Accounting for Commercial Vehicles in Urban Transportation Models

Task 2 – Literature Review

final report

prepared for

Federal Highway Administration

prepared by

Cambridge Systematics, Inc.

with

Arun Chatterjee, Ph.D.
Harry Cohen, Ph.D.

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Cambridge Systematics, Inc.
150 CambridgePark Drive, Suite 4000
Cambridge, Massachusetts 02140

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1.0 Overview of the Literature Review

1.1 Purpose and Definition

The purpose of this literature review is to assess recent and current literature relevant to the treatment of commercial vehicles in urban transportation models. This literature review includes published literature, unpublished literature, information from the Internet, GIS and survey data sources and internal project documents on related topics.

To date, most of the literature on this topic revolves around urban freight distribution. The state of the practice in the modeling of commercial vehicle travel in the urban transportation context has been geared toward developing a limited number of commercial vehicle trip generation factors, typically only disaggregated by truck type; for example, light, medium and heavy trucks. The traditional approach of relating these rates to land use activity has been found to be limited for application in travel demand modeling due to lack of data on differences in trip purpose, vehicle occupancy, and origin-destination (O-D) patterns. Other definitions of commercial vehicles rely on vehicle registration classifications.

To clarify the scope of the literature review, 13 categories of commercial vehicles were defined and included both individually and categorically in the literature review. Initial reviews on commercial vehicles in general uncovered very few sources in the literature, so the majority of the literature review was focused on individual vehicle types.

In addition, the literature review was focused on trips within an urban area (intraregional trips) rather than on trips entering or leaving an urban area (interregional trips). This is a critical distinction for urban freight trips, where much of the current literature covers interregional freight distribution rather than intraregional freight distribution. This distinction is expected to carry forward in the development of methods for estimating commercial vehicle traffic, where the interregional traffic is estimated using different techniques related to external traffic than intraregional traffic, which is estimated using more specific methods related to trip purpose, demographics and other characteristics of the region.

1.2 Approach

The approach to the literature review included separately commercial vehicles into individual types of vehicles so that individual searches could be performed. Initial literature searches indicated that this would be necessary to obtain information on some of the less studied types of commercial vehicles. The original 13 categories of commercial vehicles were identified and defined according to the type of service and purpose, and are presented in Table 1.1.

Table 1.1 Commercial Vehicles by Type, Purpose, and Service

	Vehicle Type	Purpose	Service Type
1	School Buses	Movement of People	Fixed Route Service
2	Fixed Shuttle Services at Airports, Stations, etc.	Movement of People	
3	Private Transportation: Taxi, Limos, Shuttles	Movement of People	On-Demand Service
4	Paratransit: Social Services, Church Buses	Movement of People	
5	Rental Cars	Movement of People	
6	Package and Mail Delivery; USPS, UPS, FedEx	Movement of Goods	Fixed Route Service
7	Urban Freight Distribution, Warehouse Deliveries	Movement of Goods	On-Demand Service
8	Product and Package Deliveries	Movement of Goods	
9	Construction Transport	Movement of Goods	
10	Public Utilities, Trash, Meter Readers, Maintenance	Services	Fixed Route Service
11	Public Safety: Police, Fire, Bldg. Inspections, Tow Trucks	Services	On-Demand Service
12	Trades and Services: Plumbers, Electricians, etc.	Services	
13	Outside Sales: Realtors, Door-to-Door Sales, Public Relations	Services	

General literature searches on the state of the practice models, data sources and modeling approaches were also conducted. Some of the information supporting these general categories were derived from the individual searches and were supplemented by more general literature or data found.

1.3 Outline of Report

The literature review provides an overview of the information found on state of the practice techniques in Section 2.0, on data sources in Section 3.0 and on modeling approaches in Section 4.0. The report also provides more detailed information on the individual literature reviews for each commercial vehicle type in Section 5.0.

There are two appendices providing reference and supporting information. Appendix A contains all references from the report. Appendix B contains an overview of the information in individual references to address the following questions:

- What is the objective or purpose of the study?
- What location or methods or models are described?
- What type of vehicle or service is covered?
- Are the magnitude of vehicles or trip rates described in the study?
- Are the distribution of vehicles or trip lengths or vehicle miles traveled described?
- What is the level of spatial detail?
- What data sources are used?
- Are forecasts included?
- Is the study facility-specific (e.g., airport or seaport)?
- What is the importance to our study?

