aggravated. Truck drivers are more sensitive to this factor than the drivers of other vehicle types due to the large size, heavy weight, and poor acceleration and deceleration capabilities of trucks. Truck drivers often need much larger traffic gap and yielding behavior of other drivers to make lane changes. Congestion level and other travelers' driving behavior (road etiquette or knowledge about limitations on truck driving) probably have a great effect on this factor.

'Ease of Right- or Left-Turn Maneuvers' ranked third by the drivers and first by the managers. It requires much more time and effort to make turning maneuvers with trucks than the other vehicle types considering their physical and operational characteristics. This factor is primarily influenced by physical roadway condition of an intersection (e.g., shoulder width, curb radii), but traffic signal operation (e.g., existence of a protected left-turn signal) and other drivers' behavior also have an impact on it. This factor was perceived to be most important to the trucking business by the managers. The managers at the focus group meeting indicated that it creates a serious safety hazard on a truck get stuck in the middle of making a turn and this issue is one of the biggest considerations for their arterial route choice.

'Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit' ranked fourth by the drivers and second by the managers. This factor description corresponds to what the researchers considered as speed or acceleration variance. This factor was relatively more important for the managers than for the drivers. The major elements contributing to this factor may include the level of congestion, intersection spacing, and traffic signal conditions (e.g., signal coordination, signal responsiveness) along the arterial. The importance of this factor was much less for arterial truck trip quality than freeway truck trip quality.

'Ease of Passing through Signalized Intersections along the Arterial' ranked fifth by both the drivers and managers. This factor description corresponds to what the researchers considered as 'number of stops' or 'delay' factor. Based on the previous focus group discussions, truck drivers are more sensitive to number of stops than overall delay experienced while traveling along an arterial. The specific elements contributing to this factor include intersection spacing and traffic signal conditions such as signal coordination, signal responsiveness, length of yellow interval timing at signalized intersections. This factor was perceived to be much less important than ease of turning maneuvers, which implies that they are more concerned with making a safe and easy turning maneuver than reducing number of stops or delay experienced during through movements at intersections.

'Ease of Driving at or above the Posted Speed Limit' ranked sixth by both the drivers and managers. This factor description corresponds to what the researchers considered to be a 'percent of free-flow speed'. The level of this factor directly affects average travel time, which is currently used by the HCM to define level of service on urban arterials. This factor, however, was perceived to be much less important than most other factors by both the drivers and the managers. This factor primarily depends on the level of congestion on an arterial route.

'Ease of U-Turn Maneuvers" was perceived to be least important by both the drivers and managers. According to the focus group discussions, given the high potential safety risks associated with the U-turn maneuvers, many truck drivers are reluctant to make a U-turn unless it absolutely is necessary and most major carriers have a company policy against it.

Pair-wise multiple comparisons were performed to investigate if there is a mean difference among the importance of each hypothetical arterial performance measures statistically from truck drivers' perspectives. The Games-Howell Post Hoc test results for arterial performance measures are shown in Table 5-18. There was no significant mean difference among the importance levels of Factor B, C, and D. The importance of Factor A was greatest, but the mean of the importance of Factor A was barely significantly different (greater) from those of Factor B, C, and D at 95% confidence level. The mean difference between the importance of Factor E and

F was not significant. The mean of the importance level of Factor G was significantly lower than those of other Factors. Overall, the test results suggest that potential arterial performance measure(s) should address various aspects of truck driving conditions such as Factor A, B, C, and D.

5.4 Perceptions on the Relative Importance of Each Factor on Two-Lane Highways

The same analysis procedure as in the previous section was performed to evaluate the relative importance of each factor on quality of a truck trip on two-lane highways.

5.4.1 Relative Importance of Each Factor

The mean Relative Importance, Satisfaction, and Improvement Priority Scores (*RIS*, *RSS*, and *IPS*) of each factor on the quality of a truck trip on two-lane highways are presented in Table 5-19. Again, the rankings of each factor relative to *RIS*, *RSS*, and *IPS* are marked as superscripts with the five most important factors for each issue marked in bold.

Other drivers' behavior (i.e., 'Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Two-Lane Highways' and 'Passenger Car Drivers' Road Etiquette') was found to be most important and least satisfied, thus most in need of improvement. 'Availability and Condition of Signage' and 'Pavement Condition' were perceived to be third and fourth most important, but fairly well satisfied by the truck drivers, so their improvement priority was mediocre among all the factors (eleventh and ninth in the mean *IPS* rankings). 'Lighting Conditions at Night' ranked fifth in the mean *RIS* and *IPS*. Its importance was much greater for two-lane highways than freeways in that it ranked fourteenth and fifteenth in the mean *RIS* and *IPS* for freeways. 'Shoulder Width and Condition' ranked sixth in the mean *RIS*, but third in both the mean *RSS* and *IPS*. It is noted that its importance on travel safety and operation was emphasized in the focus group meetings. 'Frequency and Timing of Construction Activities' were considered to be fourth most in need of improvement. 'Level of Congestion' and

‘Frequency of Passing Lanes’ ranked tenth and eleven in the mean *RIS* respectively, but the respondents were so dissatisfied with these factors that their relative need of improvement was fairly high (sixth and eighth in the mean *IPS* rankings). Similar to the freeway results, TIS-related factors were perceived to be least important and least in need of improvement.

Table 5-20 shows the results of the truck company manager surveys. The average relative importance scores of each factor on Overall Trucking Business (*OTB*), Operating Cost (*OC*), On-time Performance (*OP*), and Truck drivers’ trip Satisfaction (*TS*) are presented. Again, the five most important factors for each issue are marked in bold.

‘Roadway Striping Condition’ ranked first in the mean *OTB* and *OC* scores, but was perceived to be not that important to *OP* and *TS*. ‘Level of Vehicle Congestion’ and ‘Pavement Condition’ were perceived to be fairly important to every trucking business issue, ranking second and third in the mean *OTB* scores, respectively. ‘Passenger Car Drivers’ Knowledge about Truck Driving Characteristics’ ranked fourth in the mean *OTB*, but was perceived to be second most important to *OP* and most important to *TS*. ‘Shoulder Width and Condition’ ranked fifth in the mean *OTB* scores and third in the mean *OC* scores. ‘Frequency and Timing of Construction Activities’ ranked sixth in the mean *OTB* scores, but was perceived to be most important to On-time Performance (*OP*). ‘Sight Distance at Horizontal Curvatures’ and ‘Frequency of Vehicles much Slower than Your Truck’ were perceived to be much more important for *TS* than for the other issues. The importance of ‘Availability and Condition of Signage’ was much less for two-lane highways than for freeways or arterials. ‘Frequency of Faster Vehicles Passing Your Truck’ was least important in the managers’ perspectives. Again, it should be noted that the results presented here should be much less focused than the other parts of this document because they came from a small sample size (4–8). No comparison was made between the *RIS* with *TS*, given such a small sample size.

An Exploratory Factor Analysis (EFA) was applied to find common factors that account for the patterns of collinearity among the variables. The analysis was executed with a total of 64 truck driver surveys by the principle component extraction method and varimax rotation in SPSS version 15. Bartlett's test of sphericity was found to be significant (χ^2 = 485.2, *df* = 171, < 0.01) and the Kaiser–Meyer–Olkin measure of sampling adequacy was 0.59, justifying application of the factor-analytic procedure. The five factors with latent roots (eigenvalues) greater than one were retained. A scree plot also supported the decision. Table 5-21 displays the latent factors and the rotated factor loadings and communalities of their allied items. Considering the sample size of 64, the items with a loading at 0.6 or above on one factor and less than 0.45 on others were first identified (the loadings on the factor are in bold print). The five items without any loading at 0.6 or above ('Shoulder Width and Condition', 'Frequency of Faster Vehicles Passing Your Truck', 'Level of Vehicle Congestion', 'Frequency and Timing of Construction Activities', and 'Lane Widths') were noted as not loading highly on any factor. The one item ('Availability and Condition of Signage') with a factor loading of 0.6 and above on one factor, but equal to or more than 0.45 on the other(s) was considered as loading highly on two or more factors. The six items were assigned to one of the factors with respect to the perceptional correlations between the items and factors, or the levels of the factor loadings. The communalities of most items were above 0.5, denoting that more than half of the variance in each of the items is explained by the factor solution.

For quality of a truck trip on two-lane highways, 61.0% of the total variance of the observed variables was explained by four latent factors (15.1% by factor 1, 13.4% by factor 2, 12.2% by factor 3, 11.2% by factor 4, 9.2% by factor 5), resulting in 39.0% unexplained or lost variance. The first five latent factors extracted, in order of proportion of variance explained, were labeled 'travel safety elements', 'traveler information usage', 'travel speed constraints', 'physical roadway components', and 'passenger car drivers' behavior' to reflect the meaning and context of the corresponding items.

The basic summated-scale descriptive statistics were calculated for each latent factor to assess its relative importance to the two-lane highway truck trip quality. The mean *RIS* of each item was recalled to compare the relative importance of the items within each factor to the two-lane highway truck trip quality. These results are presented in Table 5-22.

Factor 5 (Passenger Car Drivers' Behavior) included two items and was exclusively important for two-lane highway truck trip quality among all the factors. Factor 4 (Physical Roadway Components) and its allied items were second most important. All the items of this factor ranked relatively high in the mean *RIS*. The signage and pavement were the two most significant items within this factor. Factor 3 (Travel Speed Constraints) was third most important. The primary items of this factor were construction and congestion level. Factor 1 (Travel Safety Elements) was second least important, but the mean *RIS* of 'Lighting Conditions at Night' and 'Shoulder Width and Condition' were fairly high (fifth and sixth in the mean *RIS*). The least important factor was Factors 2 (Traveler Information Usage) and the items relative to those factors were also least important among all the items. The importance of this factor was much less than the other four factors, according to the factor summated means.

The EFA results indicate that the respondents did not give out one or two common factor(s) that can be potentially used as performance measure(s) by which truck trip quality on a two-lane highway can be sufficiently evaluated. However, they suggest that potential two-lane highway truck LOS performance measure(s) should be strongly correlated with ‘Passenger Car Drivers’ Behavior’ and also be associated with ‘Physical Roadway Components’ such as signage, pavement, lighting, and shoulder conditions. It is probably true that ‘Travel Speed Constraints’ begin to matter as the traffic volume gets close to roadway capacity due to congestion, construction, or accident.

5.4.2 Applicability of Single Hypothetical Performance Measure to Estimate Truck Trip Quality

The relative importance of each hypothetical performance measure on two-lane highway truck trip quality was asked on the last page of both the truck driver and truck company manager surveys. A total of seven performance measures were presented identically to the two distinct groups of participants, but were questioned differently. The drivers were asked to assess applicability of each performance measure solely to estimate their truck trip quality, while the managers were asked to evaluate the relative importance of each performance measure for their trucking business with respect to overall operating cost, on-time performance, and truck drivers’ trip satisfaction. The opinions of 385 driver respondents and 34 manager respondents are summarized in Table 5-23 and Table 5-24, respectively. The two most important measures for each group are marked in bold.

‘Probability of Bing Passed or Followed by Faster Vehicles’ ranked first by the drivers and fifth by the managers, based on the average scores. This factor description corresponds to what may be considered as ‘Percent-Time-Being-followed’ (PTBF) as the current HCM uses ‘Percent-Time-Spent-Following’ (PTSF) as one of the service measures to determine level of service on two-lane highways. That is, the perceptions of truck drivers on truck trip quality become poor, as more drivers try to follow their trucks in a close proximity or pass them. The perceptional difference between the two groups on this factor was so obvious that this factor was considered to be most important by the drivers, but least important by the managers.

‘A Consistently Good Ride Quality’ ranked second by the drivers and fourth by the managers. This factor description primarily corresponds to pavement quality and may also be correlated with other drivers’ poor driving behavior to some degree. This is a factor that was identified, in the previous section, as most important for truck drivers traveling on freeways or arterials. The importance of this factor was perceived to be greater by the drivers than by the managers.

‘Width of Travel Lane and Shoulder, or Shoulder Type’ ranked third by the drivers and first by the managers. This factor description corresponds to what the focus group participants considered to be ‘amount of room for error’ factor. That is, truck drivers are uncomfortable on a two-lane highway where travel lanes and shoulders are not wide or solid enough for them to deal with an emergency situation without hampering the two-way traffic flow. This was the hottest issue regarding two-lane highway truck trip quality in the focus group discussions. This factor was perceived to be most important by the managers, but not that important by the drivers.

‘Probability of Encountering Possible Conflicts’ ranked fourth by the drivers and third by the managers. This factor contributes to travel safety aspect of truck operation. Ability of truck drivers to deal with unexpected obstacles is inferior to that of the drivers of other vehicle types due to the low acceleration and deceleration capabilities of trucks. As mentioned in the focus group study, truck driving safety is a huge concern for the trucking community. In addition to the damage to the drivers, equipment, and the goods, an accident brings about the considerable increase in truck operating cost (e.g., insurance cost, loss of sales, or loss of the contract with the customers). The importance of this factor was perceived to be at most average among the factors by both the drivers and managers.

'Opportunity for Passing Other Cars, through Passing Zones or Passing Lanes' ranked fifth by the drivers and second by the managers. This factor is highly correlated with 'Percent-Time Spent-Following' concept that is used to define level of service on two-lane highways by the current HCM. The more frequent is the passing opportunity, the less time is spent to follow slower vehicles. Given the long length and low acceleration and deceleration capabilities of trucks, passing maneuver is much more difficult and dangerous for truck drivers than the drivers of other vehicle types. This factor was perceived to be second most important by the managers, but least important by the drivers. The managers may have thought that truck travel time is affected by this factor to a considerable degree.

Pair-wise multiple comparisons were performed to investigate if there is a mean difference among the importance of each hypothetical two-lane highway performance measures statistically from truck drivers' perspectives. The Games-Howell Post Hoc test results for two-lane highway performance measures are shown in Table 5-25. The mean difference between the importance of Factor A and B was not significant. The mean importance level of Factor C was not significantly different from that of Factor D as well. However, the mean importance levels of Factor A and B were significantly different (greater) from those of Factor C and D. The mean importance level of Factor E was significantly lower than those of any other Factors.

5.5 Relative Importance of Each Category of Factors to Quality of a Truck Trip

Four categories of factors on each roadway type were compared amongst each other in terms of their contributions to truck trip quality. The same set of categories (i.e., traffic conditions, roadway conditions, traveler information systems, and other drivers' behavior) were evaluated for both freeway and two-lane highway facilities, while traffic signal conditions were included in the four categories instead of traveler information systems to be appraised for urban arterial facilities.

5.5.1 Relative Importance of Each Category of Factors for Freeways

The perceptions of 40 drivers on the relative importance of the four categories are shown in Figure 5-1. Based on the mean ranking values, the order of the categories, in order from most important to least important, was traffic conditions, other drivers' behavior, roadway conditions, and traveler information systems. The difference in the importance levels between the first two categories was small. The importance level of roadway conditions was 'average' in that about half of the respondents (21/40) considered the third category to be most important or second most important, while a significant portion of the respondents (28/40 or 70%) perceived that traveler information systems are least important.

The perceptions of 7 truck company managers were similar to those of the drivers. The order of the factor categories, in order of their importance based on the mean ranking values, were other drivers' behavior (mean rank = 1.9), traffic conditions (mean rank = 2.0), roadway conditions (mean rank = 2.1), and traveler information (mean rank = 4.0).

5.5.2 Relative Importance of Each Category of Factors for Urban Arterials

The perceptions of 34 drivers on the relative importance of the four categories are shown in Figure 5-2. Based on the mean ranking values, the order of the categories, in order from most important to least important, was traffic conditions, other drivers' behavior, roadway conditions, and signal conditions. The differences in the importance levels among the first three categories were relatively small. However, a considerable portion of the respondents (23/34 or 68%) perceived other drivers' behavior to be either most or least important, while the frequencies of the importance ranks of roadway conditions were almost uniformly distributed. Only 3 respondents (3/34 or 9%) perceived that signal conditions were most important.

The perceptions of 6 truck company managers were similar to those of the drivers. The order of the factor categories, in order of their importance based on the mean ranking values, were traffic conditions (mean rank = 1.5), other drivers' behavior (mean rank = 2.7), roadway conditions (mean rank = 2.8), and signal conditions (mean rank = 3.0).

5.5.3 Relative Importance of Each Category of Factors for Two-lane Highways

The perceptions of 37 drivers on the relative importance of the four categories are shown in Figure 5-3. Based on the mean ranking values, the order of the categories, in order from most important to least important, was roadway conditions, traffic conditions, other drivers' behavior, and traveler information systems. The difference in the importance levels among the first two categories was small. Less than half of the respondents (18/37) considered other drivers' behavior is either most or second most important, while more than half (20/37 or 54%) perceived that traveler information systems were least important.

Five truck company managers perceived traffic conditions to be most important (mean rank = 1.6). The order of the rest of the factor categories, in order of their importance based on the mean ranking values, were other drivers' behavior (mean rank = 2.2), roadway conditions (mean rank = 2.6), and traveler information (mean rank = 3.6).

5.6 Comparisons of the Importance of Each Factor Category on Various Roadway Facilities

The importance levels of each factor category were compared across the three roadway facility types (i.e., freeways, urban arterials, and two-lane highways) to investigate the relative importance of each factor category between facilities. This comparison is shown in Figure 5-4.

The importance of roadway conditions was greater for two-lane highways than for the other two facilities. The importance levels of roadway conditions for freeways and arterials were somewhat similar, but only 10 percent of the respondents (4/40) considered this factor for freeways to be least important while almost 25 percent of the respondents (8/34) considered this factor for arterials to be least important.

The relative importance of traffic conditions for the three roadway facilities is shown in Figure 5-5. The importance of traffic conditions was much more significant for freeways than for the other two facility types. Almost 70 percent of the respondents (27/40) considered this factor to be at least second most important and only 10 percent (4/40) considered this factor to be least important. The importance of this factor for two-lane highways was little greater than that for arterials in that 65 percent of the respondents (24/37) considered this factor for two-lane highways to be at least second most important while 53 percent (18/34) did for arterials.

The relative importance of other drivers' behavior for the three roadway facilities is shown in Figure 5-6. The importance of this factor was less for two-lane highways than for the other two facilities. The importance of this factor for freeways was somewhat bigger than that for arterials in that only 13 percent of the respondents (5/40) considered this factor for freeways to be least important while more than 30 percent (11/34) considered this factor for arterials to be least important.

5.7 Perceptions on the Improvement Priority of Various Roadway Types

Twenty-five truck drivers answered the question about the improvement priority of the four types of roadway facilities (i.e., freeways, urban arterials, rural multilane highways, and rural two-lane highways). Figure 5-7 shows the distributions of the responses on the relative improvement priority. Based on the mean ranking values, the order of the roadway types, in order from highest to lowest, identified as most in need of improvement was urban arterials, rural multilane highways, rural two-lane highways, and freeways. The differences in the need for improvement rankings among the first three facility types were small. Rural multilane highways, overall, were identified as only moderately in need of improvement. Eighty-eight percent of the respondents (22/25) indicated that this facility type is either second or third most in need of improvement. The rankings on the relative improvement need of freeways varied the most. Out of the total of 25 drivers, seven drivers (28%) perceived the freeway facility to be most in need of improvement and twelve drivers (48%) perceived it to be least in need of improvement. The perceptions of 5 truck company managers also showed similar results. Based on the mean ranking values, it turned out that urban arterials were perceived to be most in need of improvement (mean rank = 2.0). Rural multilane and two-lane highways followed next (mean rank = 2.6). Again, freeways were perceived to be least in need of improvement (mean rank = 2.8).

5.8 Relationships between Truck Drivers' Backgrounds and Their Perceptions on the Applicability of Each Hypothetical LOS Performance Measure

Potential correlations between truck drivers' working and socio-economic characteristics and their perceptions on applicability of each hypothetical performance measure for truck LOS estimation (hereafter referred to as just 'importance of each performance measure) were investigated with non-parametric statistical tests. Each background characteristics of the drivers (a potential explanatory variable) was individually tested with their perceptions, in order to find out whether their perceptions significantly varied by the levels of the background characteristics. The Kruskal-Wallis test and Mann-Whitney test (non-parametric version of Analysis of Variance (ANOVA) and *t*-test) were applied to the truck driver survey data. The truck drivers' background characteristics used in these analyses are presented in Table 5-26 and 5-27. The variables with only two levels were evaluated with Mann-Whitney test to investigate if the two samples came from the same population. The variables with three levels were evaluated with the Kruskal-Wallis test to investigate if they came from the same population. For the variables that were significant in the Kruskal-Wallis test, they were evaluated again with the Mann-Whitney test for the pair-wise comparisons to find out which items were different one another.

5.8.1 Truck Drivers' Backgrounds that Explain Their Perceptions on the Importance of Each Hypothetical LOS Performance Measure on Freeways

The correlations between each background characteristics of the drivers and their perceptions on the importance of each freeway performance measure were investigated. The results of the Kruskal-Wallis and Mann-Whitney tests are shown in Table 5-28 and 5-29. The perceptional difference by truck kinds and the type of goods carried was not statistically significant, so it was not tabulated.

The perceptions on the importance of 'A Consistently Good Ride Quality' (Factor A) differed by recruitment sources, earning methods, and current truck driving time of day. The postage-paid survey respondents considered this factor to be more important than the FTDC respondents. It is noted that over 90 percent of the postage-paid respondents were long-haul drivers, while more than half of the FTDC respondents were short-haul drivers. Truck drivers getting paid by miles driven perceived this factor more important, while those paid by hours driven perceived it less important. It is typical that long-haul drivers normally get paid by the mile, but short-haul drivers usually get paid by the hour to get compensated by the delay they often experience in traveling urban environments. Truck drivers currently driving between noon and 3 PM perceived this factor to be less important than others did. The results show that truck drivers having some general characteristics of long-haul drivers (frequent freeway users) perceived this factor to be more important than others did. They travel at a much higher speed than short-haul drivers, so are likely to be more sensitive to ride quality.

The perceptions on the importance of 'Ease of Maintaining a Consistent Speed, Whether Higher or Lower than Posted Speed Limit' (Factor B) varied by race and level of education.

African American truck drivers, in particular, perceived this factor to be less important, but drivers educated at least up to college level had more preference on this factor than others did. The importance of this factor may be more noticeable by drivers educated more than others.

The perceptions on the importance of 'Ease of Obtaining Useful Travel Conditions Information' (Factor C) differed by recruitment sources, earning methods, maximum governed truck speed, and level of education. The postage-paid survey respondents considered this factor to be more important than the FTDC respondents. Truck drivers getting paid by miles driven perceived this factor more important than others did. Truck drivers whose truck is speed-governed at more than 65 mi/h considered this factor to be more important than others did. Truck drivers educated at least up to college level perceived this factor to be more important. Again, the truck drivers having some general characteristics of long-haul drivers (frequent freeway users) perceived this factor to be more important than others did. Truck drivers educated more than other drivers may be more concerned with various TIS technologies.

The perceptions on the importance of 'Ease of Driving at or above the Posted Speed Limit' (Factor D) differed by recruitment sources, earning types, company types, primary load types, hauling distance, maximum governed truck speed, and truck driving time of day. The postage-paid survey respondents considered this factor to be more important than the FTDC respondents. Truck drivers getting paid by hours perceived this factor less important than others did. Truck drivers from for-hire or TL carriers perceived this factor to be more important than the others did. Long-haul drivers were more sensitive to this factor than short-haul drivers. Truck drivers whose truck is speed governed at more than 65 mi/h considered this factor to be more important than others did. Truck drivers currently driving in the morning time (9AM–noon) were less sensitive to this factor. It is just natural to consider that long-haul drivers (frequent freeway users) are more concerned about this factor than short-haul drivers, because it will be much more frustrating to not be able to drive at or above the posted speed limit on a freeway than on an arterial.

5.8.2 Truck Drivers' Backgrounds that Explain Their Perceptions on the Importance of Each Hypothetical LOS Performance Measure on Urban Arterials

The correlations between each background characteristics of the drivers and their perceptions on the importance of each arterial LOS performance measure were investigated. The results of the Kruskal-Wallis and Mann-Whitney tests are shown from Table 5-30 to 5-34. The perceptional difference by truck kinds was not statistically significant, so it was not tabulated.

The perceptions on the importance of 'A Consistently Good Ride Quality' (Factor A) varied by maximum governed truck speed and truck driving hours per day. Truck drivers whose truck is speed-governed at more than 65 mi/h perceived this factor more important than others did. Truck drivers traveling at a higher speed are likely to be more concerned about the ride quality. Truck drivers driving more than 8 hours per day were less sensitive to this factor. Truck drivers working more hours per day may get relatively numb about the ride quality.

The perceptions on the importance of 'Ease of Changing Lanes' (Factor B) differed by earning methods, truck driving hours per day, and types of goods carried. Truck drivers who get paid by the load considered this factor to be less important than the other drivers. Truck drivers driving more than 8 hours per day were less sensitive to this factor. Long-haul drivers may drive more hours per day than short-haul drivers, and those frequent freeway users may be less concerned with lane changing movements than drivers often traveling in urban environments. Truck drivers carrying food, auto parts, textiles, metals, paper and allied products, chemicals and allied products, equipment, furniture, or hazardous materials were more concerned about this factor than other drivers. The truck drivers delivering those damage-sensitive goods, probably by operating relatively large trucks may be more sensitive to a potential conflict with other vehicles, feeling more difficulty in changing lanes.

The perceptions on the importance of 'Ease of Right- or Left-Turn Maneuvers' (Factor C) differed by earning methods, company business types, truck driving hours per day, and types of goods carried. Truck drivers who get paid by the load perceived this factor to be less important than other drivers. Truck drivers from companies operating both for-hire and private businesses had less concerns on this factor than other drivers from either private or for-hire truck companies. Truck drivers driving more than 8 hours per day were less sensitive to this factor. Again, long-haul drivers may drive more hours per day than short-haul drivers, and those frequent freeway users may be less concerned with those turning movements than drivers often traveling in urban environments. Truck drivers carrying paper or allied products considered this factor to be important more than other drivers.

The perceptions on the importance level of either 'Ease of Maintaining a Consistent Speed, Whether Higher or Lower than Posted Speed Limit' (Factor D), or 'Ease of Passing through Signalized Intersections along the arterial' (Factor E) did not vary by any background characteristics of the survey respondents.

The perceptions on the importance level of 'Ease of Driving at or above the Posted Speed Limit' (Factor F) differed by recruitment sources, earning methods, primary load types, hauling distance, maximum governed truck speed, percent of late delivery, and truck driving days per week. Long-haul drivers or truck drivers having some general characteristics of long-haul drivers (i.e., postage-paid survey respondents, drivers operating a truck with more than 65 mi/h of a maximum engine-governed speed, TL drivers, and truck drivers working more than 5 days per week) perceived this factor to be more important than others did. Again, this factor is important for the drivers traveling longer time and distance for deliveries. They mostly drive on freeways to save their travel time and those frequent freeway users will get relatively easily frustrated for not being able to travel at a free-flow speed. Truck drivers who get paid by hours (mostly short-haul drivers) were less sensitive to this factor. Those at most 5 percent of whose truck trips are late were more sensitive to this factor. This factor is highly associated with travel time aspect of a truck trip. They may be so much concerned with travel time that they rarely are late for their deliveries.

The perceptions on the importance level of 'Ease of U-Turn Maneuvers' (Factor G) varied by recruitment sources, age, earning methods, company business types, hauling distance, percent of late delivery, truck driving hours per day, truck driving time of day, and types of goods carried. Postage-paid survey respondents perceived this factor to be less important than FTDC respondents. Middle-aged truck drivers were more concerned about this factor than young drivers. Truck drivers who get paid by hours were more sensitive to this factor, while those paid by the load were less sensitive to this factor. Truck drivers from private carriers perceived this factor to be more important than others did. Short-haul drivers or those more than 5 percent of whose truck trips are late were more concerned about this factor. Truck drivers working more than 8 hours per day or those currently driving at the time period between 6AM and 9AM considered this factor to be less important than others did. Truck drivers carrying food, in particular, were more concerned about this factor. Overall, short-haul drivers or truck drivers having some general characteristics of short-haul drivers (i.e., FTDC survey respondents, drivers getting paid by the hour, drivers with more than 5 percent of their trips late, and drivers carrying foods) perceived this factor to be more important than others did. They are the primary truck mode users on urban arterial facilities.

5.8.3 Truck Drivers' Backgrounds that Explain Their Perceptions on the Importance of Each Hypothetical LOS Performance Measure on Two-Lane Highways

The correlations between each background characteristics of the drivers and their perceptions on the importance of each two-lane highway LOS performance measure were investigated. The results of the Kruskal-Wallis and Mann-Whitney tests are shown from Table 5-35 to 5-37.

The perceptions on the importance of 'Probability of Being Passed or Followed by Faster Vehicles' (Factor A) differed by recruitment sources, gender, level of truck driving experience, percent of empty truck trips, race, current truck driving time of day, type of goods carried, and truck types. Postage-paid survey respondents considered this factor to be important more than FTDC respondents did. They mostly are long-haul drivers, probably using two-lane highways more often than short-haul drivers. Male drivers or Hispanic drivers were concerned with this factor more than others did. They may be more likely to get impatient when being passed or followed by other vehicles than other truck drivers may. Truck drivers with at least 15 years of job experience were less concerned with this factor than others were. They may have become less sensitive to this factor, having plenty of experience with this factor. Truck drivers with more than 25 percent of their truck trips empty perceived this factor to be less important than others did. When they drive an empty truck, it is a lot easier for them to maneuver (i.e., accelerate or decelerate) due to its lighter weight and no possible freight damage, being less sensitive to the other vehicles following or passing their truck. Truck drivers traveling at the time period between noon and 3PM perceived this factor to be more important than others did. Truck drivers carrying auto parts, stone, clay, or concrete products perceived this factor to be more important than the others did, while the drivers carrying unknown packages (FedEx packages) or drivers operating a straight (single unit) truck, in particular, were less concerned about this factor. It is likely that truck drivers carrying heavy or damage-sensitive goods, or driving larger trucks are more concerned with this factor because their maneuverability is much more inferior to that of other truck drivers.

The perceptions on the importance of 'A Consistently Good Ride Quality' (Factor B) differed by percent of late delivery, annual income level, number of working days per week, types of goods carried, and truck types. Truck drivers more than 5 percent of whose truck trips are late perceived this factor to be less important than others did. It is possible that drivers who are more punctual on deliveries drive at a higher speed than other drivers do, being more concerned with the ride quality. Truck drivers with annual income between $50,000 and $70,000 were more concerned about this factor. Truck driver carrying grains/feed perceived this factor to be more important than other did. They may be afraid of their grains/feed falling out of their truck, being more concerned with the ride quality than other truck drivers. Truck drivers working more than 5 days per week were more concerned about this factor, while those operating turnpike double were less concerned about this factor.

The perceptions on the importance of 'Width of Travel Lane and Shoulder, or Shoulder Type' (Factor C) varied by annual income level and types of goods carried. Truck drivers with annual income between $50,000 and $70,000 were more concerned about this factor. Truck drivers carrying grains/feed or hazardous materials were more sensitive to this factor. They may often need more spaces (i.e., part of shoulder width) than just one narrow lane to feel safe to travel with those collision-sensitive materials, or the importance of an adequate shoulder width and good shoulder condition (i.e., hard pavement) is greater for those drivers to park their truck safely in case of emergency (e.g., a tire-blowout) than for other truck drivers, due to worse consequences accompanied by a potential conflict with other vehicles in the main traffic stream.

The perceptions on the importance of 'Probability of Encountering Possible Conflicts' (Factor D) varied by recruitment sources, level of truck driving experience, primary load types, percent of truck trips that are not made on familiar roads, truck driving time of day, and types of goods carried. Postage-paid survey respondents considered this factor to be more important than the FTDC respondents. Most of them were long-haul drivers, who travel two-lane highways more often than short-haul drivers. Truck drivers with less than 5 years of truck driving experience considered this factor to be more important than others. They have less experience traveling on two-lane highways, thus may be more cautious about potential conflicts on the roads. Truck drivers from a truck company which operates both TL and LTL were more concerned about this factor than those from a company operating either TL or LTL. Truck drivers who travel on a familiar road less often were more concerned about this factor. Truck drivers will be more likely to be afraid of a potential conflict when they travel on an unfamiliar road. Truck drivers traveling during the time period between 7PM and midnight were less concerned about this factor, while those carrying waste and scrap were more concerned about this factor.

The perceptions on the importance of 'Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes' (Factor E) varied only by truck types. Truck drivers operating truck/trailer perceived this factor to be more important than other drivers did. They were more concerned with this factor probably because it is more difficult for them to find a chance to pass other vehicles due to the large length of their truck than for straight truck, or tractor semi-trailer truck drivers.

5.9 Perceptions on Truck Driving Environment by Time of Day

A total of 147 truck drivers answered the questions pertaining to the time of day that they currently drive their truck and the time of day that they would prefer to drive it. A multiple-response question was utilized for this issue, so the response frequencies exceeded the number of respondents. The response frequencies of current and preferred truck driving times of day were observed to explore how the quality of truck driving environment may differ by time of day. The intent of these questions was to determine whether drivers perceive conditions to be better at other times of day than the times that they actually travel, since many drivers do not have control over their driving times. The relationships between the drivers' backgrounds and their preference on truck driving time of day were also investigated.

5.9.1 Current and Preferred Truck Driving Time of Day

The distribution of the current and preferred truck driving time of day of the drivers are presented in Figure 5-8. A considerable number of the drivers (34/147 or 23%) were not driving at specific times of day regularly. The time period most used and preferred for truck driving was from 9AM to noon, while a small portion of the drivers were driving or preferred to drive their truck between 7PM and midnight. The time periods between 6AM and 9AM, noon and 3PM, and 3PM and 7PM were used for truck driving to a similar degree, but more drivers (56/147 or 38%) preferred to drive between 6AM to 9AM while fewer drivers (33/147 or 22%) preferred to drive between 3PM and 7PM. Ten percent more drivers (51/147 or 35% versus 37/147 or 25%) preferred to drive from midnight to 6AM than were actually driving during that time period. Overall, most of the drivers were driving during the day time (6AM–7PM). The time period from midnight to noon was relatively more preferred by the drivers than that from noon to midnight.

The preference on truck driving times of day was also examined from another perspective. It was examined whether the drivers who currently drive during each time period still preferred to drive during that same time interval. These proportions are shown in Figure 5-9. This was to observe how much portion of the drivers using each time frame still prefers to drive on the time period. The time periods between midnight and 3PM were generally preferred by about 80–90 percent of the current users, while the time periods between 3PM and midnight were preferred by only about 55–60 percent of the current users.

A total of 38 truck company managers identified their preference on truck driving time of day as shown in Figure 5-10. Most of the respondents preferred night-time deliveries. A significant portion of them (22/38 or 58%) preferred their drivers to travel between midnight and 6AM, while day time (from 9AM to 7PM) was hardly preferred as truck driving time by the respondents.