2.0 State of the Practice

2.1 Overview

Current state of the practice for urban transportation models that account for commercial vehicles range from the very general to very specific, but we have found no current example where a model attempted to estimate all types of commercial vehicles. Examples of the state of the practice are described in each of the three primary categories of commercial vehicles as an indication of the types of practice in use rather than as a comprehensive evaluation of all models of this type in use at this time.

2.2 Commercial Vehicles Moving People

There are no specific urban transportation models that include the movement of people in commercial vehicles as a general category of trips, but there are some examples of the inclusion of specific types of commercial vehicles in this category. These examples are described below.

Taxis have been represented as a mode choice in several mode choice models: Houston-Galveston, Cleveland, Las Vegas, and New York. In some cases, residents and non-residents (visitors) have separate models, but if this is not the case, then taxis would only represent trips by residents. The Las Vegas model is the only example that has been fully completed; all other models are under development. In this case, taxi trips are estimated and assigned to the highway network.

There are two different examples of urban models that predict school bus travel, but in both cases, school bus trips are estimated but school buses are not assigned or evaluated. In Tucson, school bus trips are estimated in the mode choice model (JHK & Associates, 1994). In Houston-Galveston, school bus trips will be estimated separately from the four-step model and subtracted from total trips as a post-process (Parsons Brinckerhoff, 1998).

There are at least three examples of airport access models for mode and destination choice of residents and non-residents. In San Francisco, the ACCESS model (Harvey, 1988) including mode choice for rental cars, taxi, and both on-demand and scheduled airport shuttles. In Portland, Cambridge Systematics (1998) estimated commercial vehicles such as airport shuttle services, shared ride shuttle services, and taxis in the mode and destination choice models. In Sacramento (DKS Associates, 2002), modeled airport trips as a separate trip purpose with a unique mode choice model for these trips.

There are also at least two examples of vanpool models. In Chicago, a stated preference survey of travelers was used to determine the variables that impact vanpooling as a modal choice. In Seattle, a vanpool model was developed from a survey of vanpoolers to determine the prior mode that vanpoolers were using. The results of this model was to subtract vanpoolers prior mode from other modes in the travel model and then assign vanpools as a separate class of vehicles in the multi-class assignment.

2.3 Commercial Vehicles Moving Goods

The best source of the current state of the practice for the magnitude of commercial vehicle trips is the NCHRP Synthesis 298 report on Truck Trip Generation Data (Fischer et al., 2001). This report focuses primarily on commercial vehicle trips related to urban freight distribution, but also includes some information on package and mail delivery as well as construction-related transport. The state of the practice is divided into three types of models:

- **Vehicle-based truck** trip generation rates used in statewide and regional travel demand models generally are estimated based on land-use categories that match up well with employment by industry sectors, corresponding to the data that MPOs typically have and/or forecast. A significant problem with this method is that these categories of land use are very broad, and trip rates vary considerably within these categories from region to region. This particularly is true for service-related trip purposes. Trip generation rates related to service industry employment lumps into a single land-use category a whole range of highly varied trip purposes with very different trip generation characteristics (and vehicle types used for trips). In these models, light trucks are sometimes loosely defined to include all commercial vehicles not included in other truck types (medium and heavy-duty trucks). When this is done, the unique characteristics of light-duty commercial vehicles (such as, rental cars, taxis, and vehicles used in outside sales) are often completely absent in the modeling process. Examples of this type of truck model can be found in Atlanta, Chicago, San Francisco, Buffalo, and Phoenix.

- **Commodity-based models** generally do not develop truck trip generation rates. Instead, annual commodity tonnage data are converted into daily truck trips using a payload conversion factor. The national Commodity Flow Survey and the TRANSEARCH database developed by Reebie Associates are the most commonly used sources of commodity flow data, and the national Vehicle Inventory and Use Survey (VIUS) and locally collected intercept surveys are the most commonly used sources of payload data. These methods tend to underestimate trips in urban areas because they do not account for trip chaining and local pickup and delivery activities (i.e., light trucks). Hence, commodity-based modeling approaches are likely to be less applicable to this project. Examples of this type of truck model can be found in Portland.