5.9.2 Relationships between Truck Drivers' Backgrounds and Their Perceptions on Preferred Truck Driving Time of Day

Potential correlations between truck drivers' working and socio-economic characteristics and their preference on different truck driving times of day were investigated with a categorical data analysis method. Each background characteristics of the respondents was individually tested if their preferences on truck driving times of day vary by the levels of the background characteristics. Chi-squared test of independence were applied to the survey data. When a variable (i.e., background characteristics) with three levels was significant in the test, Chi-squared test was performed again for each pair of the levels of the variable to observe how the perceptions differed by different levels of the variable. The Chi-squared test results are presented from Table 5-38 to 5-41.

The preference of truck driving time of day between midnight and 6AM (Time Period A) varied by truck company types, primary load types, hauling distance, number of working days per week, fleet size, type of goods carried, and truck types. Truck drivers from private truck companies, long-haul drivers, TL drivers, or drivers working more than 5 days per week preferred to travel during this time period more than others did. Truck drivers whose truck company operates between 500 and 10,000 trucks had more preference on this time period than those working for a company with at least 10,000 or less than 500 trucks. The preferences on this time period of truck drivers carrying grains/feed, household goods of stationary, auto parts, vehicles, machinery, textiles, metals, manufactured goods, waste and scrap, equipment, furniture, wood products, stone, clay, and concrete products, glass, and hazardous materials was less than those of other truck drivers. Truck drivers operating twin trailer, 3- or 4-axle semi-trailer less preferred to travel during this period, while those operating larger trucks such as 5-axle semi-trailer or rocky mountain double more preferred to travel during this period. Overall, the results show that truck drivers traveling more distance, carrying heavier freight, or operating larger trucks more preferred to travel during this time period. They may more prefer to travel at between midnight and 6AM to avoid traffic congestion more frequently occurring during day time. The maneuverability of their truck is likely to be much more restricted than that of other trucks, due to the more weight or size of their truck.

The preference of truck driving time of day between 6AM and 9AM (Time Period B) varied by earning methods and truck types. Truck drivers who get paid by the mile less preferred to travel during this time period, while truck drivers operating 3-axle semi-trailer preferred to drive during this time period more than others. Most truck drivers getting paid by the mile will try to avoid this AM peak time (6AM – 9AM) because they cannot travel as much farther as they can travel during other times of day.

The preference of truck driving time of day between 9AM and noon (Time Period C) varied by earning methods, primary load types, hauling distance, number of working days per week, type of goods carried, and truck types. Truck drivers who get paid by the mile less preferred to travel during this time period, while those who get paid by the hour had more preference on this time period. LTL drivers more preferred this time period than TL drivers. Short-haul drivers had more preference on this time period, while drivers working more than 5 days per week less preferred to travel during this time period than others. The preference on this time period of truck drivers carrying grains/feed, household goods of stationary, auto parts, vehicles, machinery, textiles, metals, manufactured goods, chemicals and allied products, paper and allied products, coal and petroleum, equipment, furniture, wood products, stone, clay, and concrete products was more than those of other truck drivers. Truck drivers operating 3- or 4-axle semi-trailer more preferred to travel during this period than others. Overall, the results show that short-haul drivers or drivers having some general characteristics of short-haul drivers (i.e., truck drivers getting paid by the hour, truck drivers carrying lighter freight) more preferred to travel during this time period. Short-haul drivers usually get paid by the hour to get compensated for traffic delay experienced on the roads unintentionally. Most of them travel in relatively urbanized areas during day time, so are much more likely to experience traffic delay. However, they may not feel the need to avoid the delay by traveling at night time since they get paid by the hour. It is also true that their delivery schedule is set up during day time that they have no choice but to travel during day time. Most shippers and receivers will not be available at night time for short-haul deliveries.

The preference of truck driving time of day between noon and 3PM (Time Period D) varied by earning methods, primary load types, hauling distance, percent of late delivery, number of working days per week, type of goods carried, and truck types. Truck drivers who get paid by the mile had less preference on this time period. LTL drivers more preferred this time period than TL drivers. Short-haul drivers, or drivers working at most 5 days per week more preferred to travel during this time period than others did. Truck drivers more than 5 percent of whose deliveries are late had more preference on this time period. The preferences on this time period of truck drivers carrying grains/feed, household goods of stationary, auto parts, vehicles, textiles, livestock, metals, manufactured goods, chemicals, paper and allied products, coal and petroleum, waste and scrap, equipment, furniture, stone, clay, and concrete products, and glass were greater than those of other truck drivers. Truck drivers operating 4-axle semi-trailer preferred to travel during this period more. Again, short-haul drivers or drivers having some general characteristics of short-haul drivers (i.e., truck drivers carrying lighter freight, truck drivers more than 5 percent of whose deliveries are late) more preferred to travel during this time period than other drivers. Short-haul drivers relatively often travel in urbanized areas, so there is more chance of being late for a delivery.

The preference of truck driving time of day between 3PM and 7PM (Time Period E) varied by number of working days per week and type of goods carried. Truck drivers working more than 5 days per week less preferred to travel during this time period than others did. Truck drivers carrying textiles, coal and petroleum, equipment, stone, clay, and concrete products, or glass had more preference on this time period.

The preference of truck driving time of day between 7PM and midnight (Time Period F) varied by independence, earning methods, maximum governed truck speed, and truck types. Truck drivers having some general characteristics of long-haul drivers (i.e., independent truck drivers, truck drivers who get paid by the mile, or drivers whose truck is governed at more than 65 mi/h) had more preference on this time period. There is less traffic during this time period than during day time, so they can go a longer distance by driving faster. Truck drivers operating straight (single unit) truck or twin trailer had more preference on this time period as well. It is not clear why they preferred to travel during this time period.

5.10 Other Transportation Service Issues for Truck Drivers

The survey respondents were asked to list any other factors that might be important to truck trip quality in addition to the ones presented in the surveys. The driver survey participants at the FTDC event did not provide inputs on this matter, probably due to the long length and complexity of the survey. However, various other factors were pointed out by the postage-paid mail-back driver survey respondents. Each of those factors is listed with its frequency (i.e., the number of respondents who mentioned the factor) in this section. Most manager respondents did not list any other factor. Some respondents repeated the factor(s) that were already given in the surveys. It was intended to not include those factors in the lists.

5.10.1 Freeway Truck Operations

The other factors contributing to truck trip quality on freeways are listed in Table 5-42. ‘Availability and security of truck parking facilities’, ‘frequency of scale/inspection stations along a route’, and ‘accessibility or location of truck stops’ were mentioned by more than one respondents. As far as other drivers’ behavior is concerned, a number of specific factors were identified, and thus separately summarized in Table 5-43. The respondents were sensitive to ‘slow vehicles in the left-most or center lane’. This issue is obviously correlated with the implementation of left-lane truck restriction. ‘Education of motoring public about truck driving characteristics’, ‘other drivers’ improper use of turn signals’, and ‘other drivers’ use of cell phones without hands-free devices’ were pointed out by more than one respondent. Many respondents also showed their repeated concerns about truck lane restriction, frequency and timing of construction activities, and speed differential between cars and trucks, even though they were evaluated in the previous sections of the surveys.

5.10.2 Urban Arterial Truck Operations

The other factors contributing to truck trip quality on urban arterials are listed in Table 5-44. ‘Various aspects of signage condition’ were identified by four respondents. ‘Availability, size, and law enforcement of truck parking spaces’ were mentioned by three respondents and two respondents were concerned with ‘night-time lighting condition’. With respect to other drivers’ behavior, ‘frequency of the drivers cutting off in front of trucks’ and ‘frequency of the drivers speeding up not to allow trucks to change lanes’ were mentioned by two respondents, respectively.

5.10.3 Two-Lane Highway Truck Operations

The other factors contributing to truck trip quality on two-lane highways are listed in Table 5-45. ‘Availability of turning maneuvers’ was identified by two respondents. Unlike passenger car drivers, truck driver have difficulty turning their truck when they happen to travel in the wrong direction on a two-lane highway, due to its big size. They may have to wait until they reach an intersection wide enough for them to turn. Two respondents were concerned with ‘frequency of school buses’. When truck drivers travel behind a slow school bus on a long stretch of a two-lane highway, they are not allowed to pass it, having to follow it for a long time. ‘Traffic signal operational characteristics in small towns on a route’ was identified by two respondents as well. Truck drivers often have to pass small towns on two-lane highway routes. They want to minimize delays and number of stops experienced in the small towns as they do on urban arterial routes.

Table 5-1. Truck Driver Survey Respondent Background Summary Statistics

Variable	Surveys collected at FTDC event	Postage-paid Mail-back Surveys	Total Surveys
Gender (%): male/female/NA[1]	99/1/0	90/7/3	93/5/2
Age in years (%): 20–29/30–39/40–49/50–59/60+/NA	4/24/48/21/3/0	4/17/36/28/13/2	4/19/40/26/10/1
Existence of dependents (%): yes/no/NA	92/7/1	77/21/2	82/16/2
Average truck driving job experience in years (standard deviation in parenthesis)	18.1 (8.9)	17.3 (11.5)	17.6 (10.7)
Company type (%): private/for-hire/both/NA	36/55/7/2	14/71/13/2	21/66/11/2
Load type (%): TL/LTL/both/NA	36/42/21/1	63/8/27/2	54/19/25/2
Owner-Operator truck driver (%): yes/no/NA	7/93/0	32/67/1	24/75/1
Average one-way truck driving distance for a delivery in miles (standard deviation in parenthesis)	298 (479)	856 (625)	674 (637)
Truck travel route and departure time determination (%): Driver/manager/both/NA	9/62/28/1	39/25/35/1	29/37/33/1
Hauling distance (%): short haul/long haul/both/NA	55/42/2/1	6/92/0/2	22/76/1/1
Truck speed governed (%): yes/no/NA	96/3/1	74/24/2	81/17/2
Average governed truck speed in miles per hour (standard deviation in parenthesis)	65.5 (3.3)	70.1 (5.5)	68.4 (5.3)
Earning methods (multiple choices, %): by mile/hour/salary/drop/load/other	34/42/4/14/4/2	64/6/2/11/16/1	53/20/3/12/11/1
Average percent of truck trips that are empty (standard deviation in parenthesis)	16.2 (16.7)	17.8 (16.1)	17.3 (16.3)
Average percent of truck deliveries that are late (standard deviation in parenthesis)	6.2 (12.2)	2.0 (4.5)	3.3 (8.1)
Average percent of truck trips that are made on unfamiliar roads (standard deviation in parenthesis)	8.7 (12.9)	17.4 (19.9)	14.6 (18.5)

(1) Not Available survey responses (the respondents did not answer the question.)

Table 5-2. Additional Truck Driver Survey Respondent Background Summary Statistics (only from the respondents at FTDC event)

Variable	Surveys collected at FTDC event
Race (%): Caucasian/Native American/African American/Hispanic/Others	70/5/6/17/2
Education level (%):	
Some or no high school/High school diploma or equivalent/	6/76/
Technical college degree (A.A.)/College degree/Post-graduate degree/NA[(1)]	9/7/1/1
Annual income level in thousand dollars (%):	
25–34/35–49/50–69/70–99/100+/NA	2/20/54/18/3/3
Company fleet size in number of trucks (%):	
<50/50–99/100–499/500–999/1,000–4,999/5,000–10,000/10,000+/NA	5/3/14/13/12/21/31/1
Average truck driving days per week (standard deviation in parenthesis)	5.1 (0.6)
Average truck driving hours per day (standard deviation in parenthesis)	9.9 (2.1)
Average number of nights per week away from their home for a delivery (standard deviation in parenthesis)	1.3 (2.1)
Average percent of number of truck trips on each roadway type:	
freeway/rural multilane highway/rural 2-lane highway/urban arterial	51/17/14/17
Average percent of truck driving hours on each roadway type:	
freeway/rural multilane highway/rural 2-lane highway/urban arterial	52/16/15/17
Truck types (multiple choices, %):	
Straight truck/Truck trailer/Twin trailer or Doubles/	6.3/3.9/19.1/
3-axle tractor semitrailer/4-axle tractor semitrailer/5-axle tractor semitrailer/	11.7/19.1/33.2/
Truck double trailer/Turnpike double/Tank truck/Flat bed	0.4/2.0/2.0/2.3
Type of goods carried (multiple choices, %):	
food/grains, feed/household goods or stationary/auto parts/vehicles/	7.6/4.1/7.6/6.3/1.8/
machinery/textiles/livestock/metals/manufactured goods/chemicals/	4.7/5.7/0.4/4.9/6.9/5.7/
paper and allied products/coal or petroleum/chemicals and allied products/	6.5/1.1/3.7/
waste and scrap/equipment/furniture/wood products except furniture/	1.4/4.8/5.7/4.6/
stone, clay, and concrete products/glass/hazardous materials/	4.9/4.7/5.7/
unknown packages (LTL)/flower	0.6/0.2

[(1)] Not Available survey responses (the respondents did not answer the question.)

Table 5-3. Truck Company Manager Survey Respondent Background Summary Statistics

Variable	Total Surveys
Gender (%): male/female	89/11
Age in years (%): 20–29/30–39/40–49/50–59/60+	3/21/26/37/13
Average truck company manager job experience in years (standard deviation in parenthesis)	12.8 (10.9)
Company type (%): private/for-hire/both	24/68/8
Load type (%): TL/LTL/both/NA[1]	66/13/16/5
Job duties as a truck company manager (multiple choices, %):	
Manage truck travel routes and schedules for delivery	31
Manage trucking equipment or facilities	8
Manage truck operation safety	33
Make contracts with customers or manage public relations	20
Manage personnel	8
Company fleet size in number of trucks (%): <50/50–99/100–499/500–999/1,000–4,999/5,000–10,000/10,000+/NA	18/3/29/13/16/13/5/3
Average percent of hauling distance of the truck trips their companies make (standard deviation in parenthesis):	
Short haul	47.3 (39.2)
Long haul	52.7(39.2)
Average percent of independent truck drivers working at their companies (standard deviation in parenthesis)	25.2 (40.4)
Average percent of their companies' truck deliveries that are late (standard deviation in parenthesis)	8.9 (9.6)
Average percent of their truck delivery service performance level that is evaluated by on-time delivery (standard deviation in parenthesis)	76.5 (32.8)
Preferred truck driving time (multiple choices, %):	
Midnight–6am/6am–9am/9am–noon/ Noon–3pm/3pm–7pm/7pm–midnight	47/21/7/ 4/6/15
Average percent of the respondents' concerns on following issues on Florida's transportation services for trucking business (standard deviation in parenthesis):	
Operating cost	46.8 (21.6)
On-time performance	30.1 (22.8)
Truck drivers' trip satisfaction	24.1 (15.0)

[1] Not Available survey responses (the respondents did not answer the question.)

Table 5-4. Additional Truck Company Manager Survey Respondent Background Summary Statistics (only from the respondents at FTDC event)

Variable	Surveys collected at FTDC event
Truck travel route and departure time determination (%):	
Driver/manager/both driver and manager/	18/55/9/
customer/driver, manager, and customer	9/9
Annual income level in thousand dollars (%):	
20–29/30–39/40–49/	9/18/18/
50–69/70–99/100–149	28/18/9
Education level (%):	
High school diploma or equivalent/	64/
Technical college degree (A.A.)/College degree	18/18
Methods by which truck drivers of their companies get paid (multiple choices, %):	
By mile/hour/salary/drop/load/other	34/42/4/14/4/2
Truck types their companies typically operate (multiple choices, %):	
Straight truck/Truck trailer/Twin trailer or Doubles/	20/4/12/
3-axle tractor semitrailer/4-axle tractor semitrailer/5-axle tractor semitrailer/	4/16/32/
Tank truck/Dump truck/Fat bed	4/4/4
Type of goods carried by their companies (multiple choices, %):	
food/grains, feed/household goods or stationary/auto parts/vehicles/	12.0/4.5/6.0/6.0/0.0/
machinery/textiles/livestock/metals/manufactured goods/chemicals/	4.5/4.5/0.0/7.0/9.0/6.0/
paper and allied products/coal or petroleum/chemicals and allied products/	7.5/0.0/4.5/
waste and scrap/equipment/furniture/wood products except furniture/	1.5/3.0/4.5/6.0/
stone, clay, and concrete products/glass/hazardous materials/others	1.5/1.5/6.0/4.5

Table 5-5. Truck Drivers' Perceptions on Each Factor on Truck Travel Quality of Service on Freeways

Factor	Mean *RIS*[a] (Rank in Parentheses)	Mean *RSS*[b] (Rank in Parentheses)	Mean *IPS*[c] (Rank in Parentheses)
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	**6.69 (1)**	**1.95 (1)**	**27.46 (1)**
Passenger Car Drivers' Road Etiquette	**6.49 (2)**	**2.09 (2)**	**25.58 (2)**
Availability and Condition of Signage	**6.28 (3)**	5.13 **(19)**	2.36 **(16)**
Pavement Condition	**6.06 (4)**	4.39 **(12)**	5.62 **(9)**
Level of Congestion	**6.01 (5)**	**3.28 (4)**	**12.30 (4)**
Lane Widths	5.88 **(6)**	4.93 **(18)**	2.35 **(17)**
Roadway Striping Condition (including reflectors)	5.87 **(7)**	4.68 **(17)**	4.40 **(12)**
Shoulder Width and Condition	5.80 **(8)**	4.52 **(15)**	4.00 **(14)**
Frequency and Timing of Construction Activities	5.77 **(9)**	3.81 **(7)**	7.51 **(7)**
Length of Merge or Diverge Lanes	5.73 **(10)**	4.39 **(12)**	4.48 **(11)**
Availability of Alternative Routes	5.71 **(11)**	3.90 **(8)**	6.63 **(8)**
Number of Lanes	5.60 **(12)**	4.47 **(14)**	4.01 **(13)**
Amount of Merge or Diverge Traffic	5.55 **(13)**	4.15 **(9)**	4.86 **(10)**
Lighting Conditions at Night	5.52 **(14)**	4.63 **(16)**	2.45 **(15)**
Lane(s) Restricted from Truck Use	5.50 **(15)**	**3.09 (3)**	**14.11 (3)**
Lower Speed Limit Only Applied to Truck Traffic	5.33 **(16)**	3.30 **(6)**	**11.35 (5)**
Governed Truck Speed Lower than Speed Limit	5.19 **(17)**	**3.28 (4)**	11.31 **(6)**
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	4.91 **(18)**	4.36 **(11)**	1.77 **(18)**
Publicity/Advertising of Traveler Information Systems	4.65 **(19)**	4.16 **(10)**	1.57 **(19)**
Sample Size	163–167	180–187	152–159

[a] Relative Importance Score of Each Factor (1–7, 1=Least Important, 7=Most Important)
[b] Relative Satisfaction Score of Each Factor (1–7, 1=Least Satisfied, 7=Most Satisfied)
[c] Improvement Priority Score of Each Factor (−42 – +42)

Table 5-6. Managers' Perceptions on Relative Importance of Each Factor on Freeways

Factor	Mean *OTB*[a] (Rank in Parentheses)	Mean *OC*[b] (Rank in Parentheses)	Mean *OP*[c] (Rank in Parentheses)	Mean *TS*[d] (Rank in Parentheses)
Level of Congestion	**5.95** **(1)**	**5.82** **(1)**	**6.06** **(1)**	**6.42** **(1)**
Frequency and Timing of Construction Activities	**5.66** **(2)**	**5.00** **(2)**	**6.06** **(1)**	**6.03** **(3)**
Availability of Alternative Routes	**5.21** **(3)**	**4.78** **(4)**	**5.24** **(4)**	5.54 **(7)**
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	**5.12** **(4)**	**4.91** **(3)**	4.82 **(6)**	**5.81** **(4)**
Passenger Car Drivers' Road Etiquette	**5.00** **(5)**	**4.73** **(5)**	4.62 **(7)**	**6.11** **(2)**
Number of Lanes	4.82 **(6)**	4.45 **(7)**	**5.03** **(5)**	5.42 **(8)**
Pavement Condition	4.69 **(7)**	4.48 **(6)**	4.29 **(11)**	**5.64** **(5)**
Availability and Condition of Signage	4.64 **(8)**	3.81 **(13)**	**5.39** **(3)**	5.37 **(9)**
Lower Speed Limit Only Applied to Truck Traffic	4.62 **(9)**	4.36 **(9)**	4.47 **(9)**	5.19 **(10)**
Governed Truck Speed Lower than Speed Limit	4.58 **(10)**	4.45 **(7)**	4.53 **(8)**	4.97 **(15)**
Amount of Merge or Diverge Traffic	4.56 **(11)**	4.12 **(11)**	4.03 **(12)**	5.61 **(6)**
Lane(s) Restricted from Truck Use	4.41 **(12)**	4.18 **(10)**	4.44 **(10)**	4.94 **(17)**
Lighting Conditions at Night	4.17 **(13)**	3.88 **(12)**	3.85 **(14)**	5.11 **(12)**
Roadway Striping Condition (including reflectors)	4.06 **(14)**	3.58 **(15)**	3.88 **(13)**	5.19 **(10)**
Shoulder Width and Condition	3.88 **(15)**	3.70 **(14)**	3.47 **(18)**	5.00 **(14)**
Lane Widths	3.86 **(16)**	3.47 **(16)**	3.82 **(15)**	4.97 **(15)**
Length of Merge or Diverge Lanes	3.66 **(17)**	3.41 **(17)**	3.13 **(19)**	5.11 **(12)**
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	3.64 **(18)**	3.29 **(18)**	3.66 **(16)**	4.44 **(18)**
Publicity/Advertising of Traveler Information Systems	3.47 **(19)**	3.26 **(19)**	3.53 **(17)**	4.09 **(19)**
Sample Size	28–30	31–33	31–34	34–36

[a] Relative Importance Score of Each Factor to Overall Trucking Business (1–7, 1=Least Important, 7=Most Important)

[b] Relative Importance Score of Each Factor to Operating Cost (1–7, 1=Least Important, 7=Most Important)

[c] Relative Importance Score of Each Factor to On-time Performance (1–7, 1=Least Important, 7=Most Important)

[d] Relative Importance Score of Each Factor to truck drivers' Trip Satisfaction (1–7, 1=Least Important, 7=Most Important)

Table 5-7. Exploratory Factor Analysis Results (Freeways)

Latent Factor and Allied Items	Rotated Factor Loadings F1	F2	F3	F4	F5	Communality
Factor 1: Physical Roadway Components						
Lighting Conditions at Night	**.73**	−.04	.12	.04	−.18	.58
Shoulder Width and Condition	**.69**	.19	.17	−.09	.14	.57
Lane Widths	**.64**	.06	.04	−.16	.25	.50
Length of Merge or Diverge Lanes	**.62**	.08	−.09	.00	.28	.48
Availability and Condition of Signage	**.57**	−.09	.00	.20	−.09	.38
Roadway Striping Condition (including reflectors)	**.52**	.22	.20	−.01	.20	.40
Pavement Condition†	(.43)	.21	.32	.02	(.56)	.65
Factor 2: Passenger Car Drivers' Behavior						
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	.14	**.90**	.07	.11	.07	.85
Passenger Car Drivers' Road Etiquette	.09	**.89**	.10	.11	.17	.85
Factor 3: Traveler Information Usage						
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	.00	.07	**.88**	.13	−.10	.81
Publicity/Advertising of Traveler Information Systems	.09	−.01	**.78**	−.07	.17	.65
Availability of Alternative Routes*	(.36)	.22	(.48)	−.11	.09	.43
Factor 4: Truck Travel Restrictions						
Lower Speed Limit Only Applied to Truck Traffic	−.03	.04	.02	**.85**	−.04	.73
Governed Truck Speed Lower than Speed Limit	.15	.16	−.04	**.75**	−.03	.61
Lane(s) Restricted from Truck Use	−.10	.00	.02	**.68**	.33	.58
Factor 5: Volume/Capacity Ratio						
Frequency and Timing of Construction Activities	.01	.00	−.10	.09	**.68**	.48
Level of Congestion	.20	.26	.34	.10	**.52**	.50
Number of Lanes†	(.46)	.20	.18	−.07	(.52)	.56
Amount of Merge or Diverge Traffic†	(.56)	.22	.07	.10	(.37)	.51
Sum of Squares (Eigenvalue)	3.3	2.0	2.0	1.9	1.9	11.1
Percent of Trace	17.6	10.5	10.4	10.0	9.9	58.4

† the item loaded highly on two or more factors

* the item did not load highly on any factor

Table 5-8. Importance of Each Factor on Truck Travel Quality of Service on Freeways

Factor	Items	Mean *RIS* (Overall Rank in Parentheses)	Factor Summated Mean (Standard Deviation in Parentheses)
Passenger Car Drivers' Behavior (F2)	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	6.69 (1)	6.61 (.89)
	Passenger Car Drivers' Road Etiquette	6.49 (2)	
Physical Roadway Components (F1)	Availability and Condition of Signage	6.28 (3)	5.90 (.82)
	Pavement Condition†	6.06 (4)	
	Lane Widths	5.88 (6)	
	Roadway Striping Condition (including reflectors)	5.87 (7)	
	Shoulder Width and Condition	5.80 (8)	
	Length of Merge or Diverge Lanes	5.73 (10)	
	Lighting Conditions at Night	5.52 (14)	
Volume/ Capacity Ratio (F5)	Level of Congestion	6.01 (5)	5.76 (.92)
	Frequency and Timing of Construction Activities	5.77 (9)	
	Number of Lanes†	5.60 (12)	
	Amount of Merge or Diverge Traffic†	5.55 (13)	
Truck Travel Restrictions (F4)	Lane(s) Restricted from Truck Use	5.50 (15)	5.30 (1.43)
	Lower Speed Limit Only Applied to Truck Traffic	5.33 (16)	
	Governed Truck Speed Lower than Speed Limit	5.19 (17)	
Traveler Information Usage (F3)	Availability of Alternative Routes*	5.71 (11)	5.09 (1.02)
	Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	4.91 (18)	
	Publicity/Advertising of Traveler Information Systems	4.65 (19)	

† the item loaded highly on two or more factors

* the item did not load highly on any factor

Table 5-9. Truck Drivers' Perceptions on Applicability of Single Performance Measure (*ASPM*) to Determine Truck Travel Quality of Service on Freeways

Hypothetical Single Performance Measure	*ASPM*[(1)] Mean	Standard Deviation
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	**5.58**	**1.44**
Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit (to enhance driving safety and minimize acceleration and deceleration)	**5.38**	**1.66**
Ease of Obtaining Useful Travel Conditions Information (to avoid expected congested areas or harsh weather)	4.88	1.73
Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)	4.82	1.95

(1) How well each performance measure would be applicable to evaluate the quality of a truck trip, if it were the only performance measure used (1–7, 1=Not at all Applicable, 7=Perfectly Applicable)

Table 5-10. Truck Company Managers' Perceptions of Relative Importance of Each Truck Driving Condition on Freeways for trucking business

Hypothetical Truck Driving Condition	*RI*[(1)] Mean	Standard Deviation
Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit (to enhance driving safety and minimize acceleration and deceleration)	**6.20**	**0.99**
Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)	**5.66**	**1.78**
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	5.57	1.31
Ease of Obtaining Useful Travel Conditions Information (to avoid expected congested areas or harsh weather)	5.43	1.54

(1) Relative Importance of Each Truck Driving Condition on Freeways for Trucking Business (1–7, 1=Least Important, 7=Most Important)

Table 5-11. Games-Howell Post Hoc Test Results (Freeways)

Pairwise Mean Comparisons [1]	d.f	q (calculated)	Results
Factor A vs Factor B	762	2.51	Population means are not different
Factor A vs Factor C	750	**8.59**	Population means are **different**
Factor A vs Factor D	713	**8.71**	Population means are **different**
Factor B vs Factor C	773	**5.77**	Population means are **different**
Factor B vs Factor D	755	**6.11**	Population means are **different**
Factor C vs Factor D	763	0.69	Population means are not different
Mean Comparison Summary	Factor A $\cong$ Factor B > Factor C $\cong$ Factor D		

[1] Factor Labels

A. A Consistently Good Ride Quality

B. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit

C. Ease of Obtaining Useful Travel Conditions Information

D. Ease of Driving at or above the Posted Speed Limit

Note: Bolded q values are significant at the 95% confidence level ($q_{0.05(4,\infty)}$ = 3.63)

Table 5-12. Truck Drivers' Perceptions of Each Factor on Truck Travel Quality of Service on Urban Arterials

Factor	Mean *RIS*[a] (Rank in Parentheses)	Mean *RSS*[b] (Rank in Parentheses)	Mean *IPS*[c] (Rank in Parentheses)
Passenger Car Drivers' Road Etiquette	**6.16 (1)**	**2.11 (1)**	**21.49 (1)**
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials	**6.14 (2)**	**2.30 (2)**	**19.44 (2)**
Curb Radii for Right Turning at Intersections	**6.07 (3)**	3.74 **(6)**	**8.07 (5)**
Pavement Condition	**5.99 (4)**	4.45 **(16)**	5.31 **(7)**
Availability and Condition of Signage	**5.89 (5)**	4.53 **(18)**	3.15 **(16)**
Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow	5.78 **(6)**	**3.40 (4)**	**9.27 (4)**
Lane Widths	5.70 **(7)**	4.22 **(14)**	4.15 **(12)**
Level of Vehicle Congestion	5.66 **(8)**	**3.12 (3)**	**9.86 (3)**
Frequency and Timing of Construction Activities	5.58 **(9)**	**3.66 (5)**	8.35 **(6)**
Roadway Striping Condition	5.54 **(10)**	4.31 **(15)**	3.30 **(15)**
Shoulder Width and Condition	5.53 **(11)**	4.20 **(13)**	3.43 **(14)**
Number of Lanes	5.45 **(12)**	3.96 **(10)**	4.60 **(11)**
Existence of Left Turn Signal Phase at Intersections	5.45 **(13)**	3.91 **(9)**	4.59 **(10)**
Length of Yellow Signal Timing at Intersections	5.44 **(14)**	3.81 **(7)**	4.66 **(9)**
Traffic Signal Responsiveness at Intersections	5.37 **(15)**	3.82 **(8)**	4.83 **(8)**
Placement of Light Poles, Trees, etc. at Roadside	5.31 **(16)**	4.18 **(12)**	2.24 **(17)**
Stop Bar Position for Truck Turning at Intersections	5.25 **(17)**	4.00 **(11)**	3.63 **(13)**
Level of Bicycle or Pedestrian Congestion	4.65 **(18)**	4.48 **(17)**	−0.91 **(18)**
Sample Size	73~76	93~97	64~68

[a] Relative Importance Score of Each Factor (1–7, 1=Least Important, 7=Most Important)
[b] Relative Satisfaction Score of Each Factor (1–7, 1=Least Satisfied, 7=Most Satisfied)
[c] Improvement Priority Score of Each Factor (–42 – +42)

Table 5-13. Managers' Perceptions on Relative Importance of Each Factor on Urban Arterials

Factor	Mean *OTB*[a] (Rank in Parentheses)	Mean *OC*[b] (Rank in Parentheses)	Mean *OP*[c] (Rank in Parentheses)	Mean *TS*[d] (Rank in Parentheses)
Frequency and Timing of Construction Activities	**5.89 (1)**	**5.86 (1)**	**6.25 (1)**	**6.44 (1)**
Pavement Condition	**5.74 (2)**	**5.86 (1)**	**5.38 (5)**	**6.33 (2)**
Level of Vehicle Congestion	**5.59 (3)**	**5.71 (3)**	**6.00 (2)**	**6.11 (4)**
Existence of Left Turn Signal Phase at Intersections	**5.41 (4)**	**5.57 (4)**	**5.75 (3)**	**6.11 (4)**
Roadway Striping Condition	**5.38 (5)**	5.00 **(9)**	4.88 **(12)**	5.67 **(11)**
Curb Radii for Right Turning at Intersections	5.25 **(6)**	**5.43 (5)**	4.63 **(16)**	**6.22 (3)**
Length of Yellow Signal Timing at Intersections	5.23 **(7)**	5.00 **(9)**	5.00 **(8)**	5.78 **(8)**
Traffic Signal Responsiveness at Intersections	5.22 **(8)**	5.00 **(9)**	5.00 **(8)**	5.78 **(8)**
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials	5.17 **(9)**	**5.43 (5)**	5.25 **(6)**	5.67 **(11)**
Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow	5.17 **(9)**	5.29 **(7)**	**5.63 (4)**	6.00 **(6)**
Availability and Condition of Signage	5.04 **(11)**	5.29 **(7)**	5.00 **(8)**	5.56 **(16)**
Passenger Car Drivers' Road Etiquette	5.02 **(12)**	4.71 **(16)**	4.75 **(13)**	5.67 **(11)**
Placement of Light Poles, Trees, etc. at Roadside	4.97 **(13)**	4.71 **(16)**	5.00 **(8)**	5.44 **(17)**
Shoulder Width and Condition	4.89 **(14)**	5.00 **(9)**	4.75 **(13)**	5.89 **(7)**
Stop Bar Position for Truck Turning at Intersections	4.87 **(15)**	4.57 **(18)**	4.38 **(18)**	5.67 **(11)**
Number of Lanes	4.73 **(16)**	4.86 **(13)**	5.25 **(6)**	5.67 **(11)**
Lane Widths	4.72 **(17)**	4.86 **(13)**	4.63 **(16)**	5.78 **(8)**
Level of Bicycle or Pedestrian Congestion	4.54 **(18)**	4.86 **(13)**	4.75 **(13)**	5.33 **(18)**
Sample Size	6	7	8	9

[a] Relative Importance Score of Each Factor to Overall Trucking Business (1–7, 1=Least Important, 7=Most Important)
[b] Relative Importance Score of Each Factor to Operating Cost (1–7, 1=Least Important, 7=Most Important)
[c] Relative Importance Score of Each Factor to On-time Performance (1–7, 1=Least Important, 7=Most Important)
[d] Relative Importance Score of Each Factor to truck drivers' Trip Satisfaction (1–7, 1=Least Important, 7=Most Important)

Table 5-14. Exploratory Factor Analysis Results (Urban Arterials)

Latent Factor and Allied Items	Rotated Factor Loadings F1	F2	F3	F4	Communality
Factor 1: Roadway and Traffic Components					
Number of Lanes	**.83**	.12	−.03	.12	.72
Lane Widths	**.68**	.26	.04	.29	.62
Pavement Condition	**.66**	.42	.23	.03	.67
Shoulder Width and Condition	**.65**	.01	.37	.41	.73
Availability and Condition of Signage*	(.52)	.21	.00	.20	.35
Frequency and Timing of Construction Activities*	(.53)	.29	.40	−.10	.54
Roadway Striping Condition*	(.52)	.01	.37	.40	.57
Level of Vehicle Congestion*	.40	.31	.35	−.06	.38
Factor 2: Intersection Crossing Constraints					
Existence of Left Turn Signal Phase at Intersections	.30	**.78**	.01	.09	.71
Length of Yellow Signal Timing at Intersections	.00	**.76**	.02	.43	.76
Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow	.18	**.74**	.36	.10	.72
Traffic Signal Responsiveness at Intersections	.17	**.70**	.15	.33	.65
Curb Radii for Right Turning at Intersections*	.28	(.51)	.10	.02	.35
Factor 3: Passenger Car Drivers' Behavior					
Passenger Car Drivers' Road Etiquette	.13	.09	**.91**	.22	.90
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials	.07	.21	**.89**	.12	.86
Factor 4: Physical Driving Deterrents					
Placement of Light Poles, Trees, etc. at Roadside	.32	.13	−.10	**.75**	.69
Level of Bicycle or Pedestrian Congestion	.06	.15	.25	**.73**	.62
Stop Bar Position for Truck Turning at Intersections	.12	.21	.13	**.63**	.47
Sum of Squares (Eigenvalue)	3.4	3.1	2.5	2.3	11.3
Percent of Trace	18.7	17.2	13.7	12.9	62.5

* the item did not load highly on any factor

Table 5-15. Importance of Each Factor on Truck Travel Quality of Service on Urban Arterials

Factor	Items	Mean *RIS* (Overall Rank in Parentheses)	Factor Summated Mean (Standard Deviation in Parentheses)
Passenger Car Drivers' Behavior (F3)	Passenger Car Drivers' Road Etiquette	6.16 (1)	6.09 (1.37)
	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials	6.14 (2)	
Roadway and Traffic Components (F1)	Pavement Condition	5.99 (4)	5.65 (.89)
	Availability and Condition of Signage*	5.89 (5)	
	Lane Widths	5.70 (7)	
	Level of Vehicle Congestion*	5.66 (8)	
	Frequency and Timing of Construction Activities*	5.58 (9)	
	Roadway Striping Condition*	5.54 (10)	
	Shoulder Width and Condition	5.53 (11)	
	Number of Lanes	5.45 (12)	
Intersection Crossing Constraints (F2)	Curb Radii for Right Turning at Intersections*	6.07 (3)	5.58 (.82)
	Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow	5.78 (6)	
	Existence of Left Turn Signal Phase at Intersections	5.45 (12)	
	Length of Yellow Signal Timing at Intersections	5.44 (14)	
	Traffic Signal Responsiveness at Intersections	5.37 (15)	
Physical Driving Deterrents (F4)	Placement of Light Poles, Trees, etc. at Roadside	5.31 (16)	5.03 (1.19)
	Stop Bar Position for Truck Turning at Intersections	5.25 (17)	
	Level of Bicycle or Pedestrian Congestion	4.65 (18)	

* the item did not load highly on any factor

Table 5-16. Truck Drivers' Perceptions of Applicability of Single Performance Measure (*ASPM*) to Determine Truck Travel Quality of Service on Urban Arterials

Hypothetical Single Performance Measure	*ASPM*[1] Mean	*ASPM*[1] Standard Deviation
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	**5.14**	**1.58**
Ease of Changing Lanes (to prepare for making turns)	**4.79**	**1.75**
Ease of Right- or Left-Turn Maneuvers	**4.79**	**1.78**
Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit (to enhance driving safety and minimize acceleration and deceleration)	4.76	1.87
Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)	4.33	1.91
Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)	4.32	1.83
Ease of U-Turn Maneuvers	3.62	2.14

[1] How well each performance measure would be applicable to evaluate quality of truck trip, if it were the only performance measure used (1–7, 1=Not at all Applicable, 7=Perfectly Applicable)

Table 5-17. Truck Company Managers' Perceptions of Relative Importance of Each Truck Driving Condition on Urban Arterials for trucking business

Hypothetical Truck Driving Condition	*RI*[1] Mean	*RI*[1] Standard Deviation
Ease of Right- or Left-Turn Maneuvers	**5.94**	**1.41**
Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit (to enhance driving safety and minimize acceleration and deceleration)	**5.70**	**1.33**
Ease of Changing Lanes (to prepare for making turns)	5.45	1.66
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	5.30	1.26
Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)	5.18	1.49
Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)	4.94	1.84
Ease of U-Turn Maneuvers	4.33	2.3

[1] Relative Importance of Each Truck Driving Condition on Urban Arterials for Trucking Business (1–7, 1=Least Important, 7=Most Important)

Table 5-18. Games-Howell Post Hoc Test Results (Urban Arterials)

Pairwise Mean Comparisons [1]	d.f	q (calculated)	Results
Factor A vs Factor B	764	**4.17**	Population means are **different**
Factor A vs Factor C	762	**4.17**	Population means are **different**
Factor A vs Factor D	748	**4.33**	Population means are **different**
Factor A vs Factor E	744	**9.09**	Population means are **different**
Factor A vs Factor F	756	**9.49**	Population means are **different**
Factor A vs Factor G	709	**15.88**	Population means are **different**
Factor B vs Factor C	772	0.03	Population means are not different
Factor B vs Factor D	766	0.29	Population means are not different
Factor B vs Factor E	765	**4.90**	Population means are **different**
Factor B vs Factor F	771	**5.17**	Population means are **different**
Factor B vs Factor G	741	**11.72**	Population means are **different**
Factor C vs Factor D	768	0.26	Population means are not different
Factor C vs Factor E	767	**4.84**	Population means are **different**
Factor C vs Factor F	771	**5.10**	Population means are **different**
Factor C vs Factor G	745	**11.62**	Population means are **different**
Factor D vs Factor E	769	**4.46**	Population means are **different**
Factor D vs Factor F	769	**4.71**	Population means are **different**
Factor D vs Factor G	756	**11.13**	Population means are **different**
Factor E vs Factor F	769	0.14	Population means are not different
Factor E vs Factor G	760	**6.88**	Population means are **different**
Factor F vs Factor G	752	**6.88**	Population means are **different**
Mean Comparison Summary	Factor A > Factor B $\cong$ Factor C $\cong$ Factor D > Factor E $\cong$ Factor F > Factor G		

[1] Factor Labels
A. A Consistently Good Ride Quality
B. Ease of Changing Lanes
C. Ease of Right- or Left-Turn Maneuvers
D. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
E. Ease of Passing through Signalized Intersections along the Arterial
F. Ease of Driving at or above the Posted Speed Limit
G. Ease of U-Turn Maneuvers

Note: Bolded q values are significant at the 95% confidence level ($q_{0.05(7,\infty)}$ = 4.17)

Table 5-19. Truck Drivers' Perceptions of Each Factor on Truck Travel Quality of Service on Two-Lane Highways

Factor	Mean *RIS*[a] (Rank in Parentheses)	Mean *RSS*[b] (Rank in Parentheses)	Mean *IPS*[c] (Rank in Parentheses)
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Two-Lane Highways	**6.38 (1)**	**2.18 (1)**	**21.10 (1)**
Passenger Car Drivers' Road Etiquette	**6.28 (2)**	**2.36 (2)**	**19.59 (2)**
Availability and Condition of Signage	**6.17 (3)**	4.45 **(19)**	4.50 **(11)**
Pavement Condition	**5.99 (4)**	4.04 **(14)**	5.50 **(9)**
Lighting Conditions at Night	**5.81 (5)**	3.73 **(7)**	**7.19 (5)**
Shoulder Width and Condition	5.80 **(6)**	**3.45 (3)**	**8.78 (3)**
Lane Widths	5.80 **(6)**	3.95 **(11)**	6.41 **(7)**
Frequency and Timing of Construction Activities	5.64 **(8)**	3.69 **(6)**	**7.35 (4)**
Roadway Striping Condition	5.59 **(9)**	4.19 **(16)**	3.88 **(13)**
Level of Vehicle Congestion	5.58 **(10)**	**3.54 (4)**	7.02 **(6)**
Frequency of Passing Lanes	5.47 **(11)**	**3.65 (5)**	5.51 **(8)**
Sight Distance at Horizontal Curvatures	5.38 **(12)**	4.13 **(15)**	2.91 **(15)**
Frequency of Passing Zones (Dashed Yellow Lines)	5.07 **(13)**	3.96 **(12)**	2.71 **(16)**
Frequency of Faster Vehicles Passing Your Truck	5.04 **(14)**	3.79 **(9)**	3.26 **(14)**
Frequency of Vehicles much Slower than Your Truck	5.03 **(15)**	3.79 **(9)**	4.90 **(10)**
Frequency of Faster Vehicles Following Your Truck	4.97 **(16)**	3.74 **(8)**	4.17 **(12)**
Frequency of Farm Tractors, Bicyclists, Pedestrians	4.80 **(17)**	4.21 **(17)**	0.75 **(17)**
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	4.62 **(18)**	4.23 **(18)**	0.71 **(18)**
Publicity/Advertising of Traveler Information Systems	4.27 **(19)**	3.99 **(13)**	0.50 **(19)**
Sample Size	66~69	75~78	61~64

[a] Relative Importance Score of Each Factor (1–7, 1=Least Important, 7=Most Important)
[b] Relative Satisfaction Score of Each Factor (1–7, 1=Least Satisfied, 7=Most Satisfied)
[c] Improvement Priority Score of Each Factor (−42 –+42)

Table 5-20. Managers' Perceptions of Relative Importance of Each Factor on Two-Lane Highways

Factor	Mean *OTB*[a] (Rank in Parentheses)	Mean *OC*[b] (Rank in Parentheses)	Mean *OP*[c] (Rank in Parentheses)	Mean *TS*[d] (Rank in Parentheses)
Roadway Striping Condition	**5.65 (1)**	**5.71 (1)**	**5.25 (3)**	**6.13 (2)**
Level of Vehicle Congestion	**5.46 (2)**	**5.14 (4)**	**5.00 (4)**	**5.75 (5)**
Pavement Condition	**5.23 (3)**	**5.43 (2)**	**5.00 (4)**	**6.00 (3)**
Passenger Car Drivers' Knowledge about Truck Driving Characteristics	**5.11 (4)**	**5.14 (4)**	**5.38 (2)**	**6.25 (1)**
Shoulder Width and Condition	**5.03 (5)**	**5.29 (3)**	4.88 **(6)**	5.63 **(8)**
Frequency and Timing of Construction Activities	4.96 **(6)**	**5.14 (4)**	**5.50 (1)**	5.63 **(8)**
Lighting Conditions at Night	4.76 **(7)**	4.57 **(9)**	4.50 **(11)**	4.88 **(13)**
Sight Distance at Horizontal Curvatures	4.72 **(8)**	4.86 **(7)**	4.63 **(8)**	**5.88 (4)**
Passenger Car Drivers' Road Etiquette	4.70 **(9)**	4.50 **(11)**	4.43 **(14)**	5.57 **(7)**
Frequency of Passing Zones (Dashed Yellow Lines)	4.70 **(9)**	4.57 **(9)**	4.63 **(8)**	5.25 **(10)**
Frequency of Vehicles much Slower than Your Truck	4.62 **(11)**	4.71 **(8)**	4.75 **(7)**	**5.75 (5)**
Frequency of Passing Lanes	4.54 **(12)**	4.43 **(12)**	4.50 **(11)**	5.13 **(11)**
Lane Widths	4.53 **(13)**	4.43 **(12)**	4.13 **(16)**	4.88 **(13)**
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	4.49 **(14)**	3.83 **(17)**	3.57 **(18)**	4.43 **(18)**
Frequency of Faster Vehicles Following Your Truck	4.16 **(15)**	4.00 **(16)**	3.88 **(17)**	4.75 **(17)**
Frequency of Farm Tractors, Bicyclists, Pedestrians	4.08 **(16)**	4.29 **(14)**	4.63 **(8)**	4.88 **(13)**
Availability and Condition of Signage	4.01 **(17)**	4.29 **(14)**	4.25 **(15)**	4.88 **(13)**
Publicity/Advertising of Traveler Information Systems	4.00 **(18)**	3.40 **(19)**	3.50 **(19)**	3.50 **(19)**
Frequency of Faster Vehicles Passing Your Truck	4.00 **(18)**	3.71 **(18)**	4.50 **(11)**	5.13 **(11)**
Sample Size	4~6	5~7	6~8	6~8

[a] Relative Importance Score of Each Factor to Overall Trucking Business (1–7, 1=Least Important, 7=Most Important)
[b] Relative Importance Score of Each Factor to Operating Cost (1–7, 1=Least Important, 7=Most Important)
[c] Relative Importance Score of Each Factor to On-time Performance (1–7, 1=Least Important, 7=Most Important)
[d] Relative Importance Score of Each Factor to truck drivers' Trip Satisfaction (1–7, 1=Least Important, 7=Most Important)

Table 5-21. Exploratory Factor Analysis Results (Two-Lane Highways)

Latent Factor and Allied Items	Rotated Factor Loadings					Communality
	F1	F2	F3	F4	F5	
Factor 1: Travel Safety Elements						
Sight Distance at Horizontal Curvatures	**.71**	−.10	.16	.16	.15	.59
Frequency of Faster Vehicles Following Your Truck	**.68**	.09	−.05	−.26	.16	.57
Lighting Conditions at Night	**.65**	.27	−.08	.31	−.09	.61
Frequency of Farm Tractors, Bicyclists, Pedestrians	**.62**	−.08	.33	.18	−.14	.55
Shoulder Width and Condition*	(.59)	.19	−.03	.17	.16	.44
Frequency of Faster Vehicles Passing Your Truck*	.39	(.58)	.26	−.14	.23	.63
Factor 2: Traveler Information Usage						
Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, etc.)	−.11	**.83**	.01	.22	.07	.75
Publicity/Advertising of Traveler Information Systems	.03	**.73**	.01	.18	.04	.57
Frequency of Vehicles much Slower than Your Truck	.31	**.72**	.10	−.22	−.03	.67
Factor 3: Travel Speed Constraints						
Frequency of Passing Zones (Dashed Yellow Lines)	−.01	.08	**.90**	.07	−.02	.82
Frequency of Passing Lanes	.06	.18	**.86**	.01	−.02	.78
Level of Vehicle Congestion*	−.04	−.16	(.47)	.27	.26	.39
Frequency and Timing of Construction Activities*	.16	.03	.42	.01	.07	.25
Factor 4: Physical Roadway Components						
Pavement Condition	.29	.15	.07	**.78**	.06	.72
Roadway Striping Condition	.40	−.06	.19	**.70**	−.03	.69
Availability and Condition of Signage†	−.16	.08	.00	**.62**	(.45)	.61
Lane widths*	.24	.30	.29	.41	−.09	.41
Factor 5: Passenger Car Drivers' Behavior						
Passenger Car Drivers' Road Etiquette	.14	.36	.07	.05	**.81**	.81
Passenger Car Drivers' Knowledge about Truck Driving Characteristics on 2–Lane Highways	.32	−.08	.15	.08	**.80**	.78
Sum of Squares (Eigenvalue)	2.9	2.5	2.4	2.1	1.7	11.6
Percent of Trace	15.1	13.4	12.2	11.2	9.2	61.0

† the item loaded highly on two or more factors

* the item did not load highly on any factor

Table 5-22. Importance of Each Factor on Truck Travel Quality of Service on Two-Lane Highways

Factor	Items	Mean *RIS* (Overall Rank in Parentheses)	Factor Summated Mean (Standard Deviation in Parentheses)
Passenger Car Drivers' Behavior (F5)	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on 2–Lane Highways	6.38 (1)	6.39 (.85)
	Passenger Car Drivers' Road Etiquette	6.28 (2)	
Physical Roadway Components (F4)	Availability and Condition of Signage†	6.17 (3)	5.86 (.84)
	Pavement Condition	5.99 (4)	
	Lane widths*	5.80 (6)	
	Roadway Striping Condition	5.59 (9)	
Travel Speed Constraints (F3)	Frequency and Timing of Construction Activities*	5.64 (8)	5.47 (.88)
	Level of Vehicle Congestion*	5.58 (10)	
	Frequency of Passing Lanes	5.47 (11)	
	Frequency of Passing Zones (Dashed Yellow Lines)	5.07 (13)	
Travel Safety Elements (F1)	Lighting Conditions at Night	5.81 (5)	5.29 (.84)
	Shoulder Width and Condition*	5.80 (6)	
	Sight Distance at Horizontal Curvatures	5.38 (12)	
	Frequency of Faster Vehicles Passing Your Truck*	5.04 (14)	
	Frequency of Faster Vehicles Following Your Truck	4.97 (16)	
	Frequency of Farm Tractors, Bicyclists, Pedestrians	4.80 (17)	
Traveler Information Usage (F2)	Availability of Traveler Information Systems (HAR, 511, CB Radio, VMS, …)	4.62 (18)	4.65 (1.10)
	Publicity/Advertising of Traveler Information Systems	4.27 (19)	
	Frequency of Vehicles much Slower than Your Truck	5.03 (15)	

† the item loaded highly on two or more factors

* the item did not load highly on any factor

Table 5-23. Truck Drivers' Perceptions of Applicability of Single Performance Measure (*ASPM*) to Determine Truck Travel Quality of Service on Two-Lane Highways

Hypothetical Single Performance Measure	*ASPM*[(1)] Mean	*ASPM*[(1)] Standard Deviation
Probability of Being Passed or Followed by Faster Vehicles	**5.10**	**1.87**
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	**5.02**	**1.53**
Width of Travel Lane and Shoulder, or Shoulder Type (to cope with unexpected situations)	4.55	1.99
Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, pedestrians, wildlife, etc.)	4.53	1.88
Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes (to minimize total travel time)	3.70	1.99

(1) How well each performance measure would be applicable to evaluate quality of truck trip, if it were the only performance measure used (1–7, 1=Not at all Applicable, 7=Perfectly Applicable)

Table 5-24. Truck Company Managers' Perceptions of Relative Importance of Each Truck Driving Condition on Two-Lane Highways for trucking business

Hypothetical Truck Driving Condition	*RI*[(1)] Mean	*RI*[(1)] Standard Deviation
Width of Travel Lane and Shoulder, or Shoulder Type (to cope with unexpected situations)	**5.5**	**1.58**
Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes (to minimize total travel time)	**5.29**	**1.66**
Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, pedestrians, wildlife, etc.)	5.24	1.42
A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)	5.09	1.46
Probability of Being Passed or Followed by Faster Vehicles	5.06	1.56

(1) Relative Importance of Each Truck Driving Condition on Freeways for Trucking Business (1–7, 1=Least Important, 7=Most Important)

Table 5-25. Games-Howell Post Hoc Test Results (Two-Lane Highways)

Pairwise Mean Comparisons [1]	d.f.	q (calculated)	Results
Factor A vs Factor B	739	0.95	Population means are not different
Factor A vs Factor C	765	**5.61**	Population means are **different**
Factor A vs Factor D	768	**5.98**	Population means are **different**
Factor A vs Factor E	763	**14.15**	Population means are **different**
Factor B vs Factor C	720	**5.19**	Population means are **different**
Factor B vs Factor D	738	**5.59**	Population means are **different**
Factor B vs Factor E	717	**14.47**	Population means are **different**
Factor C vs Factor D	765	0.18	Population means are not different
Factor C vs Factor E	766	**8.29**	Population means are **different**
Factor D vs Factor E	763	**8.35**	Population means are **different**
Mean Comparison Summary	Factor A $\cong$ Factor B > Factor C $\cong$ Factor D > Factor E		

[1] Factor Labels

A. Probability of Being Passed or Followed by Faster Vehicles
B. A Consistently Good Ride Quality
C. Width of Travel Lane and Shoulder, or Shoulder Type
D. Probability of Encountering Possible Conflicts
E. Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes

Note: Bolded q values are significant at the 95% confidence level ($q_{0.05(5,\infty)}$ = 3.86)

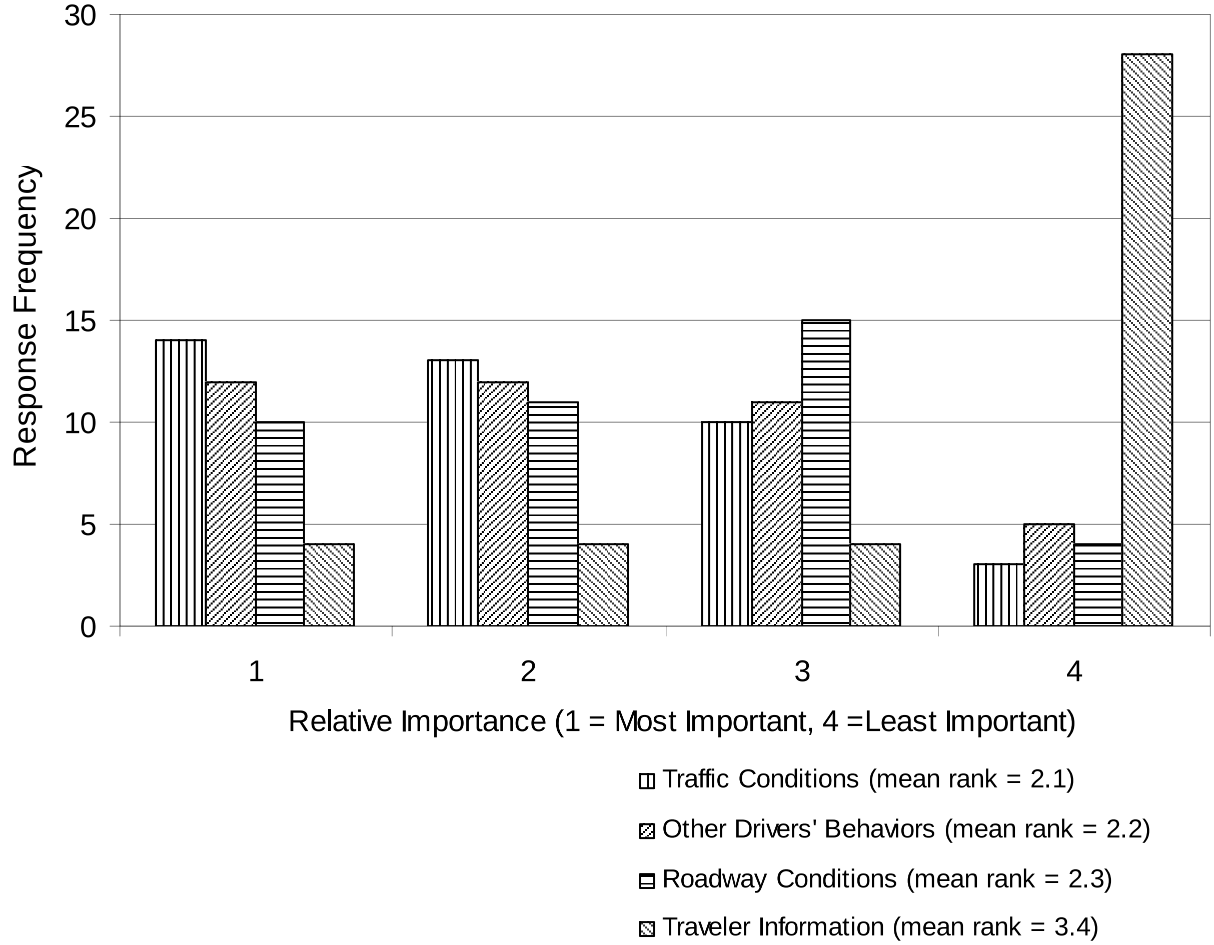


Figure 5-1. Relative Importance of Each Factor Category for Freeways

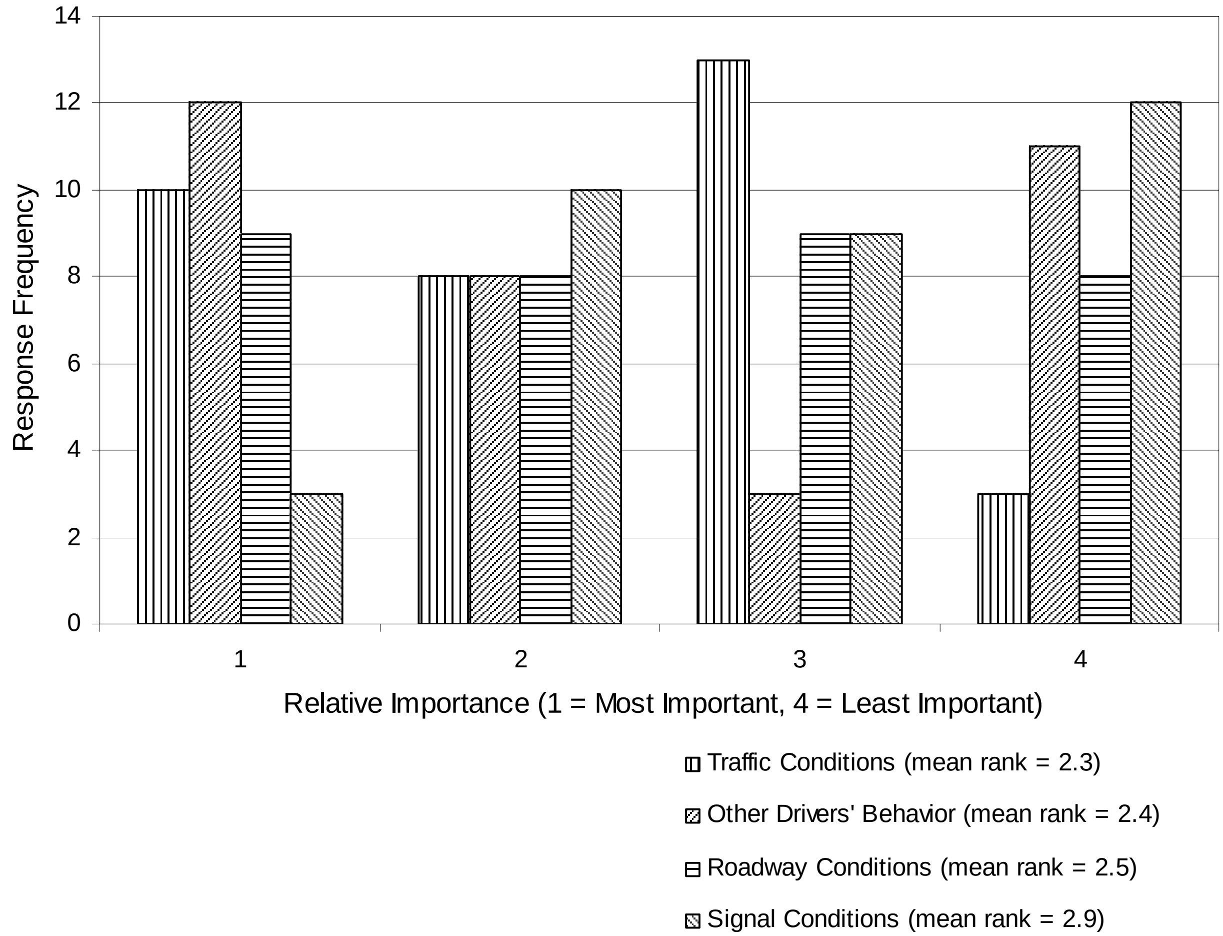


Figure 5-2. Relative Importance of Each Factor Category for Urban Arterials

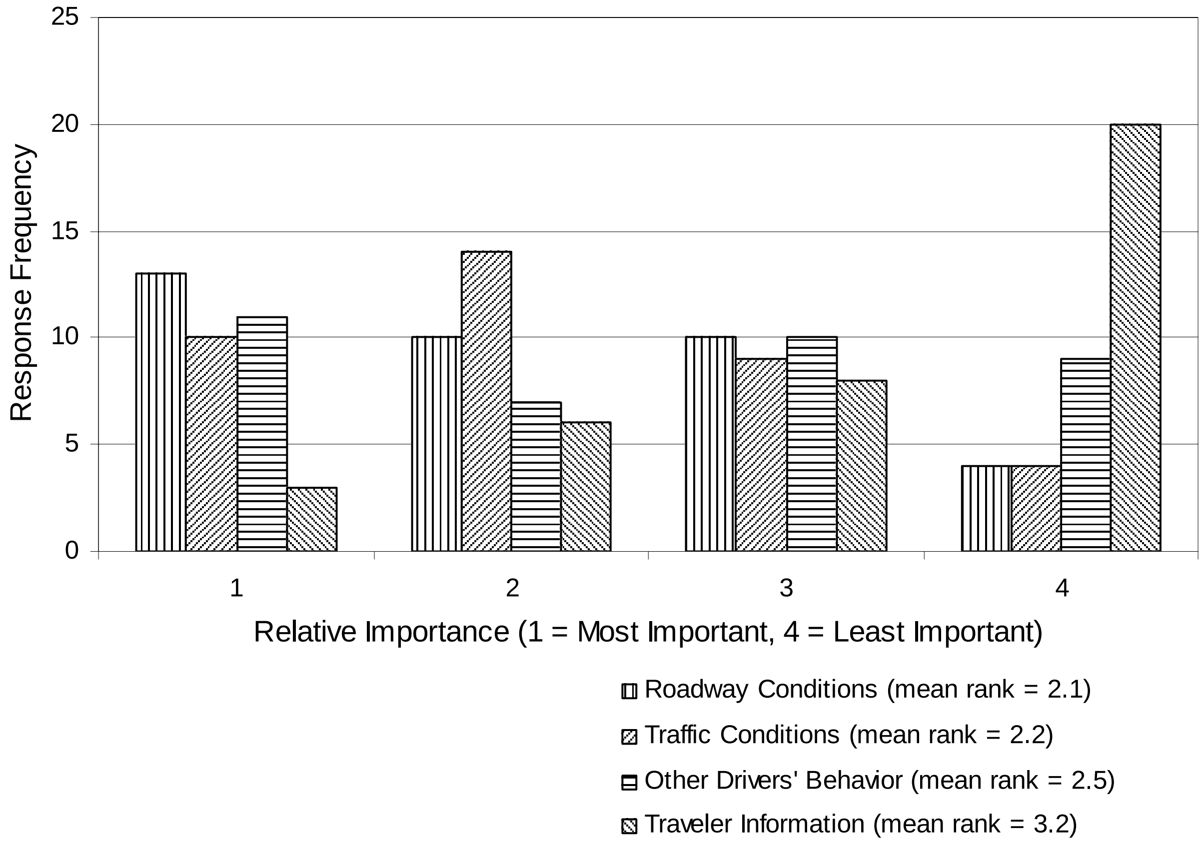


Figure 5-3. Relative Importance of Each Factor Category for Two-lane Highways

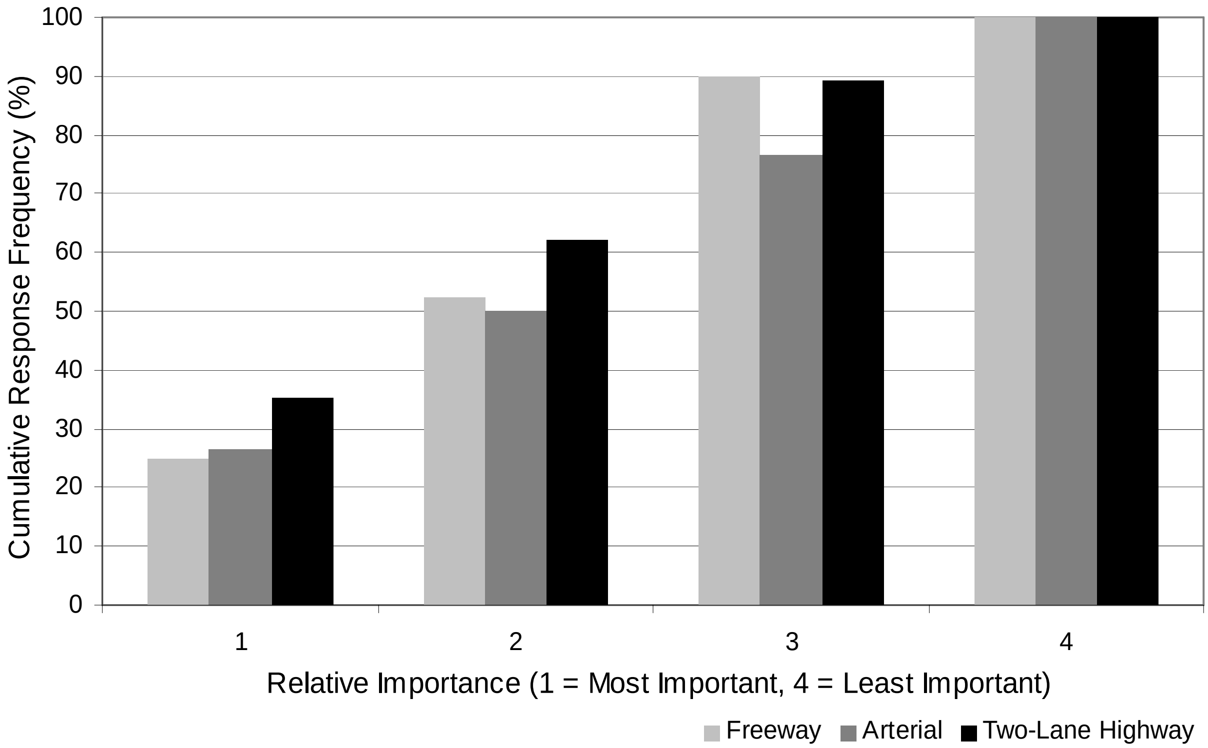


Figure 5-4. Relative Importance of Roadway Conditions on Different Roadway Types

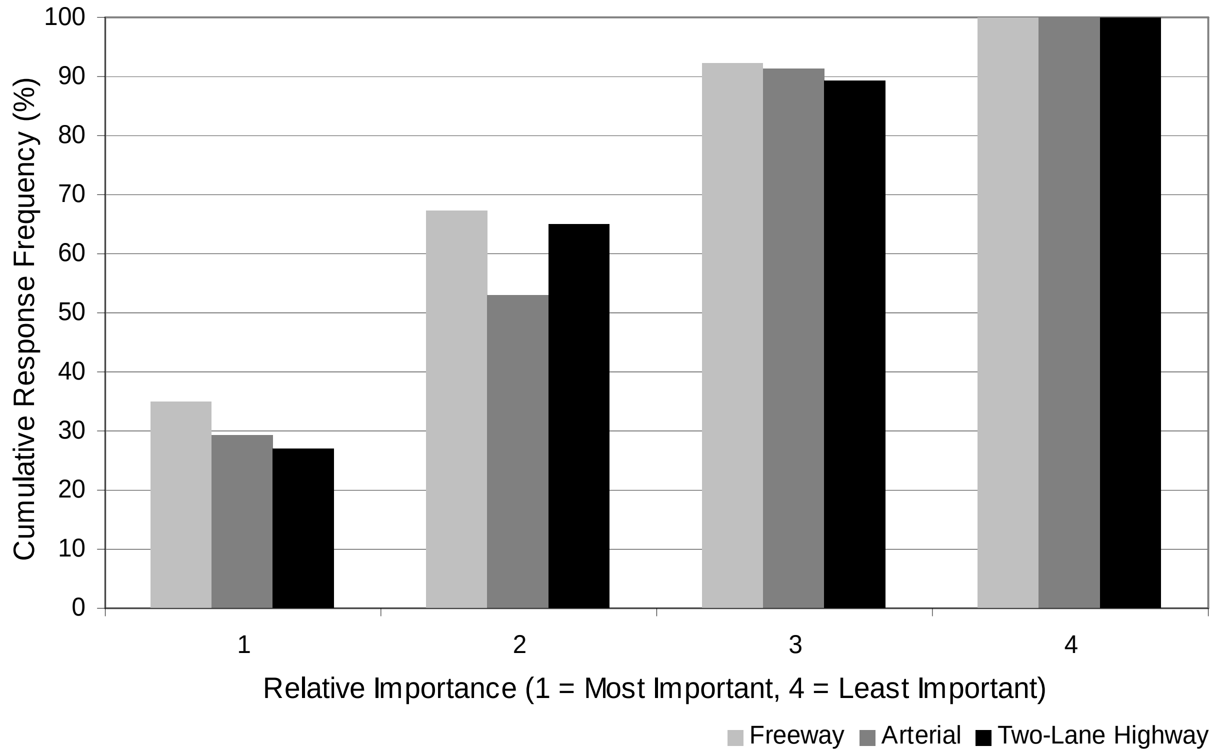


Figure 5-5. Relative Importance of Traffic Conditions on Different Roadway Types

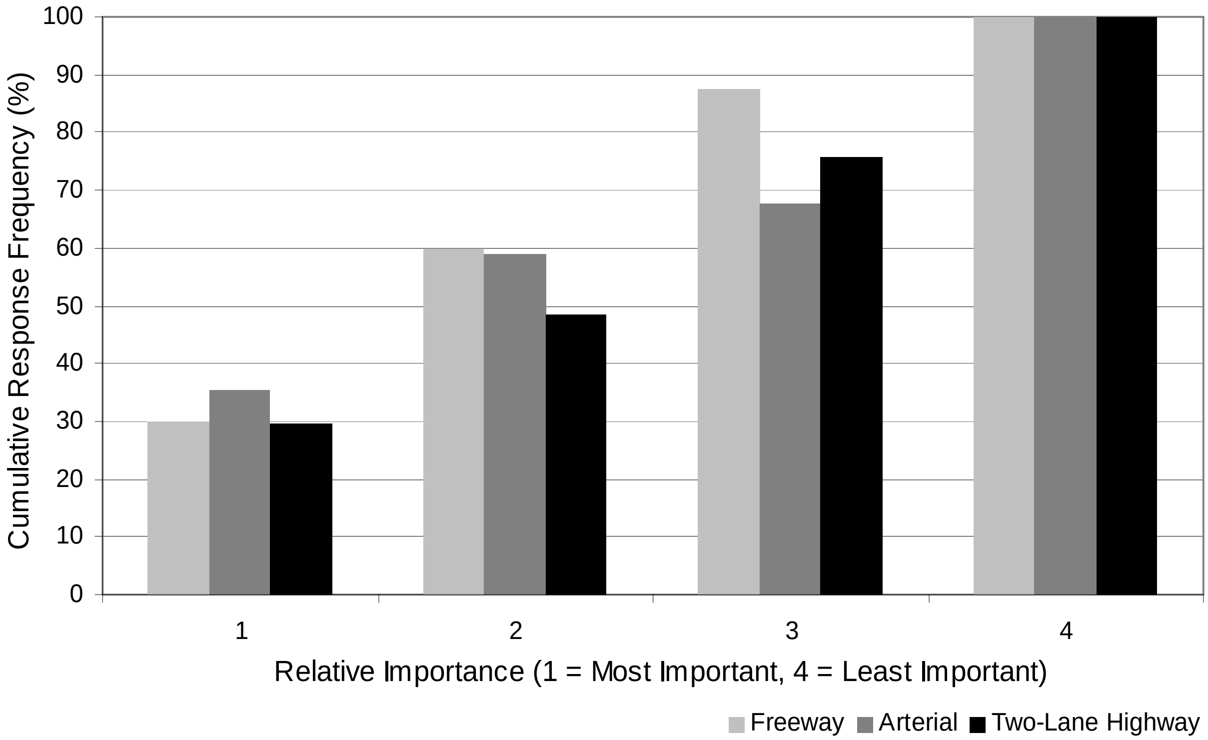


Figure 5-6. Relative Importance of Other Drivers' Behavior on Different Roadway Types