- **Hybrid models** are combinations of vehicle-based and commodity-based models. They also can include light trucks, loosely defined to include all commercial vehicles (Cambridge Systematics has developed these hybrid models in a number of cities and states). They have the same drawbacks as vehicle-based models in that the commercial vehicles are estimated using very generalist aggregate methods rather than specific data or rates for each type of commercial vehicle. Examples of this type of model can be found in Seattle and Los Angeles.

A new model for Houston proposes to stratify truck trips by mode of operation: fleet vehicles, which make numerous short trips; intermodal connections, which are fewer in both frequency and destinations; and heavy drayage, which typically connects a single origin-destination pair (Parsons Brinckerhoff, 1998).

The San Francisco model (Schlappi et al., 1993) separated "garage-based trips" from "link-based trips" to identify the differences between truck trips that traveled in individual round trips from the garage to the destination and other round trips that traveled in multiple destinations in a chain of trips.

In another study for the Greater Buffalo-Niagara region (Jack Faucett Associates, 1999), the internal truck trips were separated into three categories: parcel delivery trucks, mail trucks and all other trucks. The U.S. Postal Service provided data on mail trucks and the parcel delivery trucks were estimated from data on the largest carrier in the region. Other truck trips were estimated from a variety of sources.

The Southern California Association of Governments (Davidian, et al., 1999) documented that the largest fraction of truck trips in the metropolitan area were associated with light-heavy trucks serving households and service industries. Some attempts were made to develop new trip generation data using shipper/receiver surveys. The SCAG model also used aerial photographic land use data and econometric modeling techniques to develop new methods of developing distribution models for construction-related trips.

2.4 Commercial Vehicles for Services

There are no examples in the state of the practice where the service-related commercial vehicles are estimated uniquely from other commercial vehicles. In some cases, urban models have been developed to include service-related commercial vehicles in the estimation process. In the Quick Response Freight Manual (Cambridge Systematics, 1996), delivery and service vehicles are included in the definition of four-tire commercial vehicles and trip generation rates includes some trips from households to account for the source of many of these trips.

3.0 Data Sources

3.1 Overview

There are three primary types of data sources that can be used to support new methods for estimating commercial vehicles in urban transportation models: travel surveys, other types of surveys and geographic information systems (GIS) data. The data sources discovered during the course of the literature review are discussed in this section. This is not necessarily comprehensive of all possible data sources, but intended to identify the types of data sources that would be available.

3.2 Travel Surveys

The 1995 National Personal Transportation Survey[1] (NPTS) and the new 2000 National Household Travel Survey[2] (NHTS) are potential sources of information on certain kinds of commercial vehicles. The 1995 NPTS contains the following modes, which may be relevant to this study:

- Pickup truck;
- Other truck;
- Other privately owned vehicle (excluding autos, vans, sport utility vehicles and recreational vehicles);
- Taxicab; and
- School bus

The use of pickup and other trucks would be in combination with other information on trip purpose to identify whether these were used for commercial purposes.

The ITE Trip Generation Manual (ITE, 1997) contains vehicle trip rates for a number of land uses that may be relevant for this study:

[1] http://www-cta.ornl.gov/npts/1995/Doc/publications.shtml

[2] http://www.bts.gov/nhts/

- Waterport/Marine Terminal;
- Commercial Airport;
- General Aviation Airport;
- Truck Terminal;
- General Light Industrial;
- General Heavy Industrial;
- Industrial Park;
- Manufacturing;
- Warehousing;
- Mini-Warehouse;
- High-Cube Warehouse; and
- Utilities.

This manual reports on the vehicle trip rates per employee (or other size variable), so use of these data would require a separate estimation of employee work trips in personal vehicles to identify the commercial vehicles portion of the total vehicle trips.

There have been a number of regional commercial vehicle surveys that may provide data for this study (Denver, Houston-Galveston, Piedmont Triad, Los Angeles, Atlanta, Detroit, Portland, and El Paso). Our review of these surveys identified the need to obtain the actual data for evaluation, since the relevant information on specific vehicles was not necessarily available through documentation. The survey data were collected either through a survey of businesses that operate commercial vehicles (also referred to as shippers and carrier surveys) or by identifying commercial vehicles through registration records. There is one study (Lawson et al., 2001) that compares different types of data collection methods for shippers and carriers and determines the effectiveness of the different methods.

There have also been travel surveys to collect data on vanpooling in Seattle and Chicago. In Seattle (Cambridge Systematics, 2002), travel surveys on existing vanpooling trips and inventories of the vanpool services were used to evaluate the vanpool market. In Chicago (Koppelman et al., 2002), stated preference surveys of travelers were collected to determine the effect of proposed vanpool services on vanpool propensity.

3.3 Other Surveys

There are a number of other types of surveys that we discovered during the literature review that are relevant to different types of commercial vehicles. In Washington State (Nee et al., 2001), the Department of Transportation conducted a survey of 5,000 tow trucks to determine response times and types of incidents in the region. The original

survey data on incident response and additional data on feedback to the survey are available from the WSDOT.

In St. Louis, the East-West Gateway Coordinating Council (1996) conducted a survey of paratransit operators to collect data on trip purpose, service area, service hours, unused vehicle miles, operating and capital budgets, and other information. In addition, 431 vehicles were surveyed to estimate trips per vehicle.

There is a national organization of school bus fleets that conducts a survey of school districts and school bus contractors every year.[3] The survey collects data on bus fleet size and passenger loads for the top 100 school districts and the top 50 school bus contractors in the United States. The surveys are also used to estimate the total route mileage of school buses for each state.

3.4 GIS Data Sources

There is a long list of potential GIS data sources that could provide useful information for the evaluation of commercial vehicles in urban transportation models. The most relevant publicly available sources are listed below:

- The Bureau of Transportation Statistics (BTS) Geographic Information Services (GIS) are a national resource for transportation spatial data and GIS in transportation (GIS-T) information.

- Geospatial One-Stop E-Gov Initiative will revolutionize E-Gov by providing a geographic component for use in all Internet based E-Gov activities across local, state, tribal and Federal government.

- National Transportation Atlas Data (NTAD) Shapefile Download Center (2002) is a set of transportation-related geospatial data for the United States. The data consist of transportation networks, transportation facilities, and other spatial data used as geographic reference. 2001 data is still available.

- Dynamap/1000 Shapefile Download Center is a vector based, digital, geographic database in which streets and features are represented as line segments. Each side of a street or feature has associated data such as Census codes and Federal Information Processing Standards (FIPS) codes. The internal street network database contains nearly every street in the nation. The data is available for all 50 states and Puerto Rico.

- Federal Geographic Data Committee (FGDC) Ground Transportation Subcommittee promotes the coordination of geospatial data for ground transportation related

[3] http://www.schoolbusfleet.com/stats.cfm

activities and establishes mechanisms for the coordinated development, use, sharing, and dissemination of Geo-spatial data for ground transportation financed in whole or in part by Federal funds.

- Transportation Research Board (TRB) Spatial Data & Information Science Committee includes all aspects of the spatial, locational, and temporal data used in transportation. The Committee is interested in both research into and applications of this information and GIS-T.

- State GIS resources house data on roads, railroads, public transit, navigable waterways, commercial air routes, intermodal connections, and pipelines that can be accessed from the BTS web site. The state web sites also provide links to other local sources such as other state agencies, local governments, and universities. In some states, the universities maintain comprehensive spatial data sets, for example the University of Florida Geographic Data Library.

- The US Census Bureau provides a wide range of spatial data sets based upon the TIGER (Topologically Integrated Geographic Encoded Reference) files. The accuracy and completeness of these vary by region.

- Census 2000 Geographic Products include Census 2000 Maps and Boundary Files, Glossaries, Relationship Files, 2000 Tabulation Tallies (Number of geographic entities for Census 2000), Census 2000 TIGER/Line.

There are also a number of commercially available data sources, a few of which are listed below:

- Map vendors such as Geographic Data Technology (GDT), Tele Atlas, NavTech, Chicago Maps, Rand McNally, and Thomas Brothers Maps all supply digital map data for streets, political boundaries, topography and many other features, including utility locations, hospitals, shopping malls, and other commercial features. Data is normally purchased by a county and the price rises with the number of features or data layers. Discounts are normally available for large purchases. Some of the map vendors also provide navigable databases that include one-way streets, turning restrictions, low overhead heights and other constraints for navigation.