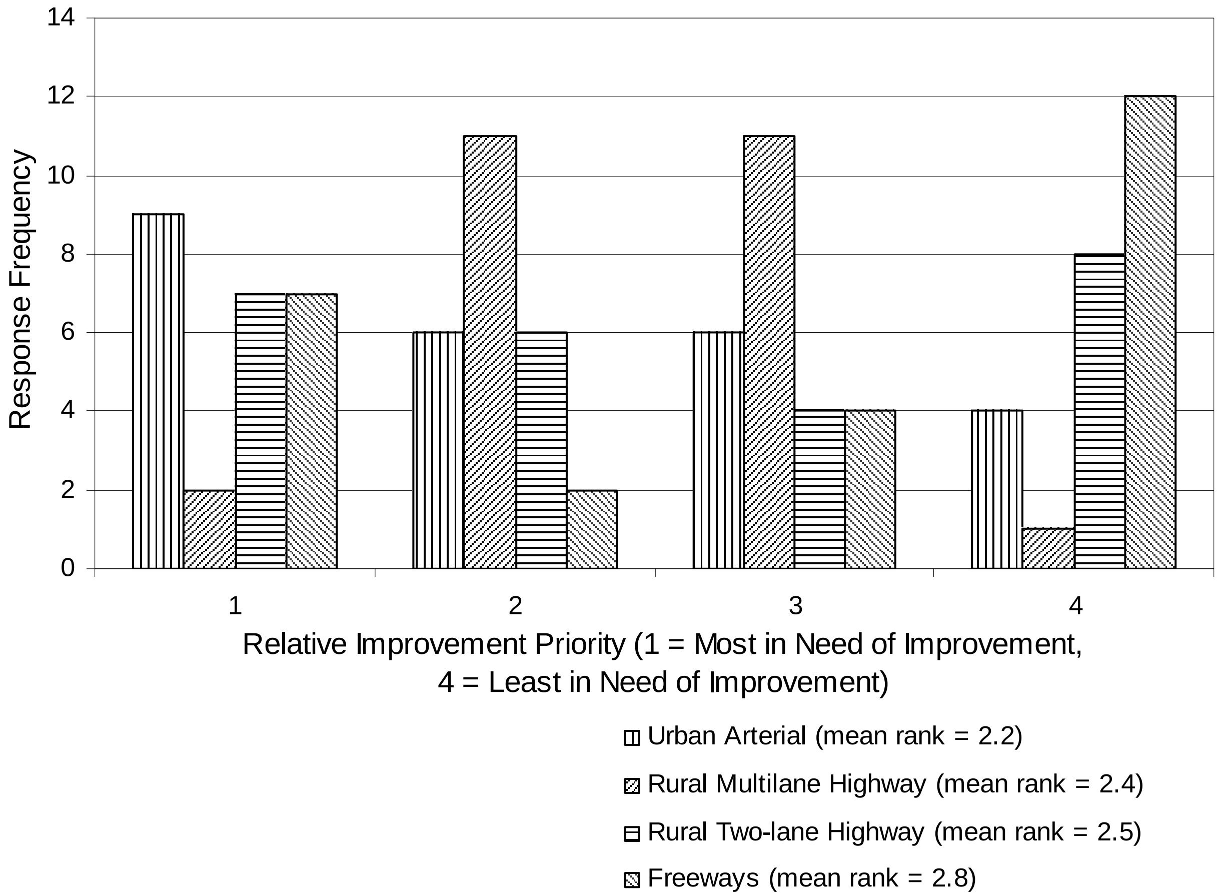


Figure 5-7. Improvement Priority of Various Roadway Facilities for Truck Trip Quality

Table 5-26. Definitions of Independent Variables used in Statistical Tests (1)

Variable	Description	Code	Definition
Source	Recruitment Sources	0	Survey respondents at the FTDC event
		1	Postage-page mail-back survey respondents
Gen	Gender	0	Man
		1	Woman
Age	Age in Years	0	< 30 (young)
		1	≥ 30 and age < 50 (middle-aged)
		2	≥ 50 (senior)
Dep	Existence of Dependent(s)	0	No
		1	Yes
Emp	Years of Truck Driving Job Experience	0	< 5 years
		1	≥ 5 years and < 15 years
		2	≥ 15 years
Indep	Independent Truck Driver	0	No
		1	Yes
Earn (Multiple Choices)	Paid by Miles Driven (M)	0	No
		1	Yes
	Paid by Hours Driven (H)	0	No
		1	Yes
	Paid by Salary (S)	0	No
		1	Yes
	Paid by Drop (D)	0	No
		1	Yes
	Paid by Load (L)	0	No
		1	Yes
CType	Businesses Types of Truck Company	0	Private (carry own goods)
		1	For-hire (carry other people's goods)
		2	Combination of private and for-hire
LType	Primary Load Types	0	TruckLoad (TL)
		1	Less-Than-truckLoad (LTL)
		2	Both TL and LTL (approximately equally)
RDTSel	Selection of Truck Route and Departure Time	0	Truck Driver
		1	Manager (transportation/logistics/dispatch)
		2	Both truck driver and manager
HDist	Hauling Distance	0	Short-haul
		1	Long-haul
GSpeed	Whether the Truck Sped is Engine-Governed	0	No
		1	Yes
MGSpeed	Engine-Governed Maximum Truck Speed	0	≤ 65 mi/h
		1	> 65 mi/h

Table 5-27. Definitions of Independent Variables used in Statistical Tests (2)

Variable	Description	Code	Definition
ETrip	Percent of Truck Trips that are Empty	0	< 10 percent
		1	≥ 10 percent and < 25 percent
		2	≥ 25 percent
LDel	Percent of Truck Trips that are Late	0	≤ 5 percent
		1	> 5 percent
PFam	Percent of Truck Trips that are not made on Familiar Roads	0	< 10 percent
		1	≥ 10 percent and < 25 percent
		2	≥ 25 percent
Race	Caucasian (CC)	0	No
		1	Yes
	Native American (NA)	0	No
		1	Yes
	African American (AA)	0	No
		1	Yes
	Hispanic (HP)	0	No
		1	Yes
Edu	Level of Education	0	No College
		1	College or Post-graduate Degree
Inc	Annual Income	0	< $50,000
		1	≥ $50,000 and < $70,000
		2	≥ $70,000
DayW	Number of Working Days per Week	0	≤ 5 days
		1	> 5 days
HourD	Number of Working Hours per Day	0	≤ 8 hours
		1	> 8 hours
NightW	Number of Nights Staying away from Home	0	< 2 nights
		1	≥ 2 nights
FSize	Company Fleet Size	0	< 500 trucks
		1	≥ 500 trucks and < 10,000 trucks
		2	≥ 10,000 trucks
G (Multiple Choices)	Types of Goods Carried	0	No (for each type of goods)
		1	Yes (for each type of goods)
T (Multiple Choices)	Truck Types	0	No (for each truck type)
		1	Yes (for each 11 truck type)
CTDTime (Multiple Choices)	Current Truck Driving Time of Day	0	No (for each time of day)
		1	Yes (for each time of day)

Table 5-28. Kruskal-Wallis and Mann-Whitney Test Statistics (Freeways-1)

Variable	Factors			
	Factor A*	Factor B*	Factor C*	Factor D*
Source (0, 1)	**1.96** (z)	1.33 (z)	**2.54** (z)	**3.86** (z)
Gen (0, 1)	0.98 (z)	0.91 (z)	1.22 (z)	0.73 (z)
Age (0, 1, 2)	3.34 ($\chi^2_{df=2}$)	0.03 ($\chi^2_{df=2}$)	4.71 ($\chi^2_{df=2}$)	3.88 ($\chi^2_{df=2}$)
Dep (0, 1)	−0.75 (z)	−1.17 (z)	−0.05 (z)	−1.64 (z)
Emp (0, 1, 2)	3.57 ($\chi^2_{df=2}$)	1.13 ($\chi^2_{df=2}$)	1.33 ($\chi^2_{df=2}$)	1.95 ($\chi^2_{df=2}$)
Indep (0, 1)	1.25 (z)	0.94 (z)	1.72 (z)	0.93 (z)
Earn_M (0, 1)	**2.07** (z)	0.70 (z)	**2.13** (z)	1.86 (z)
Earn_H (0, 1)	**−2.39** (z)	−0.51 (z)	−1.92 (z)	**−3.63** (z)
Earn_S (0, 1)	−0.61 (z)	−0.16 (z)	−1.37 (z)	0.62 (z)
Earn_D (0, 1)	−0.99 (z)	−1.77 (z)	0.86 (z)	−0.43 (z)
Earn_L (0, 1)	−0.91 (z)	−0.55 (z)	0.16 (z)	0.69 (z)
CType (0, 1, 2)	1.99 ($\chi^2_{df=2}$)	1.05 ($\chi^2_{df=2}$)	1.18 ($\chi^2_{df=2}$)	**8.00** ($\chi^2_{df=2}$) 1.64 (z , 0 vs 1) 1.94 (z , 1 vs 2) **2.87** (z , 0 vs 2)
LType (0, 1, 2)	0.82 ($\chi^2_{df=2}$)	0.61 ($\chi^2_{df=2}$)	3.28 ($\chi^2_{df=2}$)	**8.09** ($\chi^2_{df=2}$) **−2.81** (z , 0 vs 1) **2.14** (z , 1 vs 2) −0.41 (z , 0 vs 2)
RDTSel (0, 1, 2)	0.29 ($\chi^2_{df=2}$)	0.24 ($\chi^2_{df=2}$)	1.26 ($\chi^2_{df=2}$)	1.52 ($\chi^2_{df=2}$)
HDist (0, 1)	0.91 (z)	0.18 (z)	1.85 (z)	**3.74** (z)
GSpeed (0, 1)	−0.48 (z)	−0.39 (z)	−0.31 (z)	−0.14 (z)
MGSpeed (0, 1)	1.77 (z)	1.40 (z)	**2.66** (z)	**5.09** (z)
ETrip (0, 1, 2)	0.69 ($\chi^2_{df=2}$)	2.77 ($\chi^2_{df=2}$)	1.35 ($\chi^2_{df=2}$)	1.37 ($\chi^2_{df=2}$)
PFam (0, 1, 2)	1.65 ($\chi^2_{df=2}$)	0.94 ($\chi^2_{df=2}$)	1.45 ($\chi^2_{df=2}$)	2.39 ($\chi^2_{df=2}$)
LDel (0, 1)	−0.92 (z)	−0.04 (z)	−0.15 (z)	−0.92 (z)
Race_CC (0, 1)	−0.31 (z)	1.48 (z)	−0.60 (z)	1.18 (z)
Race_NA (0, 1)	−1.03 (z)	−1.07 (z)	0.21 (z)	0.16 (z)
Race_AA (0, 1)	−0.70 (z)	**−2.02** (z)	−1.25 (z)	−0.33 (z)
Race_HP (0, 1)	1.44 (z)	0.19 (z)	1.05 (z)	−1.34 (z)
Edu (0, 1)	1.92 (z)	**2.04** (z)	**2.44** (z)	−0.70 (z)
Inc (0, 1, 2)	0.37 ($\chi^2_{df=2}$)	0.10 ($\chi^2_{df=2}$)	0.10 ($\chi^2_{df=2}$)	0.10 ($\chi^2_{df=2}$)
DayW (0, 1)	0.03 (z)	−0.31 (z)	−0.28 (z)	1.87 (z)

* Factor Labels

A. A Consistently Good Ride Quality

B. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit

C. Ease of Obtaining Useful Travel Conditions Information

D. Ease of Driving at or above the Posted Speed Limit

Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-29. Kruskal-Wallis and Mann-Whitney Test Statistics (Freeways-2)

Variable	Factors			
	Factor A*	Factor B*	Factor C*	Factor D*
HourD (0, 1)	−1.59 (z)	−1.75 (z)	0.32 (z)	−0.37 (z)
NightW (0, 1)	0.94 (z)	−0.67 (z)	0.07 (z)	1.56 (z)
FSize (0, 1, 2)	2.83 ($\chi^2_{df=2}$)	5.06 ($\chi^2_{df=2}$)	0.01 ($\chi^2_{df=2}$)	2.60 ($\chi^2_{df=2}$)
CTDTime (0, 1) (0AM–6AM)	1.28 (z)	1.83 (z)	0.14 (z)	−0.25 (z)
CTDTime (0, 1) (6AM–9AM)	−1.57 (z)	−1.94 (z)	−0.41 (z)	0.57 (z)
CTDTime (0, 1) (9AM–Noon)	−0.84 (z)	−1.09 (z)	−0.72 (z)	**−2.27** (z)
CTDTime (0, 1) (Noon–3PM)	**−2.30** (z)	−1.30 (z)	−1.43 (z)	−0.31 (z)
CTDTime (0, 1) (3PM–7PM)	−1.64 (z)	−0.52 (z)	−1.26 (z)	0.41 (z)
CTDTime (0, 1) (7PM–0AM)	−0.92 (z)	0.34 (z)	−0.37 (z)	0.25 (z)

* Factor Labels
A. A Consistently Good Ride Quality
B. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
C. Ease of Obtaining Useful Travel Conditions Information
D. Ease of Driving at or above the Posted Speed Limit
Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-30. Kruskal-Wallis and Mann-Whitney Test Statistics (Urban Arterials-1)

Variable	Factors			
	Factor A*	Factor B*	Factor C*	Factor D*
Source (0, 1)	1.25 (z)	0.66 (z)	−0.15 (z)	−1.13 (z)
Gen (0, 1)	−0.28 (z)	−0.02 (z)	0.65 (z)	−0.65 (z)
Age (0, 1, 2)	2.60 ($\chi^2_{df=2}$)	1.34 ($\chi^2_{df=2}$)	2.38 ($\chi^2_{df=2}$)	0.55 ($\chi^2_{df=2}$)
Dep (0, 1)	−0.89 (z)	−1.13 (z)	−1.05 (z)	−1.59 (z)
Emp (0, 1, 2)	1.73 ($\chi^2_{df=2}$)	1.21 ($\chi^2_{df=2}$)	1.52 ($\chi^2_{df=2}$)	0.27 ($\chi^2_{df=2}$)
Indep (0, 1)	1.56 (z)	−0.10 (z)	−1.11 (z)	−1.34 (z)
Earn_M (0, 1)	0.84 (z)	0.67 (z)	0.90 (z)	0.54 (z)
Earn_H (0, 1)	−1.91 (z)	−0.88 (z)	0.53 (z)	0.69 (z)
Earn_S (0, 1)	−1.06 (z)	−0.26 (z)	−0.06 (z)	−0.26 (z)
Earn_D (0, 1)	−0.86 (z)	−1.86 (z)	−0.99 (z)	−0.50 (z)
Earn_L (0, 1)	−0.07 (z)	**−2.08** (z)	**−2.84** (z)	−1.58 (z)
CType (0, 1, 2)	3.81 ($\chi^2_{df=2}$)	1.66 ($\chi^2_{df=2}$)	**6.33** ($\chi^2_{df=2}$) −0.50 (z , 0 vs 1) **−2.33** (z , 1 vs 2) **−2.38** (z , 0 vs 2)	3.28 ($\chi^2_{df=2}$)
LType (0, 1, 2)	0.96 ($\chi^2_{df=2}$)	0.52 ($\chi^2_{df=2}$)	0.89 ($\chi^2_{df=2}$)	0.53 ($\chi^2_{df=2}$)
RDTSel (0, 1, 2)	0.18 ($\chi^2_{df=2}$)	2.55 ($\chi^2_{df=2}$)	2.37 ($\chi^2_{df=2}$)	3.42 ($\chi^2_{df=2}$)
HDist (0, 1)	0.52 (z)	0.11 (z)	−0.71 (z)	−0.80 (z)
GSpeed (0, 1)	−0.91 (z)	0.73 (z)	0.06 (z)	1.43 (z)
MGSpeed (0, 1)	**2.19** (z)	0.00 (z)	−0.56 (z)	0.26 (z)
ETrip (0, 1, 2)	1.86 ($\chi^2_{df=2}$)	2.57 ($\chi^2_{df=2}$)	1.87 ($\chi^2_{df=2}$)	1.75 ($\chi^2_{df=2}$)
PFam (0, 1, 2)	0.66 ($\chi^2_{df=2}$)	0.34 ($\chi^2_{df=2}$)	0.36 ($\chi^2_{df=2}$)	0.05 ($\chi^2_{df=2}$)
LDel (0, 1)	−1.08 (z)	−0.04 (z)	0.50 (z)	0.08 (z)
Race_CC (0, 1)	−0.89 (z)	−0.35 (z)	0.93 (z)	1.23 (z)
Race_NA (0, 1)	−0.12 (z)	−1.48 (z)	−1.44 (z)	−0.39 (z)
Race_AA (0, 1)	1.09 (z)	0.83 (z)	−0.60 (z)	−1.90 (z)
Race_HP (0, 1)	0.23 (z)	0.94 (z)	−0.35 (z)	−0.33 (z)
Edu (0, 1)	0.59 (z)	1.03 (z)	0.93 (z)	0.61 (z)
Inc (0, 1, 2)	2.74 ($\chi^2_{df=2}$)	1.34 ($\chi^2_{df=2}$)	1.23 ($\chi^2_{df=2}$)	0.99 ($\chi^2_{df=2}$)
DayW (0, 1)	−0.13 (z)	−0.17 (z)	−1.58 (z)	0.27 (z)
HourD (0, 1)	**−2.03** (z)	**−2.55** (z)	**−2.41** (z)	−1.32 (z)
NightW (0, 1)	−0.26 (z)	−1.59 (z)	−0.83 (z)	−0.20 (z)
FSize (0, 1, 2)	3.21 ($\chi^2_{df=2}$)	5.26 ($\chi^2_{df=2}$)	0.65 ($\chi^2_{df=2}$)	0.26 ($\chi^2_{df=2}$)

* Factor Labels
A. A Consistently Good Ride Quality
B. Ease of Changing Lanes
C. Ease of Right- or Left-Turn Maneuvers
D. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-31. Kruskal-Wallis and Mann-Whitney Test Statistics (Urban Arterials-2)

Variable	Factors			
	Factor A*	Factor B*	Factor C*	Factor D*
CTDTime (0, 1) (0AM–6AM)	0.32 (z)	−0.49 (z)	0.21 (z)	0.45 (z)
CTDTime (0, 1) (6AM–9AM)	−1.09 (z)	−1.05 (z)	−1.08 (z)	−1.44 (z)
CTDTime (0, 1) (9AM–Noon)	−1.26 (z)	0.26 (z)	0.79 (z)	−1.57 (z)
CTDTime (0, 1) (Noon–3PM)	−1.39 (z)	−0.35 (z)	−0.42 (z)	−0.84 (z)
CTDTime (0, 1) (3PM–7PM)	−1.33 (z)	0.03 (z)	0.09 (z)	−0.49 (z)
CTDTime (0, 1) (7PM–0AM)	−1.74 (z)	0.75 (z)	−0.94 (z)	−0.84 (z)

* Factor Labels
A. A Consistently Good Ride Quality
B. Ease of Changing Lanes
C. Ease of Right- or Left-Turn Maneuvers
D. Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($z_{\alpha/2=0.025}$ = 1.96 for two-tailed test).

Table 5-32. Kruskal-Wallis and Mann-Whitney Test Statistics (Urban Arterials-3)

Variable	Factors		
	Factor E*	Factor F*	Factor G*
Source (0, 1)	0.82 (z)	**3.32** (z)	**−3.30** (z)
Gen (0, 1)	0.16 (z)	0.87 (z)	0.53 (z)
Age (0, 1, 2)	0.53 ($\chi^2_{df=2}$)	1.03 ($\chi^2_{df=2}$)	**6.33** ($\chi^2_{df=2}$) **2.02** (z , 0 vs 1) −1.81 (z , 1 vs 2) 1.22 (z , 0 vs 2)
Dep (0, 1)	−1.27 (z)	−1.63 (z)	0.72 (z)
Emp (0, 1, 2)	1.52 ($\chi^2_{df=2}$)	0.91 ($\chi^2_{df=2}$)	0.47 ($\chi^2_{df=2}$)
Indep (0, 1)	−1.65 (z)	0.84 (z)	−1.36 (z)
Earn_M (0, 1)	1.05 (z)	1.04 (z)	−0.81 (z)
Earn_H (0, 1)	0.20 (z)	**−2.82** (z)	**2.45** (z)
Earn_S (0, 1)	−0.34 (z)	0.05 (z)	0.23 (z)
Earn_D (0, 1)	0.41 (z)	−0.29 (z)	0.53 (z)
Earn_L (0, 1)	−1.86 (z)	−0.31 (z)	**−2.25** (z)
CType (0, 1, 2)	2.26 ($\chi^2_{df=2}$)	4.61 ($\chi^2_{df=2}$)	**6.63** ($\chi^2_{df=2}$) −1.82 (z , 0 vs 1) −1.40 (z , 1 vs 2) **−2.57** (z , 0 vs 2)
LType (0, 1, 2)	0.84 ($\chi^2_{df=2}$)	**7.14** ($\chi^2_{df=2}$) **−2.66** (z , 0 vs 1) **2.01** (z , 1 vs 2) −0.31 (z , 0 vs 2)	3.70 ($\chi^2_{df=2}$)
RDTSel (0, 1, 2)	3.29 ($\chi^2_{df=2}$)	1.82 ($\chi^2_{df=2}$)	2.09 ($\chi^2_{df=2}$)
HDist (0, 1)	−0.83 (z)	**2.13** (z)	**−2.65** (z)
GSpeed (0, 1)	0.93 (z)	−0.66 (z)	1.05 (z)
MGSpeed (0, 1)	0.53 (z)	**3.06** (z)	−0.76 (z)
ETrip (0, 1, 2)	1.28 ($\chi^2_{df=2}$)	2.89 ($\chi^2_{df=2}$)	2.34 ($\chi^2_{df=2}$)
PFam (0, 1, 2)	0.96 ($\chi^2_{df=2}$)	0.63 ($\chi^2_{df=2}$)	1.36 ($\chi^2_{df=2}$)
LDel (0, 1)	0.01 (z)	**−2.14** (z)	**2.11** (z)
Race_CC (0, 1)	1.90 (z)	−0.10 (z)	0.75 (z)
Race_NA (0, 1)	0.09 (z)	−0.50 (z)	−1.67 (z)
Race_AA (0, 1)	−1.49 (z)	1.30 (z)	−0.03 (z)
Race_HP (0, 1)	−1.70 (z)	−0.22 (z)	−0.68 (z)
Edu (0, 1)	1.00 (z)	−0.60 (z)	0.95 (z)

* Factor Labels

E. Ease of Passing through Signalized Intersections along the Arterial

F. Ease of Driving at or above the Posted Speed Limit

G. Ease of U-Turn Maneuvers

Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-33. Kruskal-Wallis and Mann-Whitney Test Statistics (Urban Arterials-4)

Variable	Factors		
	Factor E*	Factor F*	Factor G*
Inc (0, 1, 2)	1.81 ($\chi^2_{df=2}$)	1.03 ($\chi^2_{df=2}$)	5.59 ($\chi^2_{df=2}$)
DayW (0, 1)	1.58 (z)	**2.64** (z)	−0.13 (z)
HourD (0, 1)	−0.76 (z)	−0.59 (z)	**−2.81** (z)
NightW (0, 1)	−0.91 (z)	0.52 (z)	−1.83 (z)
FSize (0, 1, 2)	1.71 ($\chi^2_{df=2}$)	3.94 ($\chi^2_{df=2}$)	3.64 ($\chi^2_{df=2}$)
CTDTime (0, 1) (0AM–6AM)	0.23 (z)	−1.10 (z)	1.50 (z)
CTDTime (0, 1) (6AM–9AM)	−0.59 (z)	0.45 (z)	**−2.52** (z)
CTDTime (0, 1) (9AM–Noon)	−0.67 (z)	−1.38 (z)	−0.92 (z)
CTDTime (0, 1) (Noon–3PM)	−0.84 (z)	0.71 (z)	−1.26 (z)
CTDTime (0, 1) (3PM–7PM)	0.24 (z)	1.46 (z)	−0.55 (z)
CTDTime (0, 1) (7PM–0AM)	−1.40 (z)	0.40 (z)	−1.11 (z)

* Factor Labels
E. Ease of Passing through Signalized Intersections along the Arterial
F. Ease of Driving at or above the Posted Speed Limit
G. Ease of U-Turn Maneuvers
Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-34. Mann-Whitney Test Statistics (Urban Arterials-5)

	Factors		
Types of Goods Carried	Factor B*	Factor C*	Factor G*
Food (0, 1)	**2.51** (z)		**2.04** (z)
Auto Parts (0, 1)	**2.10** (z)		
Textiles (0, 1)	**2.11** (z)		
Metals (0, 1)	**2.50** (z)		
Paper and Allied Products (0, 1)		**2.04** (z)	
Chemicals and Allied Products (0, 1)	**2.35** (z)		
Equipment (0, 1)	**2.05** (z)		
Furniture (0, 1)	**2.08** (z)		
Hazardous Materials (0, 1)	**2.26** (z)		

* Factor Labels
B. Ease of Changing Lanes
C. Ease of Right- or Left-Turn Maneuvers
G. Ease of U-Turn Maneuvers
Note: Calculated z values are the Mann-Whitney test results. Positive z value indicates that the group with larger code value perceived the corresponding factor to be more important than the other group did. Only the z values significant at the 95% confidence level are presented ($z_{\alpha/2=0.025}$ = 1.96 for two-tailed test).

Table 5-35. Kruskal-Wallis and Mann-Whitney Test Statistics (Two-Lane Highways-1)

	Factors				
Variable	Factor A*	Factor B*	Factor C*	Factor D*	Factor E*
Source (0, 1)	**2.75** (z)	1.76 (z)	−0.81 (z)	**1.97** (z)	−0.41 (z)
Gen (0, 1)	**2.27** (z)	0.27 (z)	−0.62 (z)	1.81 (z)	0.03 (z)
Age (0, 1, 2)	5.81 ($\chi^2_{df=2}$)	1.57 ($\chi^2_{df=2}$)	0.36 ($\chi^2_{df=2}$)	3.68 ($\chi^2_{df=2}$)	0.44 ($\chi^2_{df=2}$)
Dep (0, 1)	−0.94 (z)	−0.10 (z)	−0.57 (z)	−1.64 (z)	−1.40 (z)
Emp	**8.37** ($\chi^2_{df=2}$)	5.61 ($\chi^2_{df=2}$)	0.38 ($\chi^2_{df=2}$)	**6.11** ($\chi^2_{df=2}$)	2.30 ($\chi^2_{df=2}$)
(0, 1, 2)	0.05 (z , 0 vs 1)			−1.7 (z ,0 vs 1)	
	−2.7 (z , 1 vs 2)			−1.1 (z , 1 vs 2)	
	−1.6 (z , 0 vs 2)			**−2.4** (z , 0 vs 2)	
Indep (0, 1)	0.85 (z)	−0.05 (z)	−1.11 (z)	0.03 (z)	−1.29 (z)
Earn_M (0, 1)	0.50 (z)	0.37 (z)	−1.02 (z)	0.16 (z)	0.45 (z)
Earn_H (0, 1)	−1.40 (z)	−1.27 (z)	1.18 (z)	−1.41 (z)	0.05 (z)
Earn_S (0, 1)	−1.12 (z)	−0.84 (z)	−0.85 (z)	−0.52 (z)	−1.01 (z)
Earn_D (0, 1)	0.89 (z)	−1.92 (z)	−1.00 (z)	−0.55 (z)	1.30 (z)
Earn_L (0, 1)	0.37 (z)	−0.45 (z)	−1.64 (z)	−0.01 (z)	−1.92 (z)
CType (0, 1, 2)	4.52 ($\chi^2_{df=2}$)	2.37 ($\chi^2_{df=2}$)	0.87 ($\chi^2_{df=2}$)	0.26 ($\chi^2_{df=2}$)	1.80 ($\chi^2_{df=2}$)
LType	3.36 ($\chi^2_{df=2}$)	1.50 ($\chi^2_{df=2}$)	0.82 ($\chi^2_{df=2}$)	**7.36** ($\chi^2_{df=2}$)	1.04 ($\chi^2_{df=2}$)
(0, 1, 2)				−1.3 (z , 0 vs 1)	
				2.56 (z , 1 vs 2)	
				2.01 (z , 0 vs 2)	
RDTSel (0, 1, 2)	1.78 ($\chi^2_{df=2}$)	1.99 ($\chi^2_{df=2}$)	1.87 ($\chi^2_{df=2}$)	1.49 ($\chi^2_{df=2}$)	1.93 ($\chi^2_{df=2}$)
HDist (0, 1)	0.70 (z)	1.07 (z)	−1.26 (z)	0.49 (z)	−0.67 (z)
GSpeed (0, 1)	−0.76 (z)	0.84 (z)	1.26 (z)	−1.34 (z)	1.54 (z)
ETrip	**6.09** ($\chi^2_{df=2}$)	4.63 ($\chi^2_{df=2}$)	1.78 ($\chi^2_{df=2}$)	0.40 ($\chi^2_{df=2}$)	0.13 ($\chi^2_{df=2}$)
(0, 1, 2)	1.37 (z , 0 vs 1)				
	−2.5 (z , 1 vs 2)				
	−1.2 (z , 0 vs 2)				
PFam	3.49 ($\chi^2_{df=2}$)	0.63 ($\chi^2_{df=2}$)	0.76 ($\chi^2_{df=2}$)	**7.20** ($\chi^2_{df=2}$)	0.07 ($\chi^2_{df=2}$)
(0, 1, 2)				0.84 (z , 0 vs 1)	
				1.75 (z , 1 vs 2)	
				2.67 (z , 0 vs 2)	
LDel (0, 1)	−0.92 (z)	**−2.00** (z)	0.96 (z)	−0.90 (z)	0.49 (z)

* Factor Labels
A. Probability of Being Passed or Followed by Faster Vehicles
B. A Consistently Good Ride Quality
C. Width of Travel Lane and Shoulder, or Shoulder Type
D. Probability of Encountering Possible Conflicts
E. Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes
Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05} = 5.99$, $z_{\alpha/2=0.025} = 1.96$ for two-tailed test).

Table 5-36. Kruskal-Wallis and Mann-Whitney Test Statistics (Two-Lane Highways-2)

Variable	Factors				
	Factor A*	Factor B*	Factor C*	Factor D*	Factor E*
MGSpeed (0, 1)	0.67 (z)	1.23 (z)	1.57 (z)	0.43 (z)	0.72 (z)
Race_CC (0, 1)	−0.41 (z)	−1.10 (z)	1.28 (z)	−0.82 (z)	0.25 (z)
Race_NA (0, 1)	−0.43 (z)	0.46 (z)	−1.29 (z)	0.08 (z)	0.02 (z)
Race_AA (0, 1)	−1.61 (z)	1.25 (z)	0.37 (z)	1.12 (z)	0.55 (z)
Race_HP (0, 1)	**2.45** (z)	0.53 (z)	−1.18 (z)	0.02 (z)	−1.22 (z)
Edu (0, 1)	1.18 (z)	1.12 (z)	0.00 (z)	0.96 (z)	−0.59 (z)
Inc (0, 1, 2)	1.07 ($\chi^2_{df=2}$)	**6.92** ($\chi^2_{df=2}$) 1.13 (z , 0 vs 1) −**2.5** (z , 1 vs 2) −1.5 (z , 0 vs 2)	**6.05** ($\chi^2_{df=2}$) 0.53 (z , 0 vs 1) −**2.5** (z , 1 vs 2) −1.5 (z , 0 vs 2)	3.58 ($\chi^2_{df=2}$)	2.29 ($\chi^2_{df=2}$)
DayW (0, 1)	−0.84 (z)	**2.24** (z)	−0.94 (z)	0.89 (z)	0.12 (z)
HourD (0, 1)	0.99 (z)	−1.26 (z)	−1.94 (z)	−1.17 (z)	−0.55 (z)
NightW (0, 1)	−0.34 (z)	−1.13 (z)	−1.49 (z)	0.12 (z)	−1.67 (z)
FSize (0, 1, 2)	1.20 ($\chi^2_{df=2}$)	0.63 ($\chi^2_{df=2}$)	1.95 ($\chi^2_{df=2}$)	0.05 ($\chi^2_{df=2}$)	3.14 ($\chi^2_{df=2}$)
CTDTime (0, 1) (0AM–6AM)	−1.43 (z)	−0.08 (z)	1.11 (z)	0.08 (z)	−0.08 (z)
CTDTime (0, 1) (6AM–9AM)	1.11 (z)	−0.32 (z)	−1.04 (z)	0.76 (z)	0.35 (z)
CTDTime (0, 1) (9AM–Noon)	1.69 (z)	0.30 (z)	−0.61 (z)	0.19 (z)	−0.70 (z)
CTDTime (0, 1) (Noon–3PM)	**1.97** (z)	−0.62 (z)	−0.47 (z)	−0.14 (z)	−0.65 (z)
CTDTime (0, 1) (3PM–7PM)	1.83 (z)	0.81 (z)	0.27 (z)	0.07 (z)	−0.10 (z)
CTDTime (0, 1) (7PM–0AM)	−1.65 (z)	−1.87 (z)	−1.45 (z)	−**2.14** (z)	−0.24 (z)

* Factor Labels

A. Probability of Being Passed or Followed by Faster Vehicles

B. A Consistently Good Ride Quality

C. Width of Travel Lane and Shoulder, or Shoulder Type

D. Probability of Encountering Possible Conflicts

E. Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes

Note: Calculated χ^2 values are the Kruskal-Wallis ANOVA test results and calculated z values are the Mann-Whitney pair-wise comparison test results. Negative z value indicates that the group with smaller code value perceived the corresponding factor to be more important than the other group did. Bolded values are significant at the 95% confidence level ($\chi^2_{df=2,\ \alpha=0.05}$ = 5.99, $z_{\alpha/2=0.025}$ = 1.96 for two-tailed test).

Table 5-37. Mann-Whitney Test Statistics (Two-Lane Highways-3)

	Factors				
Types of Goods Carried	Factor A*	Factor B*	Factor C*	Factor D*	Factor E*
Grains/Feed (0, 1)		**2.73** (z)	**2.22** (z)		
Auto Parts (0, 1)	**2.12** (z)				
Waste and Scrap (0, 1)				**2.34** (z)	
Stone, Clay, and Concrete Products (0, 1)	**2.12** (z)				
Hazardous Materials (0, 1)			**2.52** (z)		
FedEx (unknown packages) (0, 1)	**−3.00** (z)				
Truck Type (0, 1) (Straight Truck)	**−2.63** (z)				
Truck Type (0, 1) Truck/Trailer					**2.18** (z)
Truck Type (0, 1) Turnpike Double		**−2.14** (z)			

* Factor Labels

A. Probability of Being Passed or Followed by Faster Vehicles
B. A Consistently Good Ride Quality
C. Width of Travel Lane and Shoulder, or Shoulder Type
D. Probability of Encountering Possible Conflicts
E. Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes

Note: Calculated z values are the Mann-Whitney test results. Positive z value indicates that the group with larger code value perceived the corresponding factor to be more important than the other group did. Only the z values significant at the 95% confidence level are presented ($z_{\alpha/2=0.025}$ = 1.96 for two-tailed test).

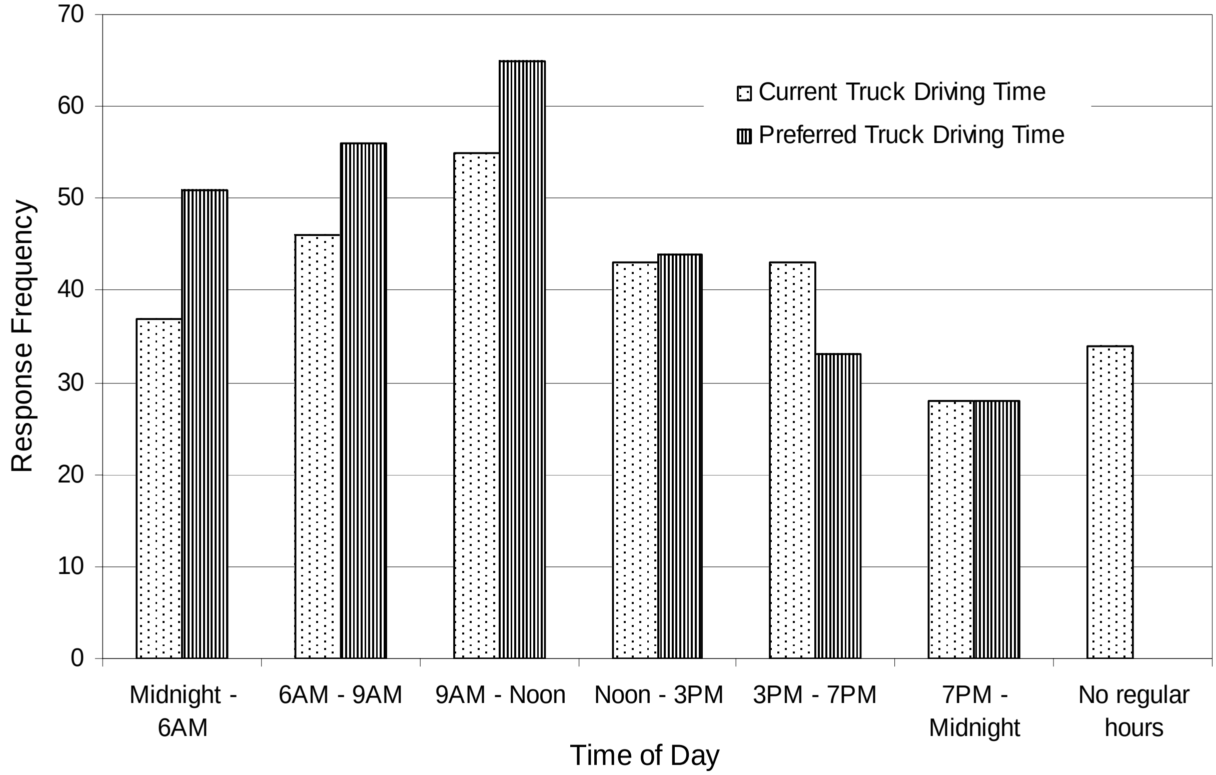


Figure 5-8. Truck Drivers' Current and Preferred Truck Driving Times of Day

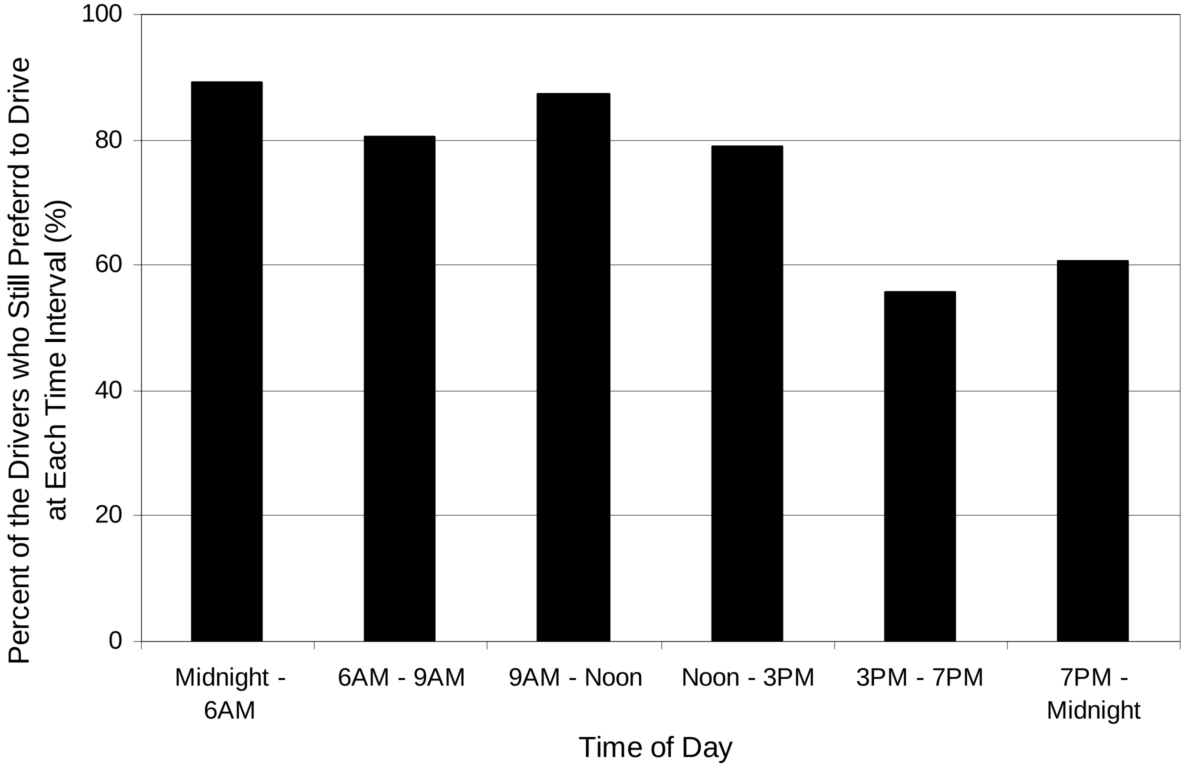


Figure 5-9. Truck Driving Time of Day Preference of Current Users

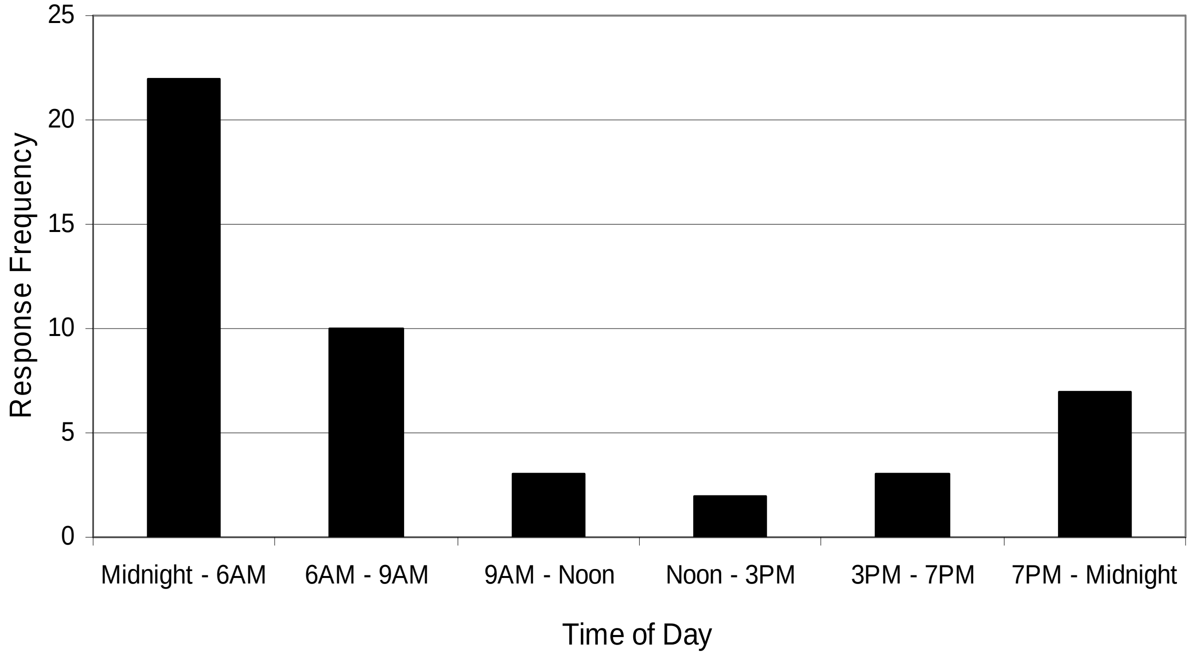


Figure 5-10. Truck Company Managers' Preference on Truck Driving Times of Day

Table 5-38. Chi-Squared Test Statistics – 1 ($\chi^2_{calculated}$)

Variable	Time Period A*	Time Period B*	Time Period C*	Time Period D*	Time Period E*	Time Period F*
	Truck Driving Times of Day					
Age (0, 1, 2)	1.54	0.90	1.29	1.20	0.48	2.74
Dep (0, 1)	0.02	3.42	0.27	0.22	0.15	0.78
Emp (0, 1, 2)	0.28	0.81	0.11	0.55	0.50	2.37
Indep (0, 1)	1.43	0.02	1.38	0.04	0.16	**5.38** (+)
Earn_M (0, 1)	1.76	**6.39** (–)	**5.98** (–)	**5.00** (–)	0.02	**13.93** (+)
Earn_H (0, 1)	2.04	0.54	**5.75** (+)	1.00	0.01	2.10
Earn_S (0, 1)	0.03	2.14	1.27	1.23	0.48	0.24
Earn_D (0, 1)	0.20	0.00	0.05	0.14	1.26	0.00
Earn_L (0, 1)	0.03	2.14	1.27	0.10	1.10	1.99
CType (0, 1, 2)	**13.42** **7.3** (0, 1, –) **3.9** (1, 2, –) **9.2** (0, 2, –)	4.58	3.84	3.93	1.98	2.64
LType (0, 1, 2)	**7.90** **7.7** (0, 1, –) 0.7 (1, 2) 2.3 (0, 2)	1.10	**6.39** **5.8** (0, 1, +) 2.6 (1, 2) 0.2 (0, 2)	**9.17** **8.9** (0, 1, +) 0.2 (1, 2) **4.7** (0, 2, +)	4.19	2.11
RDTSel (0, 1, 2)	2.81	0.62	1.11	4.68	2.82	4.82
HDist (0, 1)	**4.86** (+)	1.25	**6.16** (−)	**9.46** (–)	2.19	3.75
GSpeed (0, 1)	0.51	3.80	0.55	0.24	0.90	1.23
MGSpeed (0, 1)	2.36	0.02	3.57	0.38	0.69	**6.26** (+)
ETrip (0, 1, 2)	5.65	2.76	1.23	0.97	0.09	2.24
PFam (0, 1, 2)	4.30	3.83	5.37	3.74	4.20	2.57
LDel (0, 1)	1.09	0.57	0.19	**6.45** (+)	0.14	2.07
Race_CC (0, 1)	0.53	0.96	0.14	2.35	1.33	0.01
Race_NA (0, 1)	0.12	0.07	0.73	3.14	2.13	0.11
Race_AA (0, 1)	0.66	3.32	0.00	1.62	0.00	0.39
Race_HP (0, 1)	0.60	0.06	0.22	0.05	0.10	0.48
Edu (0, 1)	0.02	0.52	0.21	1.47	0.03	1.00
Inc (0, 1, 2)	2.31	5.80	0.61	0.69	2.23	2.29
DayW (0, 1)	**5.45**	0.00	**8.90** (–)	**7.40** (–)	**4.40** (–)	1.44
HourD (0, 1)	0.04	1.34	0.62	2.12	1.15	1.39

* Preferred Truck Driving Time of Day Labels
A. Midnight – 6AM
B. 6AM – 9AM
C. 9AM – Noon
D. Noon – 3PM
E. 3PM – 7PM
F. 7PM – Midnight
Note: Bolded χ^2 values are significant at the 95% confidence level ($\chi^2_{df=1,\ \alpha=0.05} = 3.84$, $\chi^2_{df=2,\ \alpha=0.05} = 5.99$). Positive (+) symbol in parentheses indicate that the group with larger code preferred to drive during the corresponding time period more than the other group did.

Table 5-39. Chi-Squared Test Statistics – 2 ($\chi^2_{calculated}$)

	Truck Driving Times of Day					
Variable	Time Period A*	Time Period B*	Time Period C*	Time Period D*	Time Period E*	Time Period F*
NightW (0, 1)	2.31	0.06	0.35	3.55	0.01	0.92
FSize (0, 1, 2)	**12.39** 1.5 (0, 1) **7.3** (1, 2, −) **12.0** (0, 2, −)	1.25	2.31	3.12	0.08	2.57

* Preferred Truck Driving Time of Day Labels
A. Midnight – 6AM
B. 6AM – 9AM
C. 9AM – Noon
D. Noon – 3PM
E. 3PM – 7PM
F. 7PM – Midnight
Note: Bolded χ^2 values are significant at the 95% confidence level ($\chi^2_{df=1, \alpha=0.05} = 3.84$, $\chi^2_{df=2, \alpha=0.05} = 5.99$). Positive symbol in parentheses indicate that the group with larger code preferred to drive during the corresponding time period more than the other group did.

Table 5-40. Chi-Squared Test Statistics – 3 ($\chi^2_{calculated}$)

	Truck Driving Times of Day					
Truck Types	Time Period A*	Time Period B*	Time Period C*	Time Period D*	Time Period E*	Time Period F*
Straight Truck (0, 1)						**3.97** (+)
Twin Trailer (0, 1)	**10.94** (–)					**6.38** (+)
3-Axle Semitrailer (0, 1)	**13.07** (–)	**5.51** (+)	**10.16** (+)			
4-Axle Semitrailer (0, 1)	**22.83** (–)		**10.81** (+)	**7.85** (+)		
5-Axle Semitrailer (0, 1)	**9.62** (+)					
Rocky Mountain Double (0, 1)	**4.69** (+)					

* Preferred Truck Driving Time of Day Labels
A. Midnight – 6AM
B. 6AM – 9AM
C. 9AM – Noon
D. Noon – 3PM
E. 3PM – 7PM
F. 7PM – Midnight
Note: Only the χ^2 values significant at the 95% confidence level are presented ($\chi^2_{df=1, \alpha=0.05} = 3.84$). Positive symbol in parentheses indicate that the group with larger code preferred to drive during the corresponding time period more than the other group did.

Table 5-41. Chi-Squared Test Statistics – 4 ($\chi^2_{calculated}$)

Types of Goods Carried	Truck Driving Times of Day: Time Period A*	Time Period B*	Time Period C*	Time Period D*	Time Period E*	Time Period F*
Grains/Feed (0, 1)	**7.84** (–)		**5.06** (+)	**4.71** (+)		
Household Goods or Stationary (0, 1)	**4.66** (–)		**7.71** (+)	**4.39** (+)		
Auto Parts (0, 1)	**6.01** (–)		**8.02** (+)	**7.63** (+)		
Vehicles (0, 1)	**5.06** (–)		**3.96** (+)	**4.97** (+)		
Machinery (0, 1)	**6.38** (–)		**4.66** (+)			
Textiles (0, 1)	**10.38** (–)		**9.05** (+)	**10.65** (+)	**4.38** (+)	
Livestock (0, 1)				**6.19** (+)		
Metals (0, 1)	**10.38** (–)		**5.61** (+)	**6.07** (+)		
Manufactured Goods (0, 1)	**5.78** (–)		**5.52** (+)	**5.23** (+)		
Chemicals (0, 1)			**6.39** (+)	**4.29** (+)		
Paper and Allied Products (0, 1)			**11.56** (+)	**4.34** (+)		
Coal and Petroleum (0, 1)			**9.44** (+)	**6.79** (+)	**4.60** (+)	
Chemicals and Allied Products (0, 1)			**6.61** (+)			
Waste and Scrap (0, 1)	**7.04** (–)					
Equipment (0, 1)	**11.21** (–)		**7.19** (+)	**7.27** (+)	**5.39** (+)	
Furniture (0, 1)	**6.39** (–)		**4.04** (+)	**4.76** (+)		
Wood Products Except Furniture (0, 1)	**7.65** (–)		**7.06** (+)			
Stone, Clay, and Concrete Products (0, 1)	**8.24** (–)		**7.32** (+)	**8.01** (+)	**4.53** (+)	
Glass (0, 1)	**6.38** (–)			**4.32** (+)	**4.06** (+)	
Hazardous Materials (0, 1)	**5.29** (–)					

* Preferred Truck Driving Time of Day Labels
A. Midnight – 6AM
B. 6AM – 9AM
C. 9AM – Noon
D. Noon – 3PM
E. 3PM – 7PM, F. 7PM – Midnight

Note: Only the χ^2 values significant at the 95% confidence level are presented ($\chi^2_{df=1, \alpha=0.05}$ = 3.84). Positive symbol in parentheses indicate that the group with larger code preferred to drive during the corresponding time period more than the other group did.

Table 5-42. Other Factors Affecting Truck Trip Quality on Freeways

Issues	Other Factors Affecting Truck Trip Quality on Freeways	Frequency
Rest Area /Amenities	Availability and Security of Rest Areas and/or Truck Parking Spaces (including overnight parking)	12
	Accessibility or Location of Truck Stops (near the freeway exit)	2
	Accessible Microwave ovens in Turnpike Travel Centers	1
	Availability of Wireless Internet at Rest Areas	1
Inspection /Weigh Stations	Frequency of Scales/Inspection Stations	3
	Electronic Signs at Weigh Stations Alerting Drivers of Weather Condition (e.g., tornado, thunder storm)	1
	Frequency of DOT Inspections at Scales	1
	Having to Enter Scales When Bobtailing (only tractor) or Pulling Empty Flatbed	1
	Static Scales at Weigh Stations	1
	Waiting Time at Agricultural Stations	1
Traffic Condition /Policy	Construction Workers' Vigilance of Traffic	1
	Ease of Obtaining Truck Driver's License	1
	Frequency of Recreational Vehicles (RV)	1
	Lower Toll Fees for Trucks	1
	Posted Minimum Speed Limit (too low)	1
	Upgraded Level of Law Enforcement for Speeders and DUIs (Driving Under the Influence of drugs or alcohol)	1
Traveler Information	Ease of Obtaining Information about New Regulations	1
	Ease of Obtaining Information about Peak Tourist Days	1
	Availability of Information about Motels with Truck Parking Spaces	1
Roadway Condition	Difference between Vertical Levels of Travel Lane and Shoulder	1

Table 5-43. Other Drivers' Behavior Affecting Truck Trip Quality on Freeways

Other Drivers' Behavior Affecting Truck Trip Quality on Freeways	Frequency
Slow Vehicles in Left-most or Center Lane	9
Education of Motoring Public about Truck Driving Characteristics for Safety (e.g., truck braking distance, driving around large trucks)	8
Other Drivers' Use of Turn Signal	3
Other Drivers' Use of Cell Phones without Hands-free Devices	2
Drivers Cutting in front of Trucks to Enter an On-Ramp	1
Other Drivers' Tailgating Behavior	1
Other Drivers' Yielding Behavior	1
Passenger Car Drivers' Poor Merging Behavior	1
Passenger Car Drivers' Understanding of Weigh Stations and the danger of Trucks	1
Passenger Car Drivers Using Hazard Lights when it rains	1
Speeder/Reckless Drivers	1
Truck Drivers' Road Etiquette	1

Table 5-44. Other Factors Affecting Truck Trip Quality on Urban Arterials

Issues	Other Factors Affecting Truck Trip Quality on Urban Arterials	Frequency
Roadway Condition	Signage (clarity, brevity, proper location (earlier placement), size, visibility at night)	4
	Availability, Proper Sizes, or Law Enforcement of Truck Parking Spaces	3
	Lighting Conditions at Night	2
Accident	Accident Clearance time and/or Availability of Alternative Lanes during Accident Clearance Time	1
Traffic Condition	Percent of Recreational Vehicles (RV) on the Road	1
Other Drivers' Behavior	Drivers Cutting off in front of Trucks Not Allowing Safe Stopping Distance	2
	Drivers Speeding Up Not to Allow Trucks to Change Lanes	2
	Drivers' Making Right Turns from Left Lane or Left Turns from Right Lane	1
	Other Drivers' Use of Turn Signals	1
	Reckless Motorcyclists	1
	Truck Drivers' Road Etiquette	1

Table 5-45. Other Factors Affecting Truck Trip Quality on Two-Lane Highways

Issues	Other Factors Affecting Truck Trip Quality on Two-Lane Highways	Frequency
Roadway Condition	Availability of Turning Maneuvers (left turns and U turns)	2
	Brightness of Roadway Striping	1
	Existence of Rumble strips Near the Center Line	1
	Frequency of Small Towns on a Route (on a delay perspective)	1
	Properly Trimmed Trees/Foliage (adequate clearance and sight distance)	1
	Size of Street Signs (visibility and way finding)	1
Traffic Condition	Frequency of School Buses (that do not allow for other vehicles to pass)	2
	Traffic signal Operations in Small Towns (signal responsiveness or coordination)	2
	Ease of Maintaining a Consistent Speed	1
	Frequency of Speed Limit Changes	1
Other Drivers' Behavior	Drivers Improperly Cutting in or Pulling Out in front of a Big Truck (despite the truck's low braking capability)	1
	Other Drivers' Tailgating Behavior	1
	Recreational Vehicle (RV) Drivers' Poor Driving Skills	1

CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

This study investigated the relative importance of traffic, roadway, and control factors on various transportation facilities for the trucking community in terms of truck trip quality. This chapter provides conclusions on the truck trip quality determinants and service measures for each transportation facility and recommendations on the methodologies to develop truck LOS estimation models, based on the results of this study.

6.1 Conclusions

The three issues important for the trucking community to evaluate quality of a truck trip were truck travel safety, travel time, and physical and psychological driving comfort. Truck drivers were more concerned about the driving comfort, while truck company managers were more concerned about travel time. Truck drivers at most truck companies are not very sensitive to travel time because they are usually given more than enough time to make deliveries on time and truck travel route and departure time are usually determined by the company managers. Thus, the managers are primarily responsible for any late deliveries from unexpected congestions. Independent truck drivers, however, are much more sensitive to travel time in that they make delivery appointments and schedule truck trips for their own business. Travel time is a critical concern for the managers and independent truck drivers. They typically schedule truck routes and manage their drivers to make deliveries for customers and the service quality of truck companies evaluated by the customers, primarily based on on-time delivery performance. Travel safety was a very important issue for both drivers and managers. Truck drivers are typically graded by their accident history and safe truck operation has a significant effect on overall trucking business, especially for insurance costs.

The perceptions of both groups are important for evaluating truck trip Quality Of Service (QOS), but the perceptions of truck drivers should be primarily addressed because they are the ones who drive on the roadway system. Managers may not be aware of all the situations that truck drivers encounter while traveling, or may not be sensitive to them since they are not the ones behind the wheel. They certainly want their drivers to travel comfortably and safely, but their primary concern is that the delivery gets to its destination on time.

6.1.1 Quality of a Truck Trip on Freeways

Truck drivers were most concerned about speed variance (or acceleration noise). That is, they were reluctant to experience a driving environment where they have to accelerate or decelerate their truck often due to other drivers' inconsiderate behavior and traffic congestion caused by increased traffic volume, construction activities, or truck travel restrictions (i.e., truck route, lane, or time-of-day restrictions). The importance level of pavement condition was as great as the speed variance for them. The primary concern of truck company managers was a travel time issue relative to the ratio of traffic volume to the roadway capacity. The contributing factors included level of congestion, construction activities, availability of alternative routes, and number of lanes. They were also concerned about the speed variance and pavement condition, but their importance was greater for truck drivers. Among all the listed factors, Traveler Information Systems (TIS) was perceived to be least important and least in need of improvement by both drivers and managers. The table 6-1 summarizes the relative importance of each of the main factors perceived to affect truck trip quality on freeways, by both truck drivers and truck company managers.

The speed variance (or acceleration noise) complemented by pavement condition was identified as the potential truck LOS service measure for trucks on freeways. Acceleration or speed variance reflects to a certain extent the psychological comfort of a trip, as more speed/acceleration variance may reflect more erratic driving behavior of other motorists. It also reflects to some extent capacity related issues, which are a major concern for managers. The pavement condition reflects the physical comfort of the trip. It may also be a psychological concern, as drivers may worry more about damaging their equipment or the goods on rough pavement. Pavement condition on freeways was also one of the several biggest concerns for truck company managers. Truck drivers' perceptions on the applicability of these service measures were different by their earning methods, race, level of education, current truck driving time of day.

6.1.2 Quality of a Truck Trip on Arterials

The perceptions of truck drivers on truck trip QOS determinants on arterials were summarized as 'maneuverability'. The maneuverability concept included multiple factors influencing their ability to make turning maneuvers, change lanes, and avoid acceleration or deceleration activities. Truck drivers were also concerned about the pavement condition to a great degree and the importance of curb radii and traffic signal coordination, in particular, were emphasized for truck operations at intersections. Some physical driving deterrents such as placement of light poles or trees, level of bicycle or pedestrian congestion, and improper stop bar position were perceived to be least important among all the listed factors.

Truck company managers had almost the same concerns as truck drivers identified, but their perceptions on the relative significance of each factor was somewhat different from that of truck drivers. Travel time was a big issue for truck company managers and the importance of pavement condition was greater for them than for truck drivers. The importance of the existence of protected left turn signal was significant for truck company managers, but the importance of curb radii and traffic signal coordination was less for the managers than for the drivers. Even though the results on the managers' perceptions on the relative importance of the truck trip QOS determinants are questionable due to the small sample size (6–9 responses), the perceptions of 33 managers on the relative importance of potential service measures indicated that ease of turning maneuvers, speed variance, and traffic density are more important than travel time or pavement quality issues. Ease of U turn maneuver, in particular, was perceived to be least important among all the listed potential performance measures by both drivers and managers. The table 6-2 summarizes the relative importance of each of the main factors perceived to affect truck trip quality on arterials, by both truck drivers and truck company managers.

Truck trip QOS on arterials mainly depends on how freely truck drivers can maneuver. However, the maneuverability on arterial is affected by multi-dimensional factors. Thus, it was not possible to identify one or two service measure(s) to adequately address the QOS on arterial facilities for trucks. The issues that should be included to evaluate truck LOS on arterials include pavement condition, ease of turning maneuvers, acceleration variance, ease of changing lanes, and stop-and-go condition. The factors contributing to those issues include other drivers' behavior, pavement quality, level of congestion, traffic signal coordination, existence of protected left turn signals, adequate curb radii, construction activities. Truck drivers' perceptions on the importance of those factors varied by their earning methods, truck company's primary business types, maximum governed truck speed, number of working hours per day, and types of goods carried.

6.1.3 Quality of a Truck Trip on Two-Lane Highways

The two major concerns of truck drivers traveling on two-lane highways were probability of being passed or followed and the widths and conditions of travel lane and shoulder. In this context, other drivers' behavior, pavement and shoulder widths and surface quality, construction activities, level of congestion, and frequency of passing lanes were important to their perceptions on truck trip QOS on two-lane highways. Lighting conditions at night time was also important to some degree. The widths and conditions of travel lane and shoulder were also important from the managers' perspectives, but the managers were more concerned about the opportunity to pass other vehicles than the probability of being passed or followed by other vehicles. Level of congestion, other drivers' behavior, construction activities, and sight distance at horizontal curvatures were important to their perceptions. Roadway striping condition, in particular, was considered to be exceptionally important. Again, among all the listed factors, Traveler Information Systems (TIS) was perceived to be least important and least in need of improvement by the driver survey respondents. The table 6-3 summarizes the relative importance of each of the main factors perceived to affect truck trip quality on two-lane highways, by both truck drivers and truck company managers. The results on the managers' perceptions on the relative importance of the truck trip QOS determinants are questionable due to the small sample size (4–8 responses). However, the perceptions of 34 managers on the relative importance of potential service measures indicated that the widths and conditions of travel lane and shoulder and opportunities for passing other cars are the two major concerns of truck company managers. The probability of being passed or followed by other faster vehicles was perceived to be least important in their perceptions.

Percent-Time-Being-Followed (PTBF) and Percent-Time-Spent-Following (PTSF), complemented by travel lane and shoulder widths and pavement conditions, were identified as the potential truck LOS service measures for trucks on two-lane highways. Percent-Time-Spent-Following (PTSF) is a measure that generally reflects the level of congestion on a two-lane highway, which is definitely a concern for managers. However, the truck drivers appear to be more concerned with being followed rather than following. This is a reflection of the psychological comfort level of a driver. If a truck is leading a platoon of several vehicles, the driver will begin to worry about the actions that the following auto drivers may take in trying to get around the truck. Thus, they may be more concerned about what is going on behind them than what is happening in front of them. Therefore, some combination of Percent-Time-Being-Followed and Percent-Time-Spent-Following may adequately reflect the congestion and psychological concerns of trip quality. The lane and shoulder width also reflect the psychological comfort level of the drivers, and pavement condition again relates to the physical (and possibly psychological) comfort of the trip. The shoulder width and condition, in particular, is important for the drivers to cope with an unexpected situation when a broke down occurs (e.g., tire blow-out) as discussed in the focus group sessions. Truck drivers' perceptions on the applicability of these service measures varied by their recruitment sources, gender, level of truck driving experience, percent of empty truck trips, percent of late deliveries, race, annual income level, number of working days per week, current truck driving time of day, types of goods carried, and truck types.

6.1.4 Improvement Priority of Various Transportation Facilities for Trucks

Based on the perceptions of 25 truck driver respondents, the order of the roadway types, in order from highest to lowest, identified as most in need of improvement was urban arterials, rural multilane highways, rural two-lane highways, and freeways. However, the difference in the needs of improvements among the first three facilities was fairly small.

6.1.5 Improvement Priority of the Factors on Each Transportation Facility for Trucks

Improvement Priority Score (*IPS*) of each factor was extracted from Relative Importance Score (*IPS*) and Relative Satisfaction Score (*RSS*) by the method presented in chapter 3. The *IPS* concept was that the higher *RIS* and/or lower *RSS* of a factor are, the higher *IPS* of the factor is. The six most important factors to be considered for transportation service improvement for each facility type for truck drivers are shown in Table 6-4. This result is based upon the average *IPS* of the factors.