- ESRI provides a Geography Network service that enables users to request and download specific data sets and pay for them on-line. Some of these data sets that may be provided by open-source providers can be accessed free or for only a small fee. The quality of the data is not guaranteed by ESRI, and metadata is provided that indicates the source, accuracy, and currency of the data.

Most commercial vendors place restrictions on the use of their digital data sets beyond in-house purposes. This includes publishing of the data on the internet.

The Geographic Information System (GIS) and Global Positioning System (GPS) are complementary technologies that help to expand potential applications related to commercial vehicle tracking and routing. Emergency medical services, police patrols, armored trucks,

dial-a-ride public transit services, school bus routing, taxi cabs and limos, airport shuttle as well as express deliveries can all take advantage of GIS and GPS technology for cost-effective fleet monitoring and dispatch. GIS data are mostly likely available from dispatch centers for the above services.

The following related GIS data can be obtained from public sources for the use of this study. ESRI has released 2000 Tiger layers of school districts for elementary, middle, secondary, and unified boundaries. These are polygon shapefiles covering the whole nation. The integration of school district boundary files with information regarding bus routes, schedules, events, school locations can be highly useful for school bus trip studies. There is also a NTAD Public Use Airport GIS layer for the locations of all public airports in the nation, 2001. It can be used for airport shuttle service studies. There are also various GIS utility layers available for Pipelines, Water Supply, Sewers, Storm Drains, Utility Lines, Electric Power Industry throughout the whole nation. Local GIS coverages can be obtained from state or county GIS data clearance centers. For example, the Wake County of North Carolina published their Fire District Police Stations GIS layers in 2001.

4.0 Modeling Approaches

4.1 Overview

The vast majority of modeling approaches for commercial vehicles has focused on urban freight distribution and to a lesser degree on non-goods movement truck movements, including all other trucks not carrying goods. There are a few state of the practice models for school buses, airport shuttles and taxis, as described in Section 2.0, but these methods focus on the modal choice aspects of this demand rather than the impacts of these vehicles on congestion or air quality. Truck models have often been developed directly to support air quality studies so they are more likely to evaluate impacts on congestion and air quality.

Modeling approaches that are specific to one category of commercial vehicle are described in Section 5.0 as part of the literature review for individual categories. The remainder of this section discusses the various modeling approaches for urban goods movement models and non-goods movement truck models that have been under development in recent years. We also discuss the geospatial aspects of these studies and the integration of urban truck models and GIS.

4.2 Urban Freight Models

Several years ago, Cambridge Systematics developed the FHWA *Quick Response Freight Manual* for use by state DOTs and MPOs in estimating truck trip tables and predicting truck flows. The manual was designed to provide simplified techniques and parameters to develop urban truck models. The manual provides background information on the freight transportation system and factors affecting freight demand; guidance to help planners locate and apply data and freight-related forecasts; sample techniques and transferable parameters that can be used to develop commercial vehicle trip tables; and techniques and transferable parameters for site planning. The manual also identifies alternative analytical methodologies and data collection techniques in order to improve the accuracy of the freight analysis and planning process.

In 1999, a recent Jack Faucett report establishes an approach for a suite of modeling tools to estimate freight demand. This approach included specifications for destination choice, mode choice and route choice models. The approach identified specific areas of innovation over the current state of the practice, as follows:

- Trip purposes should be used to separate goods movement trips (primary, distribution and trans-modal shipments) and non-goods movement trips (including parcel and mail delivery, service, repair and utility trucks);

- Destination choice models should link origins and destinations in commodity flow databases with economic input-output models;

- Multi-stop distribution trips should be modeled separately; and

- Simplified tools for multimodal tradeoffs should be used in urban area models.

The treatment of light trucks (non-goods movement) in this approach is based on current state of the practice vehicle-based methods and does not offer any innovations, but the model design for heavy trucks (goods movement) offers new methods that may prove relevant for this study.