Passenger car drivers' behavior knowledge about truck driving characteristics and their road etiquette were perceived to be most in need of improvement for any transportation facility type. Level of traffic congestion and frequency and timing of construction activities were perceived to be in a considerably significant need of improvement also for any transportation facility type. Truck drivers had very negative feelings about various truck travel restrictions (in terms of speed, lane, route, and/or driving time of day). Thus, they want to remove any restrictions currently implemented on FIHS, strongly being opposed to any further restrictions. Traffic signal coordination along arterials and adequate curb radii at intersections were significantly in need of improvement for arterial facilities, while shoulder width and condition and lighting condition was greatly in need of improvement for two-lane highway facilities.

6.1.6 Preference on Truck Driving Time of Day

Most truck driver respondents preferred to drive in the morning time (between 6 AM and noon) and/or during late night time (between midnight and 6 AM). The morning time, especially from 9 AM to noon, was the most preferred time of day for truck driving. The time period between 3 PM and midnight was considerably less preferred by the driver respondents. The late night time was best time of day for efficient truck operation from the truck company managers' perspectives. Their preference on the late night time for truck driving was much greater than that for any other times of day.

Most truck drivers and managers appear to agree that the late night time is good for efficient truck operation due to low traffic volume, but the preference of the drivers on the morning time (between 6 AM and noon) was greater than that for the late night time. This may indicate that quality of a truck driving environment in the morning time is not bad enough for them to risk their physiological rhythm by doing the night shift. The drivers living with their family would also not want to miss spending time with their family by driving during the late night time.

Truck drivers' preference on truck driving times of day varied by their earning methods, independence, company's primary business types, primary load types, hauling distance, percent of late delivery, number of working days per week, company fleet size, types of good carried, and truck types.

6.1.7 Relationships between Truck Drivers' Backgrounds and Their Perceptions on Truck Trip Quality

Truck drivers' perceptions on the applicability of each hypothetical truck LOS performance measure differed by various kinds of background characteristics. They include hauling distance, earning methods, recruitment sources, truck company business types, primary load types, race, education level, truck type, current truck driving time of day, type of goods carried, etc. The most important background features contributing to the perceptions were hauling distance, primary load types, earning methods, and current truck driving time of day. These generally relate to whether a truck driver is a frequent freeway user or a city driver whose trips are mostly on arterials. Most frequent freeway users are long-haul drivers, TL drivers, drivers getting paid by the mile, or drivers traveling during non-peak hours (e.g., late night time). These drivers showed more concern for freeway or two-lane highway hypothetical performance measures such as 'a consistently good ride quality', 'ease of obtaining useful travel conditions information', 'ease of driving at or above the posted speed limit', and 'probability of being passed or followed by faster vehicles'. On the other hand, most city drivers are short-haul drivers, LTL drivers, drivers getting paid by the hour, or drivers traveling during peak hours.

They were less sensitive to those freeway or two-lane highway performance measures, but indicated more concerns with ‘ease of U-turning maneuvers’ at intersections along arterials.

6.1.8 Overall Effectiveness of Research Approach

The focus group sessions were very effective in eliciting a number of factors affecting the perceptions of the trucking community on truck trip quality. Truck drivers had much to say, and they offered a lot of insight into truck driving operations. Good input was obtained from the truck company managers, but with only one session and three managers it was not as productive as the driver sessions. Transcripts from the audio-recording of focus group discussions greatly facilitated the efficient summary of the studies.

Survey studies were efficient in obtaining general perceptions of the trucking community, but there was some difficulty collecting survey data. Many survey respondents provided their valuable perceptions on the relative importance of each traffic, roadway, and/or control factor on truck trip quality. However, some respondents did not complete the surveys, or did not answer the questions correctly, especially for the sections asking for their perceptions. Truck driver surveys during the Florida Truck Driving Competition (FTDC) were effective in obtaining a good number of surveys at one time (a total of 148 surveys), but many respondents completed only parts of the surveys due to the length of the survey (6 pages) and some drivers were probably not very willing to complete it, even though they were asked to. In-field truck company manager surveys during the FTDC event were not very efficient, yielding about 1.5 surveys per hour. Postage-paid mail back truck driver surveys distributed at agricultural inspection stations were reasonably efficient (overall response rate of 7.8%); however, these surveys are generally biased toward long-haul truck drivers, as they are much more likely to have to stop at these stations (92% of the survey respondents were long-haul drivers). Postage-paid mail back truck company manager surveys, based on the FTA membership directory were reasonably efficient (a response rate of 9%); but follow-up phone contacts did not help to improve the response rate.

6.2 Recommendations

A major objective of this study was to identify appropriate service measures to use for truck LOS determination. The intent is that the results of this study would lay the groundwork for a future study, or studies, to develop quantitative LOS estimation models based on these identified service measures. This section mainly provides recommendations on how to effectively develop these LOS models for each of the roadway facility types addressed in this study. Some considerations for transportation service improvement priority for the trucking community, as well as the trucking community survey methods, are also offered.

6.2.1 Truck LOS Estimation Model Development

This section will describe some specific research approaches that might be most effective or applicable for developing quantitative LOS models for each facility type, for the preferred service measures identified in this study.

6.2.1.1 Truck LOS on freeways

Consistency in travel speed was identified as one of the primary determinants of truck trip quality on a freeway. A previous study by Kim, et al. (2003) investigated the use of acceleration noise (i.e., standard deviation of acceleration) as a potential service measure. This study utilized simulation to develop a model for acceleration noise based upon other easily measured traffic flow parameters, such as volume and speed. This work was confined to passenger cars, but it could easily be extended to trucks with some adjustments. Since many commercial trucks are now equipped with Global Positioning Systems (GPS), it may also be possible to obtain these data from truck companies, eliminating the need for on-the-road or driving simulator experiments. These data could then be used in combination with other traffic stream field measurements to develop a model based on field data, or at a minimum validate the models developed from the simulation process.

The AASHO (American Association of State Highway Officials, now AASHTO) Road Test (Highway Research Board, 1962) developed the Present Serviceability Rating (PSR) to investigate users' perceptions of pavement quality. A panel of raters actually rode in an automobile over a number of pavement sections and rated their ride experience on a scale from 0 to 5 (0 being 'Essentially Impassible' and 5 being 'Excellent'). It was found that about 95 percent of the information about the serviceability of a pavement is contributed by the roughness of the surface profile. The Present Serviceability Index (PSI) was developed as a function of multiple measures of pavement roughness (e.g., mean slope variance, surface rutting, surface cracking, and surface patching) using a multiple regression statistical technique. The AASHO Road Test rater opinions were based on car ride dynamics, so it is unclear whether the levels of PSI are applicable to the cases of large trucks.

The International Roughness Index (IRI) was developed by the World Bank in the 1980s (Sayers, et al., 1986) to establish uniformity of the physical measurement of roughness. The IRI is based on a filtered ratio (referred to as the average rectified slope) of a standard vehicle's accumulated suspension motion (meters) divided by the distance traveled by the vehicle during the measurement (kilometers). That is, the IRI measures pavement roughness in terms of the number of meters per kilometer that a laser, mounted in a specialized van, jumps as it is driven across the interstate and expressway system. Thus, commonly recommended measurement units are m/km and the lower the IRI number, the smoother the ride. The IRI has been shown to correlate well with vertical passenger acceleration (a measure of ride quality) and tire load (a measure of controllability and safety). The IRI is now considered the international standard for comparing roughness measurements and widely used by Federal Highway Administration (FHWA) as a means of determining rehabilitation needs and resource allocation for pavement condition.

Many previous studies have shown that the users' perceptions of pavement quality largely depend on the roughness of the roadway. Hveem (1960) stated that there is no doubt that mankind has long thought of road smoothness or roughness as being synonymous with pleasant or unpleasant, but the effects of a given degree of roughness vary with the speed and characteristics of the vehicle and tolerance of the vehicle driver or passenger. However, the relationship between physical measurements of pavement roughness and the users' perceptions of ride quality has not been adequately modeled. In studies by Shafizadeh and Mannering (2003 and 2006), selected participants were placed in real-world driving conditions and asked to rank the roughness of specific roadway segments. The study concluded that the users' perceptions of roadway roughness is mostly consistent with IRI and PSR, and also correlated with type and speed of vehicle used, individual's age and gender, and interior vehicle noise level. However, no driver of a large truck participated in this study.

There has been no research conducted to specifically investigate the relationships between the perceptions of truck drivers on ride quality and the measures of roadway roughness (e.g., IRI or PSI). However, given that many previous studies verified that user perceptions of roadway roughness (i.e., ride quality) can usually be adequately addressed by the measures of roadway roughness, the IRI and/or the PSI could be potentially referenced to estimate truck drivers' satisfaction of pavement quality until experiments with truck drivers can be conducted. In-field driving experiments with a representative sample of truck drivers are required for the development of accurate models to estimate truck drivers' perceptions of pavement quality from the measure of roadway roughness.

It may be possible to ask truck drivers who just reach the destination about the quality of the trip and pavement condition and obtain the truck operational data from their truck companies. This may facilitate the development of a freeway truck LOS model combining acceleration noise and pavement condition. However, this also requires research team to develop and coordinate the experiments with the truck companies beforehand.

6.2.1.2 Truck LOS on arterials

Due to the number of variables identified in this study that impact truck trip quality on arterials, a composite model is necessary. This type of model development for arterials has recently been attempted, although specific to passenger vehicles, by Flannery, et al. (2005) and Pecheux, et al. (2004), as well as in the currently ongoing NCHRP 3-70 (Multimodal Arterial Level of Service) project. These previous studies have utilized in-field driving and video simulation data collection methods. One major challenge with the video simulation approach is being able to get accurate input on pavement condition. Hall, et al. (2004) incorporated the Kentucky Transportation Cabinet (KYTC)'s inventory of pavement rideability ratings to evaluate large truck access routes between intermodal or other truck-traffic-generating sites to the National Highway System (NHS) (i.e., connectors). However, the evaluation process was not based on the perceptions of truck drivers, and thus the level of contribution of pavement condition to truck trip quality on an access route was arbitrary. If information about the importance level of pavement condition by truck type and travel speed on truck trip quality on arterials is available, it may be possible to develop a model combining pavement quality using the IRI or the PSI and other performance measures from video simulation data collection. However, in-field experiments are required to develop an accurate truck LOS model for arterials.

It also may be possible for researchers to ask truck drivers about their perceptions on trip quality and other measures at certain places along their route (e.g., fuel station), while general traffic stream field measurements are collected at the same time.

6.2.1.3 Truck LOS on two-lane highways

Three performance measures were identified that adequately address the truck trip quality on two-lane highways: Percent-Time-Being-Followed (PTBF) and Percent-Time-Spent-Following (PTSF); pavement condition; and travel lane and shoulder width. PTBF and PTSF measures could be developed from microscopic traffic simulation or field observation. The measures may be determined by headway thresholds to define in which case a truck is considered to be following or being followed. Travel lane and shoulder width information is available from the FDOT Roadway Characteristics Inventory (RCI) database. Again, if information about importance level of pavement condition according to truck type and speed on truck trip quality on two-lane highways is available, it may be possible to develop a model combining pavement quality using the IRI or the PSI and PTBF, PTSF from video simulation, and lane and shoulder width from the RCI.

6.2.2 Transportation Service Improvement for the Trucking Community

Given that urban arterials were identified as the facility type most in need of improvement, access roads from the Florida Intrastate Highway System (FIHS) to hub facilities should be primarily addressed in the development of transportation improvement programs for the trucking community. For prioritizing transportation improvement projects within each type of roadway facility, the use of an Improvement Priority Score (*IPS*) is recommended. Some general issues found to be important to the trucking community from this study are as follows:

- The motoring public's attitude and knowledge about trucks is the primary concern for the trucking community, especially for truck drivers. There is a need to publicize the importance of truck operations in the state of Florida through mass media to improve the motoring public's attitude about trucks on the road. The motoring public also needs more education about how to mix with large trucks safely in a traffic stream. It may be possible to emphasize this topic in driver's license exams and some mandatory classes may be scheduled for the drivers to rejuvenate their concerns on this topic when they obtain or renew their licenses. More emphasis on this topic in beginning driver's education classes (such as in high schools) should also be considered.

- Implementation of truck travel restriction measures requires a lot of caution because it significantly deteriorates the truck drivers' trip satisfaction. To obtain greater acceptance of these measures from the truck drivers, they may need more education as to its overall benefits, as they apparently not aware of them.

- Shoulder width and condition on two-lane highways, and curb radii on arterials are two major physical roadway concerns of the trucking community that need to be addressed by transportation service providers.

- Pavement condition is definitely important for truck trip quality, but most truck drivers are fairly satisfied with the pavement condition on Florida roadways. Thus, it is reasonable not to focus on this factor too much for transportation improvement programs for trucks. However, it should definitely be incorporated into LOS models if possible.

- Access management (e.g., median closing) should be carefully planned to eliminate unnecessary turning movements of trucks due to the high risks associated with the maneuvers.

- The trucking community generally believes that night-time delivery is beneficial for them to a considerable degree, but it is not widely performed due to the lack of benefits to the other stakeholders (e.g., receivers, customers, shippers). It is worth looking for ways to offer motivation or benefits to perform the night-time delivery to the other stakeholders for more efficient truck operations.

- Frequency and security of rest areas and truck parking spaces (especially for overnight parking) are one of the important issues for long-haul truck drivers. These issues should be addressed adequately by transportation service providers for a safe and convenient truck trip.

6.2.3 Trucking Community Surveys

This study mainly used survey methods to investigate the perceptions and opinions of the trucking community. Based on the experience, the following strategies are recommended for future survey studies of the trucking community:

- Total length of a survey should be not more than 4 pages. The length of the sections asking for the perceptions of the trucking community should be not more than 3 pages.

- Survey questions should be easily understood and completed within ~15–25 minutes. If a pilot test of the questions is possible, it will help determine the proper length and complexity of the survey. Note that the pilot test needs to be conducted with the same audience.

- With the truck driving audience, there appeared to be considerable variance in the ability of drivers to understand all of the questions, as well their diligence in filling out the survey (this was more so the case for the FTDC survey effort). Thus, in a future survey effort, to help determine the overall validity of the survey responses, the inclusion of a couple of "dummy" question should be considered. These "dummy" questions would be questions that any respondent can easily answer correctly.

- Survey data collection as a part of an event (such as the FTDC) has advantages in collecting a large sample at one time, but may produce a considerable number of invalid surveys in that some participants will not fill it out diligently if they are generally unwilling to participate.

Table 6-1. Truck Trip Quality of Service Determinants on Freeways

Freeway QOS	Truck Drivers' Perceptions	Truck Company Managers' Perceptions
Truck Trip QOS Determinants	1. Other Drivers' Behavior 2. Pavement Condition 3. Level of Congestion 4. Truck Travel Restrictions 5. Construction Activities	1. Level of Congestion 2. Construction Activities 3. Alternative Routes 4. Other Drivers' Behavior 5. Number of Lanes 6. Pavement Condition
Primary Concern	Driving Comfort (Physical and Psychological)	Travel Time and Driving Safety
Potential Service Measure(s)	Speed Variance (or Acceleration Noise) and Pavement Condition	

Table 6-2. Truck Trip Quality of Service Determinants on Arterials

Arterial QOS	Truck Drivers' Perceptions	Truck Company Managers' Perceptions*
Truck Trip QOS Determinants	1. Other Drivers' Behavior 2. Curb Radii for Right Turns 3. Level of Congestion 4. Traffic Signal Coordination 5. Pavement Condition 6. Construction Activities	1. Construction Activities 2. Pavement Condition 3. Level of Congestion 4. Protected Left Turn Signals 5. Curb Radii for Right Turns 6. Other Drivers' Behavior 7. Traffic Signal Coordination
Primary Concern	Maneuverability	Maneuverability and Travel Time
Potential Service Measure(s)	Multiple Factors (Pavement Condition, Left- or Right-Turning Maneuvers, Speed Variance, Traffic Density)	

* The sample size for the truck company manager responses on Truck Trip QOS Determinants on arterials was low (6–9); thus, the reliability of these responses is questionable. However, the sample size for their responses on the importance levels of Potential Service Measure(s) was acceptable (33).

Table 6-3. Truck Trip Quality of Service Determinants on Two-Lane Highways

Two-Lane Highway QOS	Truck Drivers' Perceptions	Truck Company Managers' Perceptions*
Truck Trip QOS Determinants	1. Other Drivers' Behavior 2. Pavement Condition 3. Shoulder Width and Condition 4. Lighting Conditions at Night 5. Construction Activities 6. Level of Congestion 7. Frequency of Passing Lanes	1. Roadway Striping Condition 2. Level of Congestion 3. Pavement Condition 4. Other Drivers' Behavior 5. Shoulder Width and Condition 6. Construction Activities 7. Sight Distance at Horizontal Curvatures
Primary Concern	Driving Comfort (Physical and Psychological) and Travel Safety	Travel Safety and Travel Time
Potential Service Measure(s)	Percent-Time-Being-Followed (PTBF), Percent-Time-Spent-Following (PTSF), Lane and Shoulder Width, and Pavement Condition	

* The sample size for the truck company manager responses on Truck Trip QOS Determinants on two-lane highways was low (4–8); thus, the reliability of these responses is questionable. However, the sample size for their responses on the importance levels of Potential Service Measures was acceptable (34).

Table 6-4. Top Six Factors in the Need for the Improvement on Each Roadway Type for Trucks

Freeways	Urban Arterials	Two-Lane Highways
1. Improve Passenger Car Drivers' Knowledge about Truck Driving Characteristics 2. Improve Passenger Car Drivers' Road Etiquette 3. Remove Truck Lane Restrictions 4. Reduce Traffic Congestion 5. Do not implement lower Truck Speed Limit 6. Increase Governed Truck Speed Limit	1. Improve Passenger Car Drivers' Road Etiquette 2. Improve Passenger Car Drivers' Knowledge about Truck Driving Characteristics 3. Reduce Traffic Congestion 4. Improve Traffic Signal Coordination 5. Increase Curb Radii for Right Turns 6. Frequency and Timing of Construction Activities	1. Improve Passenger Car Drivers' Knowledge about Truck Driving Characteristics 2. Improve Passenger Car Drivers' Road Etiquette 3. Improve Shoulder Width and Condition 4. Frequency and Timing of Construction Activities 5. Improve Lighting Conditions at Night 6. Reduce Traffic Congestion

APPENDIX A
COOPERATION REQUEST LETTER SENT TO FTA

UNIVERSITY OF FLORIDA
Department of Civil and Coastal Engineering

512 Weil Hall
PO Box 116580
Gainesville, FL. 32611
Tel: (352) 392-9537 x1450
Fax: (352) 392-3394

The Strategic Intermodal System (SIS) was established by the Florida Department of Transportation (FDOT) in 2003 to support transportation facilities that are necessary for Florida's rapidly growing and ever changing economy. The main objective of the SIS is to provide safe, efficient, and convenient transportation services for all types of transportation users on the most critical transportation facilities in Florida.

The FDOT contracted with the Transportation Research Center (TRC) at the University of Florida to investigate the trucking industry's perceptions and opinions about truck operations on SIS roadway facilities. The objective of this research is to determine the important factors and issues for the trucking community in order to provide guidance to the FDOT so it can develop methods to assess how well it is addressing the needs of freight transportation on the SIS.

It is planned to use focus groups and field surveys to solicit this information from the trucking community. Perspectives from both truck company operators and truck drivers are desired. The scope of the issues to be considered include any aspects of roadway facilities important to truck operations (interstates, highways, ramps, connectors, rest areas, truck fuelling stations, weigh stations, intersections, construction zones, etc.) between origin and destination points.

It is desirable to obtain input from a representative cross section of the trucking industry in Florida. For truck drivers, variation in factors such as driving experience, truck configuration driven, types of cargo hauled, and routes driven are of interest. For truck company operators, variation in company factors such as operational characteristics, fleet size, types of drivers employed, types of cargo hauled, primary origin and destination points are of interest.

The TRC is interested in partnering with the FTA to help achieve the objectives of this project. Specific areas where the TRC hopes the FTA may be able to provide assistance include:

- Identifying potential candidate truck companies and truck drivers that are interested in participating in this research project
- Facilitating contact with these trucking company operators and truck drivers
- Identifying good locations to conduct focus groups with truck company operators
- Identifying good locations to conduct field surveys with truck drivers (e.g., specific truck stops, rest areas, etc.)
- Identification of truck industry special events that might be forums for obtaining input (e.g., FTA Leadership Conference, Truck Driving Championship in Tampa)

With the assistance of the FTA, it is hoped that the TRC will be able to recruit a representative sample of members of the trucking community to participate in the focus group and survey efforts. In this case, comprehensive input can be obtained, which will lead to reliable research results and ultimately to improved practices by the FDOT for the assessment of the service quality issues on state roadway facilities.

APPENDIX B
FOCUS GROUP INSTRUCTION

UNIVERSITY OF FLORIDA
Transportation Research Center

Truck Trip Quality Focus Group Interview

The Strategic Intermodal System (SIS) was established by the Florida Department of Transportation (FDOT) in 2003 to support transportation facilities that are necessary for Florida's rapidly growing and ever changing economy. The main objective of the SIS is to provide safe, efficient, and convenient transportation services for all types of transportation users on the most critical transportation facilities in Florida. The FDOT contracted with the Transportation Research Center (TRC) at the University of Florida to investigate the trucking industry's perceptions and opinions about truck operations on SIS roadway facilities. The objective of this research is to determine the important factors and issues for the trucking community in order to provide guidance to the FDOT so it can develop methods to assess how well it is addressing the needs of freight transportation on the SIS.

Objectives of this focus group exercise:

1. Identify the factors (e.g., traffic and/or roadway related) that you perceive are important for truck operations on roadways in Florida.
2. Determine to what degree each important factor contributes to your perception of truck trip quality.

Format of this focus group session:

1. The background, objectives, and benefits of this focus group interview will be explained by the moderator.
2. Fill out a participant's background survey and submit it to an assistant.
3. The moderator will describe the format of the focus group session, and the points to keep in mind.
4. A focus group issue with its corresponding questions will be introduced by the moderator to the participants with an electronic slide displaying them.
5. For each of the given questions, the participants discuss with the moderator and amongst themselves, and provide their perceptions or opinions relevant to the issue. Additional questions may also be asked by the moderator about why and how much those factors are important to the participant's trip quality experiences. The moderator may inquire about the importance of other factors that are not brought up by the participants.
6. Repeat numbers 4 and 5 above for each focus group issue (a total of 4 or 5 focus group issues will be presented).

Points to keep in mind:

- A complete truck trip from origin to destination should be considered. Thus, traffic or roadway conditions on all the roadway types (e.g., freeways, urban streets, intersections, merging or diverging sections, weaving sections, etc.) should be considered.
- Truck industry regulatory issues (e.g., number of continuous hours of driving, maximum non-permit weight loads, etc.) are beyond the scope of this study.
- For efficient use of the time period allotted for the interview, the moderator may need to interrupt and redirect the discussion if the moderator feels the discussion is getting off track.

APPENDIX C
GUIDELINES FOR FOCUS GROUP PARTICIPANT SELECTION SENT TO FTA

UNIVERSITY OF FLORIDA
Department of Civil and Coastal Engineering

512 Weil Hall
PO Box 116580
Gainesville, FL. 32611
Tel: (352) 392-9537 x1450
Fax: (352) 392-3394

Guidelines for Participant Selection

(Focus Groups of Truck Drivers and Truck Company Managers)

This document is to serve as a guide for the selection of participants in the upcoming focus group meetings of truck drivers and truck company managers. This study focuses mainly on long-haul trucking operations on Florida's Strategic Intermodal System (SIS) facilities. Two focus group meetings of each type of participants (truck drivers and truck company managers) is desired for this study, with 8~10 participants in each session.

Eligible Truck Driver Participants

1) All the participants must be long-haul truck drivers with frequent travel on Florida's Strategic Intermodal System (SIS), which includes major freeways, highways, and arterials in Florida.
   Florida SIS website; http://www.dot.state.fl.us/planning/sis/
   FIHS website; http://www.dot.state.fl.us/planning/systems/fihs/
2) All the participants should have at least one year of work experience as a truck driver.

Participant Composition for Truck Driver Focus Group Sessions

1) The group of participants for each focus group should be from a mix of for-hire and private truck companies. The ratio of the number of participants from for-hire companies to that from private companies is ideally 3:2.
2) The group of participants for each focus group should be from a mix of truck companies with both Truckload and Less-Than-Truckload (LTL) operations. Participants from big companies having both operations are preferred.
3) The truck types the participants are operating should reasonably represent overall truck traffic using Florida's SIS facilities. At least one truck driver operating each of the following truck types are recommended;
   - Straight Trucks
   - Truck Trailers
   - Tractor Trailers
4) The inclusion of participants representing a minority group (either race or gender) is desired, but not essential. If it can be easily accommodated, the ratio of the number of non-minority to that of minority is ideally 7:3.

Eligible Truck Company Manager Participants

1) One group of participants from for-hire companies, and one group with private companies are suggested.
2) All the participants must be transportation/logistics managers at the companies generating frequent long-haul truck travel on Florida's Strategic Intermodal System (SIS), which includes major freeways, highways, and arterials in Florida.
   Florida SIS website; http://www.dot.state.fl.us/planning/sis/
   FIHS website; http://www.dot.state.fl.us/planning/systems/fihs/
3) All the participants should have at least one year of work experience as a truck company transportation/logistics manager.

Participant Composition for Truck Company Manager Focus Group Session

1) The group of participants for each focus group should be from a mix of truck companies with both Truckload and Less-Than-Truckload (LTL) operations. Participants from big companies having both operations are preferred.
2) Various fleet sizes of the companies in which the participants are involved is preferred.
3) Geographic concentration of the locations of the potential participants may be important for recruitment (assuming we go to them for the focus group sessions).

Recruiting Truck Drivers for a Meeting

It is not realistic to obtain a random sample of long-haul truck drivers in Florida. They often spend a significant portion of their time away from home, and their schedules are also apt to change for time-variant demand for deliveries. Given such constraints for recruiting truck drivers, the following participant sources are considered for this study:

1) Members of Florida Road Team
2) Truck Drivers from a single company or two companies

A previous focus group study of truck drivers by Hostovsky and Hall in 2002 was held in Toronto at the annual convention of the Ontario Trucking Association (OTA) with their Road Knights Team, which consists of 10 professional drivers. The Florida Road Team of the Florida Trucking Association (FTA) appears to be the equivalent of the Road Knights Team. This group appears to be an excellent source for a focus group session.

The other focus group would most likely need to be based on a single company or two, which could get its drivers together for this study. The company may be one of the companies the Florida Road Team members are associated with, or may be one recommended by the FTA Executive Committee. Mr. Mike Akridge of the FDOT also pointed out some potential sources of truck driver recruitment:

- Watkins Motor Lines, Inc (Lakeland, FL, one of the nation's largest Less-Than-Truckload (LTL) carriers)
- Landstar Systems, Inc (a big logistics and transportation provider)
- Roundtree Transport & Rigging, Inc

Recruiting Truck Company Managers for a Meeting

It is generally difficult to gather manager-level participants at one place and time. They are usually very busy people, and may value their time somewhat higher than others. In 2004, Holguin et al. conducted two focus groups with truck dispatchers as part of the Evaluation Study of the Port Authority of New York and New Jersey's Value Pricing Initiative. Another study by Morris et al. in 1998 performed 13 industry sector focus groups, but with only 2-4 participants per group. Some of them also used a conference call. It is preferred that all participants come from different companies to provide for a diversity of backgrounds. One potential avenue for this is to piggy-back a focus group meeting onto an upcoming conference or meeting of truck company managers. If it is not possible to use a pre-planned meeting of truck company managers, participants should be recruited from the FTA's membership list. The FTA members are categorized into six groups: common carriers, dump truck carriers, household goods carriers, private carriers, specialized riggers/heavy haulers, and tank truck carriers. The majority of the members are the common (for-hire) or private carriers. In 2002, private trucks moved 32.7 percent, and for-hire trucks moved 43.3 percent of the total freight value originating in Florida (2002 Commodity Flow Survey, BTS). One survey indicated different perceptions about various sources of traffic information between private and for-hire trucking company managers (Regan and Golob, 2002). Therefore, one group with common (for-hire) carriers, and the other with private carriers may be the best configuration of focus groups as differences in perceptions/attitudes between the two groups can be more easily explored.

APPENDIX D
FOCUS GROUP MODERATOR'S GUIDE

The purpose of this document is to provide an overview of what is expected in the oncoming focus group meetings of truck drivers and truck company managers to the moderator, who will facilitate the discussions. The document includes the items or issues that should be explained or brought up in the meetings by the moderator so that the discussions can be organized to produce useful results for this research and the participants are also motivated to lead the discussions in the meetings. The contents of this document are listed in a chronological order for each focus group meeting session.

1) Sign-in Form and Informed Consent Form Distribution *(expected time frame = 5 minutes)*

Each participant is asked to provide his/her name on the Sign-in Form, and fill out the Informed Consent Form before taking part in the focus group meeting. The Informed Consent Form is required for the Institutional Review Board at the University of Florida (UFIRB) to ensure that the participants were aware of the risks and benefits of participating in this study and that they voluntarily agreed to participate in it.

2) Welcome and Introductions *(expected time frame = 5 minutes)*

Introduction of moderator and assistant(s). Express appreciation to participants for agreeing to participate and share their valuable experience and knowledge about trucks operations in Florida. Self-introductions of participants.

3) Overview of Study Background, Objectives, and Benefits *(expected time frame = 5 minutes)*

The background, objectives, and potential benefits of this study will be briefly described by the moderator. A separate hand-out addressing these issues will also be provided to each participant (Refer to Appendix E).

4) Focus Group Participants' Background Survey *(expected time frame = 10 minutes)*

One- or two-page hand-outs to each truck driver will be distributed to gather information about participants' personal characteristics and job duties, as well as truck, delivery, and cargo characteristics (Refer to Appendix F). Truck company operators/managers will be asked about business operation characteristics, fleet size, types of cargo hauled, primary origin and destination, etc (Refer to Appendix G). The moderator is required to ask the participants to fill out the forms and hand them in.

5) Explanation of Format and Scope of the Focus Group Session *(expected time frame = 5 minutes)*

To obtain the perceptions or opinions of the participants more efficiently and productively, the format and the scope of the focus group session will be explained to the participants. This will be included in the hand-out to each participant as well (Refer to Appendix E).

6) Focus Group Questions *(total expected time frame = 1 hour and 30 minutes)*

During the course of each focus group session, several open-ended or subject-specific questions will be presented by the moderator to the participants. The participants will then discuss each topic amongst themselves and with the moderator. A same set of issues will be introduced in both driver and manager focus groups, but their corresponding questions will be differently phrased for some issues. Each question should be written on a white board, or presented on an electronic slide, or the like, for all participants to easily see. The selected issues and questions are listed below in chronological order with the approximate time assigned for discussion of each subject within a two-hour focus group meeting. Additional questions may also be asked about why the commented factors are important or the participants' experience related to the factors.

Truck Route and Departure Time Selection (expected time frame = 15 minutes)

- Who is responsible for selecting a travel route and departure time for your delivery?
- When selecting a travel route and departure time for your delivery, what factors do you consider and what is their relative overall significance?

Transportation Service Improvement Priorities for Trucking Community (expected time frame = 10 minutes)

- What types of facilities (freeways, multi-lane highways, two-lane highways, or arterials) would you emphasize most to improve roadway and traffic conditions for better truck operations in the State of Florida?

- If you're in charge of policy at FDOT, what would be your top priorities for improving truck tip quality/travel conditions for commercial trucks?

Factors affecting Truck Trip Quality (expected time frame = 50 minutes)

- What is important for the quality of a truck trip on <u>freeways</u> and how significant is each factor to your overall perception of trip quality?

- What is important for the quality of a truck trip on <u>multi-lane highways</u> and how significant is each factor to your overall perception of trip quality?

- What is important for the quality of a truck trip on <u>two-lane highways</u> and how significant is each factor to your overall perception of trip quality?

- What is important for the quality of a truck trip on <u>urban arterials</u> and how significant is each factor to your overall perception of trip quality?

- What is important for the quality of a truck trip on <u>hub facilities</u> and how significant is each factor to your overall perception of trip quality?

Truck Delivery Schedule Reliability (expected time frame = 15 minutes)

- How often has your delivery been late?

- What do you do to avoid a late delivery?

- What are the typical consequences for you/your company when a delivery is late?

- What do you think most affects a truck driver's ability to reach his/her destination by the scheduled time?

Ending questions

- Is there anything else important about truck operations on Florida's state roadway systems that you would like to mention?

<u>Total expected time = 2 hours</u>

APPENDIX E
FOCUS GROUP PARTICIPANTS' BACKGROUND SURVEY RESULTS

Table E-1. 1st Truck Driver Focus Group Participants' Background Survey Results (November, 15th, 2005)

	Participants				
Backgrounds	Truck Driver 1	Truck Driver 2	Truck Driver 3	Truck Driver 4	Truck Driver 5
Company Name	Con-way Southern Express	Publix Supermarkets	Watkins Motor Lines	FedEx Ground Orlando	Watkins Motor Lines
Gender	Male	Male	Male	Male	Male
Age	40 – 49	40 – 49	50 – 59	50 – 59	40 – 49
Race	Caucasian	Caucasian	Caucasian	Caucasian	Caucasian
Truck Driving Job Experience	21 years	18 years	30 years	30 years	29 years
Working Days Per Week	5 days	4 days	5 days	5 days	5 days
Working Hours Per Day	10 hours	8 hours	9 hours	10 hours	9.5 hours
Number of Nights Away From Home	0 night	0 night	0 night	0 night	0 night
Earning Method(s)	By the mile, or hour	By the mile, hour, or salary	By the mile	By the mile	By the mile, or hour
Annual Income by Truck Driving	\$50,000 – 74,999	\$50,000 – 74,999	\$75,000 or more	\$75,000 or more	\$50,000 – 74,999
Company Type	For-hire	Private	For-hire	For-hire	For-hire
Company Fleet Size	10,000 trucks	600 trucks	4,000 trucks	5,000 trucks	4,000 trucks
Primary Load Type	LTL	TL	LTL	Both TL & LTL	LTL
Geographic Coverage of Truck Driving	Entire Florida and Other States	Florida and Other States	Part of Florida State	Florida and Other States	Florida and Other States
One-way Delivery Distance	265 miles	160 miles	244 miles	280 miles	249 miles
Route and Departure Time Selection	Transportation, or Logistics Managers	Myself	Transportation, or Logistics Managers	Transportation, or Logistics Managers	Transportation, or Logistics Managers
Truck Kind(s)	Twin Trailer, 4-Axle Tractor Semitrailer	5-Axle Tractor Semitrailer	5-Axle Tractor Semitrailer, Rocky Mountain Double, Turnpike Double	Twin Trailer, 3-, 4-, 5-Axle Tractor Semitrailer	Twin Trailer, 4-Axle Tractor Semitrailer

Table E-1. Continued

Types of Goods	Anything except livestock	Mainly food	Anything except livestock, coal or petroleum	Household goods or stationary, auto parts, textiles, metals, manufactured goods, paper and allied products, furniture, wood products	Anything except vehicles, livestock, coal or petroleum, waste and scrap, equipment, stone, clay, glass, and concrete products

Table E-2. 1st Truck Company Manager Focus Group Participants' Background Survey Results (November, 17th, 2005)

	Participants		
Backgrounds	Truck Company Manager 1	Truck Company Manager 2	Truck Company Manager 3
Company Name	Publix Supermarkets	CTL Distribution	Commercial Carrier Corp
Gender	Male	Male	Male
Age	40 – 49	30 – 39	30 – 39
Truck Company Manager Job Experience	25 years	10 years	5 years
Annual Income as a Manager	\$70,000 – 99,999	\$70,000 – 99,999	\$50,000 – 69,999
Company Type	Private	For-hire	For-hire
Company Fleet Size	850 trucks	432 trucks	1,200 trucks
Primary Load Type	TL	TL	TL
Geographic Coverage of Trucking Business	Florida and Other States	Florida and Other States	Florida and Other States
Distribution of Truck Driving Distance of the Company	Local: 50% Short-haul: 50% Long-haul: 0%	Local: 50% Short-haul: 30% Long-haul: 20%	Local: 10% Short-haul: 70% Long-haul: 20%
Route and Departure Time Selection	Facility Dispatcher	Myself	Myself
Types of Goods	Food, household goods or stationary	Chemicals and allied products, coal or petroleum, hazardous materials	Food, paper and allied products, stone, clay, glass, and concrete products
Truck Kind(s)	5-Axle Tractor Semitrailer	Twin Trailer, 5-Axle Tractor Semitrailer	5-Axle Tractor Semitrailer

Table E-3. 2^{nd} Truck Driver Focus Group Participants' Background Survey Results (December, 8^{th}, 2005)

	Participants			
Backgrounds	Truck Driver 1	Truck Driver 2	Truck Driver 3	Truck Driver 4
Company Name	Publix Supermarkets	FedEx Ground	Overnite Transportation (a UPS)	TDT
Gender	Male	Male	Male	Male
Age	40 – 49	40 – 49	30 – 39	50 – 59
Race	Caucasian	Caucasian	Caucasian	Caucasian
Truck Driving Job Experience	16 years	29 years	18 years	30 years
Working Days Per Week	5 days	5 days	5 days	5 days
Working Hours Per Day	12 hours	8 hours	7 hours	11 hours
Number of Nights Away From Home	0 night	0 night	3 night	5 night
Earning Method(s)	By the mile, type of goods, or loading amount	By the mile	By the mile, or hour	By the mile, or the drop
Annual Income by Truck Driving	\$50,000 – 74,999	\$75,000 or more	\$50,000 – 74,999	\$25,000 – 34,999
Company Type	Private	For-hire	For-hire	For-hire
Company Fleet Size	1,300 trucks	5,000 trucks	7,500 trucks or more	250 trucks
Primary Load Type	TL	LTL	LTL	Both TL & LTL
Geographic Coverage of Truck Driving	Part of Florida State	Florida and Other States	Florida and Other States	Florida and Other States
One-way Delivery Distance	150 miles	1,112 miles	400 miles	1,350 miles
Route and Departure Time Selection	Transportation, or Logistics Managers	Transportation, or Logistics Managers	Transportation, or Logistics Managers	Myself
Types of Goods	Food, household goods or stationary	Small Packages	Anything but livestock, coal or petroleum, vehicles, waste and scrap, and equipment	Grains/Feed, household goods or stationary, metals, manufactured goods, wood products except furniture

Table E-3. Continued

Truck Kind(s)	5-Axle Tractor Semitrailer	Twin Trailer or "Doubles"	Twin Trailer, 4-Axle Tractor Semitrailer	5-Axle Tractor Semitrailer

APPENDIX F
TRUCK DRIVER FOCUS GROUP BACKGROUND SURVEY FORM

UNIVERSITY OF FLORIDA

Transportation Research Center

Participant's Background Survey (Truck Trip Level of Service Focus Group)

Participant's Name: ______________________________

Name of the Company you are working for:

____

1) What is your gender? ☐ Male ☐ Female

2) What is your Age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years

3) Which of the following groups do you most identify yourself as? ☐ Caucasian ☐ Native American

   ☐ African American ☐ Hispanic ☐ Asian ☐ Pacific Islander ☐ Other _________ (please specify)

4) How many years have you been driving trucks? (truck driving job experience) ______ years

5) How many days do you usually work per week? _____ days

6) How many hours do you usually drive per day? _____ hours

7) How many days per week do you usually spend away from your home? ______ days

8) How do you get paid? ☐ By the mile ☐ By the hour ☐ Salary ☐ Other _________ (please specify)

9) How much do you earn annually by truck driving? ☐ Under $15,000 ☐ $15,000 – 24,999

   ☐ $25,000 – 34,999 ☐ $35,000 – 49,999 ☐ $50,000 – 74,999 ☐ $75,000 or more

10) What type of company are you primarily involved in?

    ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods)

    ☐ Combination Private & For-Hire

11) What is the primary load type of your delivery?

    ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)

12) How many trucks does your company operate? _______________ trucks (fleet size)

13) What is the primary geographic coverage of your truck driving?

☐ Parts of Florida State ☐ Entire Coverage of Florida State ☐ Florida and Other States

14) On average, how many miles do you drive your truck for a delivery (one-way)? ____________ miles

15) Who primarily selects a truck route and departure time for your delivery?

☐ Yourself ☐ Transportation/Logistics Managers ☐ Both Yourself & Managers

☐ Other ____________________________ (please specify)

16) What types of goods do you primarily carry? (please place a check mark on all the items that are applicable)

☐ Food ☐ Grains/Feed ☐ Household Goods or Stationary ☐ Auto Parts ☐ Vehicles ☐ Machinery ☐ Textiles

☐ Livestock ☐ Metals ☐ Manufactured Goods ☐ Chemicals ☐ Paper and Allied Products

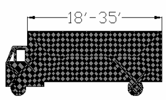
☐ Coal or Petroleum ☐ Chemicals and Allied Products ☐ Waste and Scrap ☐ Equipment

☐ Furniture ☐ Wood Products Except Furniture ☐ Stone, Clay, Glass, and Concrete Products (Minerals)

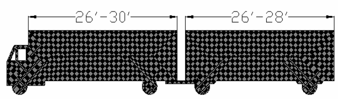
☐ Hazardous Materials ☐ Others ____________________________ (please specify)

17) What type of truck do you usually drive? (please circle all that are applicable)

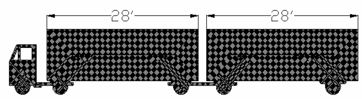
1. Straight Truck



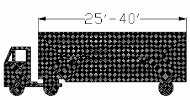
2. Truck/Trailer



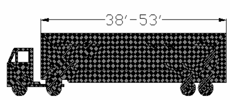
3. Twin Trailer or "Doubles"



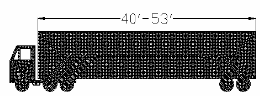
4. 3-Axle Tractor Semitrailer



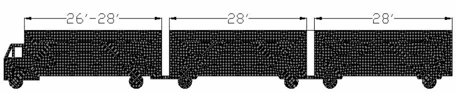
5. 4-Axle Tractor Semitrailer



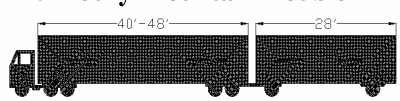
6. 5-Axle Tractor Semitrailer



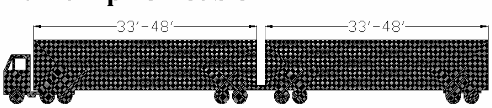
7. Truck/Double Trailers



8. Rocky Mountain Double



9. Turnpike Double



10. Other

______________________ (please specify)

Florida Trucking Association

APPENDIX G
TRUCK COMPANY MANAGER FOCUS GROUP BACKGROUND SURVEY FORM

UNIVERSITY OF FLORIDA

Transportation Research Center

Participant's Background Survey (Truck Trip Level of Service Focus Group)

Participant's Name: ________________________________

Name of the Company you are working for:

____

1) What is your gender? ☐ Male ☐ Female

2) What is your age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years

3) How many years have you been working as a manager at the trucking company? ______ years

4) How much do you earn annually by working as a manager at the trucking company?

   ☐ Under $20,000 ☐ $20,000 – 29,999 ☐ $30,000 – 39,999 ☐ $40,000 – 49,999

   ☐ $50,000 – 69,999 ☐ $70,000 – 100,999 ☐ $100,000 – 149,999 ☐ $150,000 or more

5) What type of company are you primarily involved in?

   ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods)

   ☐ Combination Private & For-Hire

6) What is the primary load type of your company's delivery?

   ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)

7) What is the geometric coverage of the truck trips you are operating?

   ☐ Parts of Florida State ☐ Entire Coverage of Florida State ☐ Florida and Other States

8) In annual average, what percent of trips of the truck drivers in your company are local, short-haul, or long-haul? (Total = 100 %)

   Local (Pickup and delivery, typically within 50 miles radius) _____ %

   Short-Haul (intercity, one-way, distance 50-200 miles) _____ %

   Long-Haul (intercity, one-way, distance more than 200 miles) _____ %

9) How many trucks does your company operate? _______________ trucks (fleet size)

10) Who primarily selects a truck route and departure time for delivery?

☐ Yourself ☐ Truck Drivers ☐ Both Yourself & Truck Drivers

☐ Other ___________________________ (please specify)

11) What types of goods do the truck drivers of your company primarily carry?
(please place a check mark on all the items that are applicable)

☐ Food ☐ Grains/Feed ☐ Household Goods or Stationary ☐ Auto Parts ☐ Vehicles ☐ Machinery ☐ Textiles

☐ Livestock ☐ Metals ☐ Manufactured Goods ☐ Chemicals ☐ Paper and Allied Products

☐ Coal or Petroleum ☐ Chemicals and Allied Products ☐ Waste and Scrap ☐ Equipment

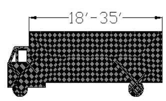
☐ Furniture ☐ Wood Products Except Furniture ☐ Stone, Clay, Glass, and Concrete Products (Minerals)

☐ Hazardous Materials ☐ Others ______________________________ (please specify)

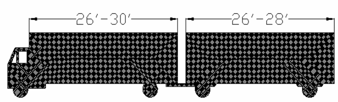
12) What types of trucks do the truck drivers of your company typically drive? _____________________

(please circle all that are applicable)

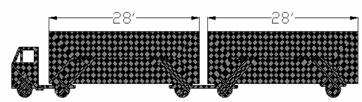
1. Straight Truck



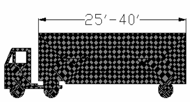
2. Truck/Trailer



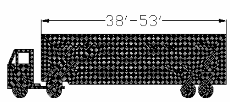
3. Twin Trailer or "Doubles"



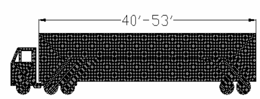
4. 3-Axle Tractor Semitrailer



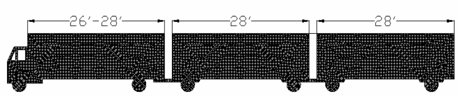
5. 4-Axle Tractor Semitrailer



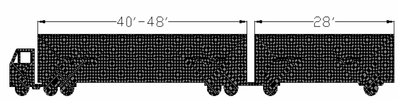
6. 5-Axle Tractor Semitrailer



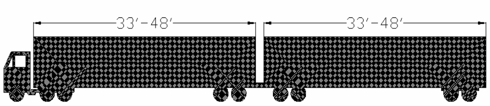
7. Truck/Double Trailers



8. Rocky Mountain Double



9. Turnpike Double



10. Other

______________________________ (please specify)

Florida Trucking Association

APPENDIX H
TRUCK DRIVER SURVEY FORM

Transportation Research Center
512 Weil Hall, PO Box 116580
Gainesville, FL. 32611
Tel: (352) 392-9537 ext 1450
Fax: (352) 846-1699

About You & Your Truck Trips

1) What is your gender? ☐ Male ☐ Female

2) What is your Age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years

3) Other than yourself, do you have any dependents? (e.g., spouse and/or young children)? ☐ Yes ☐ No

4) Which of the following groups do you most identify yourself as?

   ☐ Caucasian ☐ Native American ☐ African American ☐ Hispanic ☐ Asian ☐ Pacific Islander ☐ Other

5) What is your highest level of education?

   ☐ Some or no high school ☐ High school diploma or equivalent

   ☐ Technical college degree (A.A.) ☐ College degree ☐ Post-graduate degree

6) How much do you earn annually by truck driving? ☐ Under $15,000 ☐ $15,000 – 24,999

   ☐ $25,000 – 34,999 ☐ $35,000 – 49,999 ☐ $50,000 – 69,999 ☐ $70,000 – 99,999 ☐ $100,000 or more

7) How many years have you been employed as a commercial truck driver? ______ years

8) How many days do you usually drive a truck per week? _____ days

9) How many hours do you usually drive a truck per day? _____ hours

10) How many nights per week do you usually stay away from your home for your delivery? ______ night(s)

11) On average, how many miles do you drive your truck for a delivery (one-way)? _____________ miles

12) Are you an owner-operator (independent) truck driver? ☐ Yes ☐ No

13) If you are hired by a company, how do you primarily get paid?

    ☐ By the mile ☐ By the hour ☐ Salary ☐ By a drop ☐ Other ___________________ (please specify)

14) What types of companies are you primarily involved in?

    ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods) ☐ Combination Private & For-Hire

15) What is the primary load type of your delivery?

    ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)

16) How many trucks does the company you are working for operate (fleet size)? ☐ Less than 50 ☐ 50 ~ 99

    ☐ 100 ~ 499 ☐ 500 ~ 999 ☐ 1,000 ~ 4,999 ☐ 5,000 ~ 9,999 ☐ 10,000 or more

17) What is the most common origin of your truck trips (city, state or zip code)? ______________________________

    What is the most common destination of your truck trips (city, state or zip code)? __________________________

18) Who primarily selects a truck route and departure time for your delivery?

    ☐ Yourself ☐ Transportation/Logistics Managers ☐ Both Yourself & Managers ☐ Other _______________

19) How would you categorize the majority of your hauling distance?

    ☐ Short-Haul (Majority of working time in a one-week period is spent within a 100 miles from home terminal)

    ☐ Long-Haul (Majority of working time in a one-week period is spent outside a 100 miles from home terminal)

20) On average, what percent of your truck trips and truck driving hours are on the following transportation facilities?

Freeways	_____ %	Freeways	_____ %
Rural Multi-lane Highways	_____ %	Rural Multi-lane Highways	_____ %
Rural Two-lane Highways	_____ %	Rural Two-lane Highways	_____ %
Urban Arterials	_____ %	Urban Arterials	_____ %
Total Number of Trips = 100 %		**Total Truck Driving Hours = 100 %**	

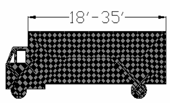
21) Is your truck engine speed governed? ☐ Yes ☐ No If, yes, what speed? _____ miles/hour

22) What types of goods do you primarily carry? (please check all that apply)

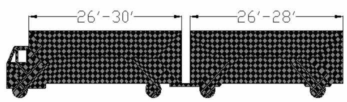
☐ Food ☐ Grains/Feed ☐ Household Goods or Stationary ☐ Auto Parts ☐ Vehicles ☐ Machinery
☐ Textiles ☐ Livestock ☐ Metals ☐ Manufactured Goods ☐ Chemicals ☐ Paper and Allied Products
☐ Coal or Petroleum ☐ Chemicals and Allied Products ☐ Waste and Scrap ☐ Equipment
☐ Furniture ☐ Wood Products Except Furniture ☐ Stone, Clay, and Concrete Products ☐ Glass
☐ Hazardous Materials ☐ Others ________________________________ (please specify)

23) What types of trucks do you usually drive? (please circle all that are applicable)

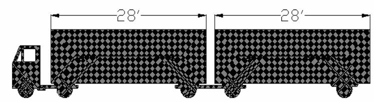
1. Straight Truck



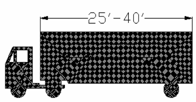
2. Truck/Trailer



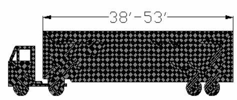
3. Twin Trailer or "Doubles"



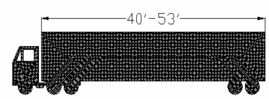
4. 3-Axle Tractor Semitrailer



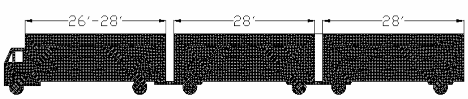
5. 4-Axle Tractor Semitrailer



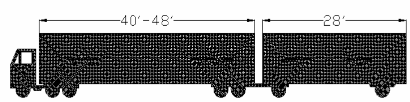
6. 5-Axle Tractor Semitrailer



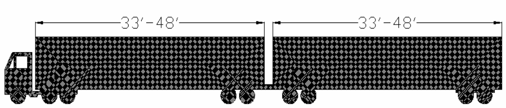
7. Truck/Double Trailers



8. Rocky Mountain Double



9. Turnpike Double



10. Tank Trucks

11. Others (Dump Trucks, Flat beds, etc.)

______________________ (please specify)

24) Overall, what percent of your truck trips are **empty**? ________ %

25) On average, what percent of your truck deliveries are **late**? ________ %

26) On average, what percent of your truck trips are made **on a road that you are NOT familiar with**? ________ %

27) When do you typically drive your truck for a delivery? (please check all that apply)

☐ Midnight ~ 6 AM ☐ 6 AM ~ 9 AM ☐ 9 AM ~ Noon
☐ Noon ~ 3 PM ☐ 3 PM ~ 7 PM ☐ 7 PM ~ Midnight ☐ no regular hours

28) When do you prefer to drive your truck for a delivery? (please check all that apply)

☐ Midnight ~ 6 AM ☐ 6 AM ~ 9 AM ☐ 9 AM ~ Noon
☐ Noon ~ 3 PM ☐ 3 PM ~ 7 PM ☐ 7 PM ~ Midnight

Your Perceptions of Truck Trip Quality on Freeways

Below are listed some roadway, traffic, and/or control factors which may affect your truck trip quality on freeways. Please fill in the circles with your perceptions about **the Relative Importance of each factor on your truck trip quality on Freeways** and **the Relative Satisfaction with each factor provided overall by Florida's Freeway Facilities** on a **scale of -3 to +3**. Please **review all the factors listed below** and **consider "0" as an Average Importance (or Satisfaction) Level**.

ROADWAY AND/OR TRAFFIC FACTORS affecting YOUR TRUCK TRIP QUALITY ON FREEWAYS		Least Important (or Satisfied) -3 -2 -1 / As Important (or Satisfied) As Others 0 / Most Important (or Satisfied) +1 +2 +3	
		Relative Importance	**Relative Satisfaction**
		-3 -2 -1 0 1 2 3	**-3 -2 -1 0 1 2 3**
Roadway Conditions	Availability and Condition of Signage	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency and Timing of Construction Activities	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane Widths	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane(s) Restricted from Truck Use	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Length of Merge or Diverge Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lighting Conditions at Night	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lower Speed Limit Only Applied to Truck Traffic	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Number of Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Pavement Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Roadway Striping Condition (including reflectors)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Shoulder Width and Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traffic Conditions	Amount of Merge or Diverge Traffic	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Governed Truck Speed Lower than Speed Limit	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Level of Congestion	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traveler Information Systems (TIS)	Availability of TIS (HAR, 511, CB Radio, VMS, …)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Publicity/Advertising of TIS	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Availability of Alternative Routes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Passenger Car Drivers' Road Etiquette	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Others (Please Specify the Factors & Rate It)			
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○

Please **Rank** the factor categories listed below **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance on your overall truck trip quality on Florida's Freeway Facilities**.

Roadway Conditions (   ) *Traffic Conditions* (   ) *Traveler Information* (   ) *Other Drivers' Behaviors* (   )

Your Perceptions of Truck Trip Quality on Urban Arterials

Below are listed some roadway, traffic, and/or control factors which may affect your truck trip quality on Urban Arterials. Please fill in the circles with your perceptions about **the Relative Importance of each factor on your truck trip quality on Urban Arterials** and **the Relative Satisfaction with each factor provided overall by Florida's Urban Arterial Facilities** on **a scale of -3 to +3.** Please **review all the factors listed below** and **consider "0" as an Average Importance (or Satisfaction) Level**.

Scale: -3 = Least Important (or Satisfied); 0 = As Important (or Satisfied) As Others; +3 = Most Important (or Satisfied). Axis: -3 -2 -1 0 +1 +2 +3

ROADWAY AND/OR TRAFFIC FACTORS affecting YOUR TRUCK TRIP QUALITY ON URBAN ARTERIALS		Relative Importance -3 -2 -1 0 1 2 3	Relative Satisfaction -3 -2 -1 0 1 2 3
Roadway Conditions	Availability and Condition of Signage	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Curb Radii for Right Turning at Intersections	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency and Timing of Construction Activities	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane Widths	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Number of Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Pavement Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Placement of Light Poles, Trees, etc. at Roadside	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Roadway Striping Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Shoulder Width and Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Stop Bar Position for Truck Turning at Intersections	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traffic Conditions	Level of Bicycle or Pedestrian Congestion	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Level of Vehicle Congestion	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traffic Signal Conditions	Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Existence of Left Turn Signal Phase at Intersections	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Length of Yellow Signal Timing at Intersections	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Traffic Signal Responsiveness at Intersections	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Passenger Car Drivers' Road Etiquette	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Others (Please Specify the Factors & Rate It)			
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○

Please **Rank** the factor categories listed below **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance on your overall truck trip quality on Florida's Arterial Facilities**.

Roadway Conditions ( ) *Traffic Conditions* ( ) *Signal Conditions* ( ) *Other Drivers' Behaviors* ( )

Your Perceptions of Truck Trip Quality on Rural Two-Lane Highways

Below are listed some roadway, traffic, and/or control factors which may affect your truck trip quality on Rural Two-Lane Highways. Please fill in the circles with your perceptions about **the Relative Importance of each factor on your truck trip quality on Rural Two-Lane Highways** and **the Relative Satisfaction with each factor provided overall by Florida's Rural Two-Lane Highway Facilities** on **a scale of -3 to +3**. Please **review all the factors listed below** and **consider "0" as an Average Importance (or Satisfaction) Level**.

ROADWAY AND/OR TRAFFIC FACTORS affecting YOUR TRUCK TRIP QUALITY ON RURAL TWO-LANE HIGHWAYS		**Least Important (or Satisfied)** -3 -2 -1 **As Important (or Satisfied) As Others** 0 +1 +2 **Most Important (or Satisfied)** +3	
		Relative Importance	**Relative Satisfaction**
		-3 -2 -1 0 1 2 3	-3 -2 -1 0 1 2 3
Roadway Conditions	Availability and Condition of Signage	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency and Timing of Construction Activities	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency of Passing Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency of Passing Zones (Dashed Yellow lines)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane Widths	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lighting Conditions at Night	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Pavement Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Roadway Striping Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Shoulder Width and Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Sight Distance at Horizontal Curvatures	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traffic Conditions	Frequency of Farm Tractors, Bicyclists, Pedestrians	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency of Faster Vehicles Passing Your Truck	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency of Faster Vehicles Following Your Truck	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency of Vehicles much Slower than Your Truck	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Level of Vehicle Congestion	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
TIS	Availability of TIS (HAR, 511, CB Radio, VMS, …)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Publicity/Advertising of TIS	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on 2-Lane Highways	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Passenger Car Drivers' Road Etiquette	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Others (Please Specify the Factors & Rate It)			
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○

Please **Rank** the factor categories listed below **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance on overall truck trip quality on Florida's Rural Two-Lane Facilities**.

Roadway Conditions ( ) *Traffic Conditions* ( ) *Traveler Information* ( ) *Other Drivers' Behaviors* ( )

Your Opinion about Truck Trip Quality on Various Transportation Facilities

Below you will find **potential performance measures for determining truck trip quality** on each type of transportation facility in Florida. Please give **your opinion about <u>how well each performance measure would be applicable to evaluate your truck trip quality, if it were the only performance measure used</u>** on **a scale of 1 to 7 (1 = Not at all Applicable, 7 = Perfectly Applicable)** and place a check mark in the box next to **<u>the one best performance measure for evaluating truck trip quality for each facility type</u>**.

(1 ~ 7)

Truck Trip Quality on Freeways

☐ ______ Ease of Driving at or above the Speed Limit (to minimize total travel time)

☐ ______ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)

☐ ______ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)

☐ ______ Ease of Obtaining Useful Traveler Information (to avoid expected congested areas or harsh weather)

(1 ~ 7)

Truck Trip Quality on Urban Arterials

☐ ______ Ease of Changing Lanes (to prepare for making turns)

☐ ______ Ease of Driving at or above the Speed Limit (to minimize total travel time)

☐ ______ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)

☐ ______ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)

☐ ______ Ease of Right or Left Turning Maneuvers

☐ ______ Ease of U-Turning Maneuvers

☐ ______ Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)

(1 ~ 7)

Truck Trip Quality on Rural Two-lane Highways

☐ ______ Probability of Being Passed or Followed by Faster Vehicles

☐ ______ Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, or pedestrians)

☐ ______ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)

☐ ______ Amount of Room for Error (to cope with unexpected situations)

☐ ______ Opportunities for Passing Other Cars (to minimize total travel time)

How would you **<u>Rank the relative needs of improvement of the roadway, traffic, and/or control conditions of each type of Florida's transportation facilities</u>** for a truck trip delivery? **(1 ~ 4, 1 = Most in Need of Improvement, 4 = Least in Need of Improvement)**

_____ Freeways _____ Rural Multi-lane highways

_____ Rural Two-lane highways _____ Urban Arterials

APPENDIX I
TRUCK COMPANY MANAGER SURVEY FORM

Transportation Research Center
512 Weil Hall, PO Box 116580
Gainesville, FL. 32611
Tel: (352) 392-9537 ext 1450
Fax: (352) 846-1699

About You & Your Truck Company

1) What is your gender? ☐ Male ☐ Female
2) What is your Age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years
3) What is your highest level of education?
   ☐ Some or no high school ☐ High school diploma or equivalent
   ☐ Technical college degree (A.A.) ☐ College degree ☐ Post-graduate degree
4) How much do you earn annually by working as a manager at the trucking company?
   ☐ Under $20,000 ☐ $20,000 – 29,999 ☐ $30,000 – 39,999 ☐ $40,000 – 49,999
   ☐ $50,000 – 69,999 ☐ $70,000 – 99,999 ☐ $100,000 – 149,999 ☐ $150,000 or more
5) How many years have you been working as a manager at trucking companies? ______ years
6) What are your job duties in your company? (please check all that apply)
   ☐ Manage truck drivers with delivery routes and schedules
   ☐ Provide truck drivers with safety training
   ☐ Make delivery contracts with customers
   ☐ Others ____ (please describe)
   ____ (please describe)
7) What types of companies are you primarily involved in?
   ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods) ☐ Combination Private & For-Hire
8) What is the primary load type of your company's delivery?
   ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)
9) How many trucks does the company you are working for operate (fleet size)? ☐ Less than 50 ☐ 50 ~ 99
   ☐ 100 ~ 499 ☐ 500 ~ 999 ☐ 1,000 ~ 4,999 ☐ 5,000 ~ 9,999 ☐ 10,000 or more
10) How do the truck drivers of your company primarily get paid?
    ☐ By the mile ☐ By the hour ☐ Salary ☐ By a drop ☐ Other ___________________ (please specify)
11) What percent of the truck drivers in your company are owner-operator (independent) truck drivers? _______ %
12) What is the primary geographic coverage of truck trips you are operating?
    ☐ Parts of Florida ☐ Entire Coverage of Florida ☐ Florida and Other States
13) On annual average, what percent of trips of the truck drivers of your company is short-haul, or long-haul?
    Short-Haul (Majority of working time in a one-week period is spent within 100 miles from home terminal) _____%
    Long-Haul (Majority of working time in a one-week period is spent outside 100 miles from home terminal) _____%
    Total = 100 %
14) On average, what percent of the truck deliveries that the truck drivers of your company make are **late**? ________ %

15) Who primarily selects a truck route and departure time for a delivery?

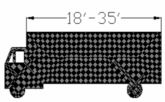
☐ Yourself ☐ Truck Drivers ☐ Both Yourself & Drivers ☐ Other _______________ (please describe)

16) What types of goods do the truck drivers of your company primarily carry? (please check all that apply)

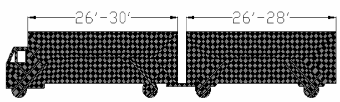
☐ Food ☐ Grains/Feed ☐ Household Goods or Stationary ☐ Auto Parts ☐ Vehicles ☐ Machinery
☐ Textiles ☐ Livestock ☐ Metals ☐ Manufactured Goods ☐ Chemicals ☐ Paper and Allied Products
☐ Coal or Petroleum ☐ Chemicals and Allied Products ☐ Waste and Scrap ☐ Equipment
☐ Furniture ☐ Wood Products Except Furniture ☐ Stone, Clay, and Concrete Products ☐ Glass
☐ Hazardous Materials ☐ Others ________________________________ (please specify)

17) What types of trucks do the truck drivers of your company typically drive? (please circle all that are applicable)

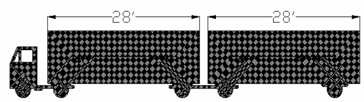
1. Straight Truck



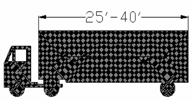
2. Truck/Trailer



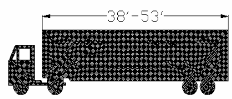
3. Twin Trailer or "Doubles"



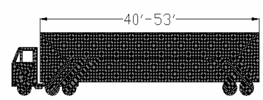
4. 3-Axle Tractor Semitrailer



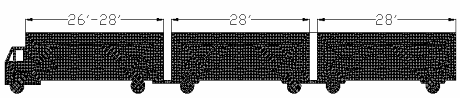
5. 4-Axle Tractor Semitrailer



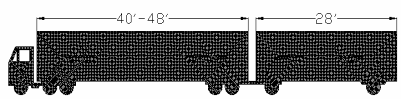
6. 5-Axle Tractor Semitrailer



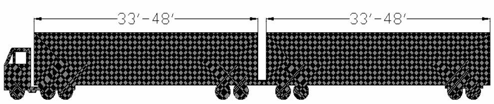
7. Truck/Double Trailers



8. Rocky Mountain Double



9. Turnpike Double



10. Tank Trucks

11. Others (Dump Trucks, Flat beds, etc.)

______________________ (please specify)

18) In your opinion, when are the good time periods to make a delivery for trucking business? (please check all that apply)

☐ Midnight ~ 6 AM ☐ 6 AM ~ 9 AM ☐ 9 AM ~ Noon
☐ Noon ~ 3 PM ☐ 3 PM ~ 7 PM ☐ 7 PM ~ Midnight

19) On average, **what percent of your truck delivery service performance level** is evaluated with **on-time deliveries** by your customers? _________ %

20) What are **the factors other than on-time delivery** by which **your truck delivery service performance level** is evaluated by your customers? (e.g., billing errors)

____ (please describe)

21) What percent of your concerns are on **following issues on Florida's transportation services** for trucking business?

Overall Truck Operating Cost ______ % (e.g., accident, insurance, equipment, labor, toll, or anything that costs)

On-Time Performance ______ % (e.g., early delivery, late delivery, travel time reliability, etc.)

Truckers' Trip Satisfaction ______ % (e.g., driver shortage, perceived level of safety, travel time, etc.)

Total = 100 %

Your Perceptions of Transportation Services on Freeways for Trucking Industry

Below are listed some roadway, traffic, and/or control factors **on Freeways** which may affect your trucking business. Please fill in the blanks column by column with your perceptions about **the Relative Importance of each factor among all the listed factors on Freeways for Overall Operating Cost, On-Time Performance, and Truck Drivers' Trip Satisfaction, respectively** on **a scale of -3 to +3 (-3 = Least Important among the factors, +3 = Most Important among the factors)**. Please **consider "0" as an Average Importance Level.**

ROADWAY AND/OR TRAFFIC FACTORS ON FREEWAYS Affecting TRUCKING BUSINESS		Overall Operating Cost (-3 ~+3)	On-Time Performance (-3 ~ +3)	Truckers' Trip Satisfaction (-3 ~ +3)
Roadway Conditions	Availability and Condition of Signage			
	Frequency and Timing of Construction Activities			
	Lane Widths			
	Lane(s) Restricted from Truck Use			
	Length of Merge or Diverge Lanes			
	Lighting Conditions at Night			
	Lower Speed Limit Only Applied to Truck Traffic			
	Number of Lanes			
	Pavement Condition			
	Roadway Striping Condition (including reflectors)			
	Shoulder Width and Condition			
Traffic Conditions	Amount of Merge or Diverge Traffic			
	Governed Truck Speed Lower than Speed Limit			
	Level of Congestion			
Traveler Information Systems (TIS)	Availability of TIS (HAR, 511, CB Radio, VMS, …)			
	Publicity/Advertising of TIS			
	Availability of Alternative Routes			
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways			
	Passenger Car Drivers' Road Etiquette			
Others (Please Specify the Factors & Rate It)				

Please **Rank** the factor categories below on Overall Florida's Freeway Transportation Services **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance for trucking business.**

Roadway Conditions (   ) *Traffic Conditions* (   ) *Traveler Information* (   ) *Other Drivers' Behaviors* (   )

Your Perceptions of Transportation Services on Urban Arterials for Trucking Industry

Below are listed some roadway, traffic, and/or control factors **on Urban Arterials** which may affect your trucking business. Please fill in the blanks column by column with your perceptions about **the Relative Importance of each factor among all the listed factors on Urban Arterials for Overall Operating Cost, On-Time Performance, and Truck Drivers' Trip Satisfaction, respectively** on a scale of **-3 to +3 (-3 = Least Important among the factors, +3 = Most Important among the factors)**. Please **consider "0" as an Average Importance Level.**

ROADWAY AND/OR TRAFFIC FACTORS ON URBAN ARTERIALS Affecting TRUCKING BUSINESS		Overall Operating Cost (-3 ~ +3)	On-Time Performance (-3 ~ +3)	Truckers' Trip Satisfaction (-3 ~ +3)
Roadway Conditions	Availability and Condition of Signage			
	Curb Radii for Right Turning at Intersections			
	Frequency and Timing of Construction Activities			
	Lane Widths			
	Number of Lanes			
	Pavement Condition			
	Placement of Light Poles, Trees, etc. at Roadside			
	Roadway Striping Condition			
	Shoulder Width and Condition			
	Stop Bar Position for Truck Turning at Intersections			
Traffic Conditions	Level of Bicycle or Pedestrian Congestion			
	Level of Vehicle Congestion			
Traffic Signal Conditions	Coordinated Traffic Signal Timings at Intersections along the Arterial for Continuous Traffic Flow			
	Existence of Left Turn Signal Phase at Intersections			
	Length of Yellow Signal Timing at Intersections			
	Traffic Signal Responsiveness at Intersections			
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Urban Arterials			
	Passenger Car Drivers' Road Etiquette			
Others (Please Specify the Factors & Rate It)				

Please **Rank** the factor categories below on Overall Florida's Arterial Transportation Services **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance for trucking business.**

Roadway Conditions (   ) *Traffic Conditions* (   ) *Signal Conditions* (   ) *Other Drivers' Behaviors* (   )

Your Perceptions of Rural 2-Lane Highway Services for Trucking Industry

Below are listed some roadway, traffic, and/or control factors **on Rural 2-Lane Highways** which may affect your trucking business. Please fill in the blanks column by column with your perceptions about **the Relative Importance of each factor among all the listed factors on Rural 2-Lane Highways for Overall Operating Cost, On-Time Performance, and Truck Drivers' Trip Satisfaction, respectively** on **a scale of -3 to +3 (-3 = Least Important among the factors, +3 = Most Important among the factors)**. Please **consider "0" as an Average Importance Level.**

ROADWAY AND/OR TRAFFIC FACTORS ON RURAL 2-LANE HIGHWAYS Affecting TRUCKING BUSINESS		Overall Operating Cost (-3 ~ +3)	On-Time Performance (-3 ~ +3)	Truckers' Trip Satisfaction (-3 ~ +3)
Roadway Conditions	Availability and Condition of Signage			
	Frequency and Timing of Construction Activities			
	Frequency of Passing Lanes			
	Frequency of Passing Zones (Dashed Yellow lines)			
	Lane Widths			
	Lighting Conditions at Night			
	Pavement Condition			
	Roadway Striping Condition			
	Shoulder Width and Condition			
	Sight Distance at Horizontal Curvatures			
Traffic Conditions	Frequency of Farm Tractors, Bicyclists, Pedestrians			
	Frequency of Faster Vehicles Passing Your Truck			
	Frequency of Faster Vehicles Following Your Truck			
	Frequency of Vehicles much Slower than Your Truck			
	Level of Vehicle Congestion			
TIS	Availability of TIS (HAR, 511, CB Radio, VMS, …)			
	Publicity/Advertising of TIS			
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on 2-Lane Highways			
	Passenger Car Drivers' Road Etiquette			
Others (Please Specify the Factors & Rate It)				

Please **Rank** the factor categories below on Florida's Rural 2-Lane Hwy Transportation Services **From 1 To 4** (**1 = Most Important, 4 = Least Important**) in terms of **their relative importance for trucking business.**

Roadway Conditions (   ) *Traffic Conditions* (   ) *Traveler Information* (   ) *Other Drivers' Behaviors* (   )

Your Opinion about Truck Driving Conditions on Various Transportation Facilities

Below you will find **specific truck driving conditions** on each type of transportation facility in Florida. Please give **your opinion about the Relative Importance of each driving condition among all the listed conditions for your trucking business in terms of overall operating cost, on-time performance, and truck drivers' trip satisfaction** on **a scale of -3 to +3 (-3 = Least Important, +3 = Most Important).** Please **consider "0" as an Average Importance Level of all the driving conditions within each facility type**. Also, place a check mark in the box next to **the one most important driving condition for your trucking business for each facility type**.

(-3 ~ +3) **Truck Driving Conditions on Freeways**

- ☐ _____ Ease of Driving at or above the Speed Limit (to minimize total travel time)
- ☐ _____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
- ☐ _____ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)
- ☐ _____ Ease of Obtaining Useful Traveler Information (to avoid expected congested areas or harsh weather)

(-3 ~ +3) **Truck Driving Conditions on Urban Arterials**

- ☐ _____ Ease of Changing Lanes (to prepare for making turns)
- ☐ _____ Ease of Driving at or above the Speed Limit (to minimize total travel time)
- ☐ _____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
- ☐ _____ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)
- ☐ _____ Ease of Right or Left Turning Maneuvers
- ☐ _____ Ease of U-Turning Maneuvers
- ☐ _____ Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)

(-3 ~ +3) **Truck Driving Conditions on Rural Two-lane Highways**

- ☐ _____ Probability of Being Passed or Followed by Faster Vehicles
- ☐ _____ Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, or pedestrians)
- ☐ _____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
- ☐ _____ Amount of Room for Error (to cope with unexpected situations)
- ☐ _____ Opportunities for Passing Other Cars (to minimize total travel time)

How would you **Rank the relative needs of improvement of the roadway, traffic, and/or control conditions of each type of Florida's transportation facilities** for your trucking business? **(1 ~ 4, 1 = Most in Need of Improvement, 4 = Least in Need of Improvement)**

_____ Freeways _____ Rural Multi-lane highways

_____ Rural Two-lane highways _____ Urban Arterials

APPENDIX J
IMPROVEMENT PRIORITY SCORE (*IPS*)

Table J-1. Improvement Priority Scores (*IPS*)

Case Ranking	*RIS* (1–7)	*RSS* (1–7)	*IPS* (−42– +42)
1	7	1	42
2	6	1	30
3	5	1	20
4	7	2	17.5
5	4	1	12
5	6	2	12
7	7	3	9.33
8	5	2	7.5
9	3	1	6
9	6	3	6
11	7	4	5.25
12	4	2	4
13	5	3	3.33
14	6	4	3
15	7	5	2.8
16	2	1	2
17	3	2	1.5
18	4	3	1.33
19	5	4	1.25
20	6	5	1.2
21	7	6	1.17
22	1	1	0
22	2	2	0
22	3	3	0
22	4	4	0
22	5	5	0
22	6	6	0
22	7	7	0
29	6	7	–1.17
30	5	6	–1.2
31	4	5	–1.25
32	3	4	–1.33
33	2	3	–1.5
34	1	2	–2
35	5	7	–2.8

Table J-1. Continued

36	4	6	–3
37	3	5	–3.33
38	2	4	–4
39	4	7	–5.25
40	1	3	–6
40	3	6	–6
42	2	5	–7.5
43	3	7	–9.33
44	1	4	–12
44	2	6	–12
46	2	7	–17.5
47	1	5	–20
48	1	6	–30
49	1	7	–42

APPENDIX K
POSTAGE-PAID TRUCK DRIVER SURVEY FORM

Transportation Research Center
UF UNIVERSITY of FLORIDA

Florida Truck Driver Opinion Survey

The Strategic Intermodal System (SIS) plan was established by the Florida Department of Transportation (FDOT) to support transportation facilities that are necessary for Florida's rapidly growing and ever changing economy. The main objective of the SIS is to provide safe, efficient, and convenient transportation services for all types of transportation users on the most critical transportation facilities in Florida.

This survey is part of a research project being sponsored by the FDOT to investigate the Florida trucking community's perceptions and opinions about truck operations on the SIS roadway facilities. The objective of this research is to determine the factors important to the Florida trucking community in order to inform the FDOT of what should be focused on to better accommodate truck traffic on the state roadway systems.

Please complete this 3-page survey and return by September, 1st. No postage is necessary. It is not necessary to include your name or address, as the survey results are intended to be anonymous. We appreciate your assistance.

About You & Your Truck Trips

1) What is your gender? ☐ Male ☐ Female
2) What is your Age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years
3) Other than yourself, do you have any dependents? (e.g., spouse and/or young children) ☐ Yes ☐ No
4) How many years have you been employed as a commercial truck driver? ______ years
5) On average, how many miles do you drive your truck for a delivery (one-way)? ________ miles
6) Are you an owner-operator (independent) truck driver? ☐ Yes ☐ No
7) If you are hired by a company, how do you primarily get paid?

   ☐ By the mile ☐ By the hour ☐ Salary ☐ By a drop ☐ Other __________________ (please specify)
8) What types of companies do you primarily work for?

   ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods) ☐ Combination Private & For-Hire
9) What is the primary load type of your delivery?

   ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)
10) Who primarily selects a truck route and departure time for your delivery?

    ☐ Yourself ☐ Transportation/Logistics Managers ☐ Both Yourself & Managers ☐ Other _______________
11) How would you categorize the majority of your hauling distance?

    ☐ Short-Haul (Majority of working time in a one-week period is spent **within** a 100 miles from home terminal)
    ☐ Long-Haul (Majority of working time in a one-week period is spent **outside** a 100 miles from home terminal)
12) Is your truck engine speed governed? ☐ Yes ☐ No If, yes, what speed? _______ MPH
13) Overall, what percent of your truck trips are **empty**? ________ %
14) On average, what percent of your truck deliveries are **late**? ________ %
15) On average, what percent of your truck trips are **made on roads that you are NOT familiar with**? __________ %

Your Perceptions of Truck Trip Quality on Freeways

Below are listed some factors which may affect your truck trip quality on freeways. Please fill in the circles with your perceptions about **<u>the Relative Importance of each factor on your truck trip quality on Freeways</u>** and **<u>the Relative Satisfaction with each factor provided overall by Florida's Freeway Facilities,</u>** on **a scale of -3 to +3**. Please **review all the factors listed below** and **<u>consider "0" as an Average Importance (or Satisfaction) Level</u>**.

ROADWAY AND/OR TRAFFIC FACTORS affecting YOUR TRUCK TRIP QUALITY ON FREEWAYS		Least Important (or Satisfied) -3 -2 -1 / As Important (or Satisfied) As Others 0 / +1 +2 +3 Most Important (or Satisfied)	
		Relative Importance	**Relative Satisfaction**
		-3 -2 -1 0 1 2 3	**-3 -2 -1 0 1 2 3**
Roadway Conditions	Availability and Condition of Signage	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Frequency and Timing of Construction Activities	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane Widths	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lane(s) Restricted from Truck Use	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Length of Merge or Diverge Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lighting Conditions at Night	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Lower Speed Limit Only Applied to Truck Traffic	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Number of Lanes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Pavement Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Roadway Striping Condition (including reflectors)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Shoulder Width and Condition	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traffic Conditions	Amount of Merge or Diverge Traffic	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Governed Truck Speed Lower than Speed Limit	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Level of Congestion	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Traveler Information Systems (TIS)	Availability of TIS (HAR, 511, CB Radio, VMS, …)	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Publicity/Advertising of TIS	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Availability of Alternative Routes	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
	Passenger Car Drivers' Road Etiquette	○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
Others (Please Specify the Factors & Rate It)			
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○
		○ ○ ○ ○ ○ ○ ○	○ ○ ○ ○ ○ ○ ○

Your Opinions about Truck Trip Quality on Various Transportation Facilities

Below you will find **potential performance measures for determining truck trip quality** on each type of transportation facility in Florida. Please give **your opinion about <u>how well each performance measure would be applicable to evaluate your truck trip quality, if it were the only performance measure used</u>** on **a scale of 1 to 7 (1 = Not at all Applicable, 7 = Perfectly Applicable)**.

Truck Trip Quality on Freeways

(1 ~ 7)

_____ Ease of Driving at or above the Speed Limit (to minimize total travel time)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
_____ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)
_____ Ease of Obtaining Useful Traveler Information (to avoid expected congested areas or harsh weather)
_____ Other (describe) ____

Truck Trip Quality on Urban Arterials

(1 ~ 7)

_____ Ease of Changing Lanes (to prepare for making turns)
_____ Ease of Driving at or above the Speed Limit (to minimize total travel time)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
_____ Ease of Maintaining a Consistent Speed (to enhance driving safety and minimize acceleration and deceleration)
_____ Ease of Right or Left Turning Maneuvers
_____ Ease of U-Turning Maneuvers
_____ Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)
_____ Other (describe) ____

Truck Trip Quality on Rural Two-lane Highways (1 lane each direction)

(1 ~ 7)

_____ Probability of Being Passed or Followed by Faster Vehicles
_____ Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, or pedestrians)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or tires)
_____ Width of travel lane and shoulder (to cope with unexpected situations)
_____ Opportunities for Passing Other Cars (to minimize total travel time)
_____ Other (describe) ____

Thank you for completing this survey. When completed, please fold the survey so that the return address is displayed. Please tape shut for mailing with the double-stick tape provided. If you have any questions about this survey, please contact the Transportation Research Center at the University of Florida (352-392-9537 x1450).

APPENDIX L

POSTAGE-PAID TRUCK COMPANY MANAGER SURVEY FORM

Transportation
Research Center
UF UNIVERSITY of FLORIDA

Florida Truck Company Manager Opinion Survey

The Strategic Intermodal System (SIS) plan was established by the Florida Department of Transportation (FDOT) to support transportation facilities that are necessary for Florida's rapidly growing and ever changing economy. The main objective of the SIS is to provide safe, efficient, and convenient transportation services for all types of transportation users on the most critical transportation facilities in Florida.

This survey is part of a research project being sponsored by the FDOT to investigate the Florida trucking community's perceptions and opinions about truck operations on the SIS roadway facilities. The objective of this research is to determine the factors important to the Florida trucking community in order to inform the FDOT of what should be focused on to better accommodate truck traffic on the state roadway system.

Please complete this 3-page survey and return by September, 29th. No postage is necessary. It is not necessary to include your name or address, as the survey results are intended to be anonymous. We appreciate your assistance.

About You & Your Truck Company

1) What is your gender? ☐ Male ☐ Female

2) What is your Age? ☐ 20 to 29 years ☐ 30 to 39 years ☐ 40 to 49 years ☐ 50 to 59 years ☐ 60+ years

3) How many years have you been working as a manager at trucking companies? ______ years

4) What are your job duties in your company? (please check all that apply)

   ☐ Manage truck drivers with delivery routes and schedules ☐ Provide truck drivers with safety training
   ☐ Make delivery contracts with customers ☐ Others ________________________________ (please describe)

5) Which type of company are you working for?

   ☐ Private (carry own goods) ☐ For-Hire (carry other people's goods) ☐ Combination Private & For-Hire

6) What is the primary load type of your company's delivery?

   ☐ Truckload (TL) ☐ Less-Than-Truckload (LTL) ☐ Both TL & LTL (approximately equally)

7) How many trucks does the company you are working for operate (fleet size)? ☐ Less than 50 ☐ 50 ~ 99

   ☐ 100 ~ 499 ☐ 500 ~ 999 ☐ 1,000 ~ 4,999 ☐ 5,000 ~ 9,999 ☐ 10,000 or more

8) What percent of the truck drivers in your company are owner-operator (independent) truck drivers? _______ %

9) On annual average, what percent of trips of the truck drivers of your company is short-haul, or long-haul?

   Short-Haul (Majority of working time in a one-week period is spent **within** 100 miles from home terminal) _____%
   Long-Haul (Majority of working time in a one-week period is spent **outside** 100 miles from home terminal) _____%
   Total = 100 %

10) On average, what percent of the truck deliveries that the truck drivers of your company make are **late**? ________ %

11) In your opinion, when are the best time periods to make a delivery? (please check all that apply)

    ☐ Midnight~6AM ☐ 6AM~9AM ☐ 9AM~Noon ☐ Noon~3PM ☐ 3PM~7PM ☐ 7PM~Midnight

12) On average, **what percent of your truck delivery service performance level** is evaluated with **on-time deliveries** by your customers? _________ %

13) What percent of your trucking company business concerns are on the following issues?

Overall Truck Operating Cost ______ % (e.g., accident, insurance, equipment, labor, toll, etc.)
On-Time Performance ______ % (e.g., early delivery, late delivery, travel time reliability, etc.)
Truck Drivers' Trip Satisfaction ______ % (e.g., travel time, perceived level of safety, driving comfort, etc.)
Total = 100 %

Your Perceptions of Transportation Services on Freeways for Trucking Industry

Below are listed some factors on Freeways which may affect your trucking business. Please fill in the blanks column by column with your perceptions about **the Relative Importance of each factor among all the listed factors on Freeways for Overall Operating Cost, On-Time Performance, and Truck Drivers' Trip Satisfaction, respectively** on **a scale of 1 to 7 (1 = Least Important among the factors, 7 = Most Important among the factors)**.

ROADWAY and/or TRAFFIC FACTORS ON FREEWAYS Affecting TRUCKING BUSINESS		Overall Operating Cost (1 ~7)	On-Time Performance (1 ~ 7)	Truckers' Trip Satisfaction (1 ~ 7)
Roadway Conditions	Availability and Condition of Signage			
	Frequency and Timing of Construction Activities			
	Lane Widths			
	Lane(s) Restricted from Truck Use			
	Length of Ramp Merge or Diverge Lanes			
	Lighting Conditions at Night			
	Lower Speed Limit Only Applied to Truck Traffic			
	Number of Lanes			
	Pavement Condition			
	Roadway Striping Condition (including reflectors)			
	Shoulder Width and Condition			
Traffic Conditions	Amount of Merge or Diverge Traffic			
	Governed Truck Speed Lower than Speed Limit			
	Level of Congestion			
Traveler Information Systems (TIS)	Availability of TIS (HAR, 511, CB Radio, VMS, …)			
	Publicity/Advertising of TIS			
	Availability of Alternative Routes			
Other Drivers' Behaviors	Passenger Car Drivers' Knowledge about Truck Driving Characteristics on Freeways			
	Passenger Car Drivers' Road Etiquette			
Others (Please Specify the Factors & Rate It)				

Your Opinions about Truck Driving Conditions on Various Transportation Facilities

Below you will find **specific truck driving conditions** on each type of transportation facility in Florida. Please give **your opinion about the Relative Importance of each driving condition among all the listed conditions for your trucking business in terms of overall operating cost, on-time performance, and truck drivers' trip satisfaction** on **a scale of 1 to 7 (1 = Least Important, 7 = Most Important)**.

(1 ~ 7) Truck Driving Conditions on Freeways

_____ Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)
_____ Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
(to enhance driving safety and minimize acceleration and deceleration)
_____ Ease of Obtaining Useful Travel Conditions Information (to avoid expected congested areas or harsh weather)
_____ Other (describe) ____

(1 ~ 7) Truck Driving Conditions on Urban Arterials

_____ Ease of Changing Lanes (to prepare for making turns)
_____ Ease of Driving at or above the Posted Speed Limit (to minimize total travel time)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)
_____ Ease of Maintaining a Consistent Speed, whether Higher or Lower than Posted Speed Limit
(to enhance driving safety and minimize acceleration and deceleration)
_____ Ease of Right- or Left-Turn Maneuvers
_____ Ease of U-Turn Maneuvers
_____ Ease of Passing through Signalized Intersections along the Arterial (to minimize stops or delays)
_____ Other (describe) ____

(1 ~ 7) Truck Driving Conditions on Rural Two-lane Highways (1 lane each direction)

_____ Probability of Being Passed or Followed by Faster Vehicles
_____ Probability of Encountering Possible Conflicts (with farm tractors, bicyclists, pedestrians, wildlife, etc.)
_____ A Consistently Good Ride Quality (to enhance ride comfort and minimize impact on goods or equipment)
_____ Width of Travel Lane and Shoulder, or Shoulder Type (to cope with unexpected situations)
_____ Opportunities for Passing Other Cars, through Passing Zones or Passing Lanes (to minimize total travel time)
_____ Other (describe) ____

Thank you for completing this survey. When completed, please fold the survey so that the return address is displayed. Please tape shut for mailing with the double-stick tape provided. If you have any questions about this survey, please contact the Transportation Research Center at the University of Florida (352-392-9537 x1450).

APPENDIX M
POSTAGE-PAID MANAGER SURVEY COVER LETTER

UNIVERSITY OF FLORIDA

Department of Civil and Coastal Engineering

Scott S. Washburn, Ph.D., P.E.
Associate Professor
365 Weil Hall, PO Box 116580
Gainesville, FL 32611-6580
Tel: 352-392-9537 ext. 1453
Fax: 352-392-3394
Email: swash@ce.ufl.edu

Company Name
Xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

August 25, 2006

Subject: **Florida Truck Company Manager Opinion Survey**

To Mr./Mrs. **Xxxxxxx (Florida Trucking Association Member)**

A survey study to identify ways to better accommodate truck traffic on Florida's state roadway system was initiated by the Florida Department of Transportation (FDOT). This study is being conducted by the Transportation Research Center (TRC) at the University of Florida (UF), in cooperation with the Florida Trucking Association (FTA). The survey focuses on truck company managers' perceptions about the relative importance of each roadway, traffic, and/or control factor of various transportation facilities for Florida's trucking industry. The results of this study are expected to provide FDOT with guidance to develop methods to evaluate how well it is addressing the needs of freight transportation on the state roadway system and for prioritization decisions for roadway improvement projects for truck traffic.

With the assistance of the FTA and its membership directory, the TRC has identified a sample of truck companies that meet various selection criteria. Your input is critical to our goal to obtain balanced input from an appropriate cross-section of companies.

Please distribute the enclosed surveys to the managers (transportation, logistics, safety, dispatch, etc.) of your company. When completed, the surveys can be individually mailed, as they are pre-addressed. Additionally, the surveys are postage pre-paid; thus, no additional postage is necessary. It is not necessary to include any names on the surveys. Your assistance is greatly appreciated.

Sincerely,

Scott S. Washburn

APPENDIX N
SURVEY DATA FILTERING CRITERIA

This document describes the reasons why the survey data reduction strategy was necessary and how it was applied to survey responses for each section of the survey. For both driver and manager surveys, the identical survey data filtering criteria were used to determine the validity of the survey responses. Only the valid survey responses were used for data analysis.

Section 1: Background of the Respondents

Almost all the respondents completed the participant background section of the survey. A few participants did not fill out all the questions. It was required to check the validity of the survey responses for several questions such as percent of empty trips, percent of late trips, etc. For instance, several truck driver participants indicated that over 50 percent of their trips are empty, but those responses are not reasonably possible. Thus, they were excluded for survey data analyses.

Section 2: Relative importance and satisfaction of each factor

Relative importance and satisfaction of each factor on each roadway type was asked in an interval rating scale. It was witnessed that many respondents did not answer all the questions in the section, or did not pay enough attention to complete the section as directed. Some respondents indicated that all or most of the factors are equally important or satisfactory, not trying to give their opinions about the relative importance or satisfaction of each factor among all the listed factors. Some other respondents only completed either the relative importance or the relative satisfaction section, or did not distinguish the relative importance scores from satisfaction scores, or presented the same scores for both the relative importance and satisfaction of all or most of the factors. Another group of respondents did not give relative importance or satisfaction scores for all the listed factors, creating some missing data. Considering these observations, following data screening criteria was used to distinguish valid survey responses for data analysis:

- Validity of survey responses for this section should be determined for each column of each roadway facility (e.g., Relative Importance on Freeways, Relative Satisfaction on 2-Lane Highways, etc).
- When the relative importance scores (or satisfaction scores) of all the listed factors present a small variance, the column data should not be considered for survey data analyses. At least, scores of 4 or more factors should be different from the mode of all the scores in that column.
- When there are more than 2 missing scores in a column, the data for that column should be considered invalid.
- When the relative importance score is identical to the satisfaction score for most of the listed factors, both column data should be discarded. At least 4 importance scores should be different from their corresponding satisfaction scores for both column data to be determined to be valid.
- When there is any score(s) presented in "other" section without indicating self-identifying factor, the data for that whole column should be eliminated.

Section 3: Relative importance of each category of factors

Relative importance of each category of factors on each roadway type was asked in a ranking scale. A significant portion (more than 70%) of the participants did not respond to these questions. Some respondents answered them in an interval-rating scale. It is not clear whether they really regarded those ranking-scale questions as interval-rating scale questions. Thus, following criteria was used to pick out the valid survey responses for data analysis:

- Validity of survey responses for this section should be determined for each question.
- Only the responses in the ranking scale (i.e., ranking the items from 1 to 4) should be considered valid.
- Responses with any missing data should be discarded.

Section 4: Applicability of single performance measure

Applicability of single performance measure to determine quality of a truck trip was asked in an interval-rating scale. Most participants completed this survey section as directed. However, there still were some respondents who did not answer the questions. Some other respondents indicated that all the listed performance measures are equally applicable. Following criteria were used to discern the valid survey responses for data analysis:

- Validity of survey responses for this section should be determined for each roadway type.
- When there are 2 or more missing scores within a roadway type, all data for that roadway type are considered invalid.
- When the same score is given to all factors for 2 or more roadway types, the data in the whole section should be eliminated.

Section 5: Relative improvement need of each roadway facility type

The relative improvement need of each roadway facility type was questioned in a ranking scale. Most participants did not respond to this question. Some respondents answered it in an interval-rating scale. It is not clear whether they really regarded those ranking-scale questions as interval-rating scale questions. Valid surveys were determined by the criteria used in the section 3.

LIST OF REFERENCES

Alexander David G. and Moore David. (2003). “Winter road management project”, Idaho Technology Transfer Center, in conjunction with American Trucking Associations Foundation, Inc., on-line survey website: <http://www.webs.uidaho.edu/winterroads/trucker_survey.asp>, (October 11, 2006)

American Trucking Associations Foundation, Inc. (2005). *American trucking trends 2004*, Alexandria, V.A.

American Trucking Associations Foundation, Inc. (1997). *Motor carrier and freight movement operational characteristics in the Baltimore region*, prepared for the Baltimore Metropolitan Council, Alexandria, V.A.

Bureau of Transportation Statistics. (2004). *2002 Commodity flow survey*, Washington, D.C.

Center for Public Policy. (2001). *A survey of the opinions of the driving public and drivers of large trucks on road safety issues: road safety survey*, Virginia Commonwealth University, V.A.

Conover W. J. (2001). *Practical nonparametric statistics*, 3rd Edition, John Wiley & Sons.

Crum Michael R., Morrow Paula C., Olsgard Patricia, and Roke Philip J. (2001). “Truck driving environments and their influence on driver fatigue and crash rates.” *Transportation Research Record. 1779,* Transportation Research Board, D.C., 125–133.

Dunnett Charles W. (1980). “Pairwise multiple comparisons in the unequal variance case.” *Journal of the American Statistical Association, Vol.75, No. 372*, 796–800.

Field, A. P. (2005). *Discovering statistics using SPSS*, 2nd Edition, Sage Publications, London.

Finnegan Clare, Finlay Hugh, and Mahony Margaret O. (2004). “An initial assessment of the potential for urban distribution centres in Dublin.” *83rd Annual Meeting of Transportation Research Board*, Washington, D.C.

Finnegan Clare, Finlay Hugh, Mahony Margaret O., and Sullivan Donal O. (2005). “Urban freight in Dublin city centre: survey analysis and strategy evaluation.” *84th Annual Meeting of Transportation Research Board*, Washington, D.C.

Flannery Aimee, Wochinger Kathryn, and Martin Angela. (2005). “Driver assessment of service quality on urban streets.” *Transportation Research Record. 1920,* Transportation Research Board, Washington, D.C., 25–31.

Florida Department of Transportation. (2003). *Florida's strategic intermodal system plan*, Tallahassee, F.L.

Golob Thomas F. and Regan Amelia C. (2002). "The perceived usefulness of different source of traffic information to trucking operations." *Transportation Research Part E Vol. 38*, 97–116.

Greene William H. (2000). *Econometric analysis*, 4th Edition, Prentice Hall.

Hair Joseph F., Black Bill, Babin Barry, Anderson Rolph E., and Tatham Ronald L. (2005). *Multivariate data analysis*, 6th Edition, Prentice Hall.

Hall Fred, Wakefield Sarah, and Kaisy Ahmed Al. (2001). "Freeway quality of service: what really matters to drivers and passengers?" *Transportation Research Record. 1776,* Transportation Research Board, Washington, D.C., 17–23.

Hall Lisa Aultman, Hill Michael L., and Agent Ken. (2004). "Methodology for evaluating large truck access to intermodal and other facilities." *Transportation Research Record. 1999,* Transportation Research Board, Washington, D.C., 61–68.

Highway Research Board. (1962). *The AASHO road test: report 5–pavement research*, Highway Research Board Special Report 61-E.

Hostovsky, Charles and Hall, Fred L. (2004). "Freeway quality of service: perceptions from tractor-trailer drivers." *Transportation Research Record. 1852,* Transportation Research Board, Washington, D.C., 19–25.

Hveem, F. N. (1960). *Devices for recording and evaluating pavement roughness*, Highway Research Board, Research Record 264.

Kim Jin-Tae, Courage Kenneth G., Washburn Scott S., and Bonyani Gina. (2003). "Framework for investigation of level-of-service criteria and threshold on rural freeways." *Transportation Research Record. 1852,* Transportation Research Board, Washington, D.C., 239–245.

Koehne Jodi, Mannering Fred, and Hallenbeck Mark. (1997). "Analysis of trucker and motorist opinions toward truck-lane restrictions." *Transportation Research Record. 1560,* Transportation Research Board, Washington, D.C., 73–83.

Larson Paul D. and Poist Richard F. (2004). "Improving response rates to mail surveys: a research note." *Transportation Journal, Vol. 43, No. 4*, 67–74.

Lawson, Catherine T. and Riis, Anne-Elizabeth. (2001). "We're really asking for it: using surveys to engage the freight community." *Transportation Research Record. 1763,* Transportation Research Board, Washington, D.C., 13–19.

Lawson, Catherine T., Kirk, Alan R., Strathman, James G., and Riis, Anne-Elizabeth. (2002). "Making contact: developing an effective methodology to survey the freight community." *81st Annual Meeting of Transportation Research Board*, Washington, D.C.

Levene H. (1960). *Robust tests for the equality of variance*, Contributions to Probability and Statistics, Stanford University Press, I. Olkin, eds. Palo Alto, C.A.

Loudon William R. (2000). "Surveys of freight shippers and carriers: lessons learned", DKS Associates, *ITE District 6 Meeting*, San Diego, C.A.

Martilla, John A. and James, John C. (1977) "Importance-performance analysis." *Journal of Marketing, Vol. 41, No. 1*, American Marketing Association, 77–79.

McCord Keith. (2006). "UPS drivers discouraged from making left turns", Local News, KSL TV reporting, KSL website: <http://www.ksl.com/?nid=148&sid=360685>, (December 22, 2006)

Morris, Anne G., Kornhauser, Alain L., and Kay, Mark J. (1998). "Urban freight mobility: collection of data on time, costs, and barriers related to moving product into the central business district." *Transportation Research Record. 1613,* Transportation Research Board, Washington, D.C., 27–32.

Ott R. Lyman and Longnecker Michael T. (2006). *An introduction to statistical methods and data analysis*, 6th Edition, Duxbury Press.

Pecheux, Kelly Klaver, Flannery Aimee, Wochinger Kathryn, Rephlo Jennifer, and Lappin Jane. (2004). "Automobile drivers' perceptions of service quality on urban streets." *Transportation Research Record. 1883,* Transportation Research Board, Washington, D.C., 167–175.

Regan, Amelia C. and Golob, Thomas F. (1999). "Freight operators' perceptions of congestion problems and the application of advanced technologies: results from a 1998 survey of 1,200 companies operating in California." *Transportation Journal, Vol. 38, No. 3*, 57–67.

Sayers, M., Gillespie, T., and Queiroz, C. (1986). "The international road roughness experiment: a basis for establishing a standard scale for road roughness measurements." *Transportation Research Record. 1084,* Transportation Research Board, Washington, D.C., 76–85.

Shafizadeh Kevin and Mannering Fred. (2003). "Acceptability of pavement roughness on urban highways by driving public." *Transportation Research Record. 1860,* Transportation Research Board, Washington, D.C., 187–193.

Shafizadeh Kevin and Mannering Fred. (2006). "Statistical modeling of user perceptions of infrastructure condition: application to the case of highway roughness." *ASCE Journal of Transportation Engineering*, 133–140.

Southwestern Pennsylvania Regional Planning Commission. (1996). *Freight transportation issues in southwestern Pennsylvania: a survey of manufacturers and transportation service providers*, Pittsburgh, P.A.

Statistical Package for the Social Sciences (SPSS) Inc. (2006). *SPSS for Windows version 15.0*, Statistics Software, Chicago, I.L.

Transportation Research Board. (2000). *Highway capacity manual (HCM)*, National Academy of Sciences, Washington, D.C.

U.S. Department of Transportation and Federal Highway Administration. (2002). *Freight analysis framework*, Washington, D.C.

Veras Jose Holguin, Polimeni John, Cruz Brenda, Xu Ning, List George, Nordstrom Jeana, Haddock Jorge. (2005). "Off-peak freight deliveries: challenges and stakeholders' perceptions." *84th Annual Meeting of Transportation Research Board*, Washington, D.C.

Washburn Scott S., Kirschner David S. (2006). "Rural freeway level of service based on traveler perception." *85th Annual Meeting of Transportation Research Board*, Washington, D.C.

Washburn Scott S. (2002). *Multimodal quality of service, part I: truck level of service*, prepared for the Florida Department of Transportation, Tallahassee, F.L., Project Final Report, BC 354-28.

Washburn Scott S., Ramlackhan Kirby, and McLeod Douglas S. (2004). "Quality of service perceptions by rural freeway travelers: an explanatory analysis." *83rd Annual Meeting of Transportation Research Board,* Washington, D.C.

Zhang Li, and Prevedouros Panos D. (2005). "User perceptions of signalized intersection level of service." *84th Annual Meeting of Transportation Research Board*, Washington, D.C.

BIOGRAPHICAL SKETCH

As an architect, architectural engineer, and transportation engineer, Byungkon (Cody) Ko has experienced a wide range of disciplines throughout his life. Inspired by his mother, who had been an architectural agent, he started studying architectural design and engineering at Dankook University in Korea. At that time, he dealt with a number of architectural projects as an active member of "Artlier Compe", a study group intended to discover and materialize what people want and need through various contemporary architectural design competitions.

He continued his career at an architectural consulting company after graduation. He had worked as an architectural engineer and architect, managing construction sites, designing buildings, and drawing construction details. While he was gaining the real field experiences, he got interested in the origin, structure, and condition of traffic network that he realized architectural planning and infrastructure are strongly associated with. He also witnessed and inquired many serious traffic operation and management problems consistently brought up in Seoul, Korea. All such concerns have grown further to result in a motivation for him to get into the field of transportation.

He earned his Master's and Ph.D. degree in transportation engineering at the University of Florida. He had worked as a teaching assistant for "Transportation Engineering" course, and played a major role in conducting several FHWA- or FDOT-funded transportation research projects under the supervision of a couple of faculty members. He has mostly involved investigating the effectiveness of ITS safety countermeasures such as flexible traffic separators, variable message signs, pedestrian countdown signals on overall traffic safety and operation. He had been a key person in all aspects of the research studies, from the installation of surveillance cameras in the field to the statistical analyses of the collected data. His dissertation for Ph.D. degree is about the identification of preferred performance measures for the assessment of truck level of service. The study required him to conduct focus group studies and surveys studies to elicit perceptions of Florida trucking community, truck drivers and truck company managers. He designed focus group and survey questionnaires and analyzed the data qualitatively and quantitatively to complete the study.