Boerkamps et al. (2000) discuss the need for behavioral urban freight models that can predict goods flow and vehicle flows and outline a conceptual framework consisting of the markets, actors, and supply chain elements of freight movements. The GoodTrip model (Boerkamps et al., 2000) develops estimates of goods flows, urban freight traffic, and their impact based on logistical chains. In GoodTrip, the logistical chain links activities of consumers, supermarkets, hypermarkets, distribution centers, and producers. The model was used in a case study for the city of Groningen, Holland.

There is also freight research that has used a variety of approaches, including mathematical modeling (Vanek, 2001); econometric methods such as a mixed discrete/continuous choice model of mode and shipment size (Abdelwahab, 1998); a multinomial probit model (Garrido and Mahmassani, 2000); and a variety of network-based approaches (Beuthe et al., 2001) and (Friesz et al., 1998). Faris and Ismart (1999) present a practical and low-cost modeling technique to include freight demand and truck movements in the development of long-range transportation plans for a small to medium urban area.

Some researchers developed gravity type models for urban freight vehicles (List and Turnquist, 1994, He and Crainic, 1998, Gorys and Hausmanis, 1999) and Oppenhiem (1993) developed a combined equilibrium model of urban passenger travel and good movement. Pendyala et al. (2000) provide a synthesis of approaches and the body of knowledge of freight transportation factors; freight travel demand modeling methods; freight transportation planning issues; and freight data needs, deficiencies, and collection methods. Prem & Yu (1995) applied traditional urban transportation planning techniques in a new way to perform detailed analysis of freight movement for the Quad County Regional Transportation Organization in Washington State.

Regan and Garrido (2001) discuss the state of the art and future directions in modeling freight demand and shipper behavior including a section on urban goods movement. Souleyrette et al. (1998) developed a freight planning typology and a layered architecture for freight demand modeling that separately simulates traffic for one commodity at a time. Shankar and Pendyala (2001) propose a comprehensive framework for the modeling of freight demand and discuss the econometric and statistical issues associated with

estimating and applying such a framework. Taniguchi et al. (2002) review the development and application of mathematical computer-based models that have been used in the planning and evaluation of city logistic schemes.

4.3 Geospatial Aspects of Urban Freight Movements

In London (Visser et al., 1996) a disaggregated modeling approach to urban freight transportation was developed to evaluate policy measures on accessibility and environmental amenity (e.g., noise) and includes a decision support system developed in GIS. They characterize the model as a simulation model with GIS. The focus of the modeling activity is on the delivery of mostly consumer goods to retail stores, hotels, and restaurants. Other delivery services such as mail, courier, and waste removal are not included in this study.

There is significant research on the different aspects of logistics in transportation, including dynamic routing and scheduling, latest theory and techniques of logistics in supply chain management, and case studies of the impact of logistics in urban planning (Taniguchi et al., 2001). E. Taniguchi and R.G. Thompson provide an overview of recent advances in modeling city logistics. H. Ieda, A. Kimura, and Y. Yin, report the results of a study on the improvement of home delivery systems and the effect of introducing a new measure in a concentrated high-rise residential area. T. Yamada, E. Taniguchi and Y. Itoh, review the reasons why multi-carrier joint delivery services in urban areas are not popular by employing a gaming simulation of carriers' behavior. The impact of logistics on urban form and particularly the clustering of transportation logistics centers in urban areas is reviewed by K. Button, Konkani, and R. Stough. This raises many challenges for city planners as J. Boerkamps discusses in a conceptual study on urban freight transport policy planning from the viewpoint of logistics.

There is also a collection of papers that is probably the most comprehensive volume on GIS in transportation (Transportation Research, 2000). The volume covers many areas of GIS-T research and issues of urban freight are represented in two papers. Southworth and Peterson, describe the development and application of a single, integrated digital representation of a multimodal and transcontinental freight transportation network in GIS. While not focused on urban areas per se, the paper methods and issues discussed are applicable to urban modeling situations.

Arentze and Timmermans, focus on urban areas in their paper that describes a spatial decision support system for retail plan generation and impact assessment. The paper describes an operational system for integrated land-use and transportation planning called Location Planner. On the supply side, there are location-allocation models to estimate the number of facilities needed to serve the neighborhoods. The models are specified as spatial consumer choice models but by extension can indicate the concentration of retail outlets in future planning scenarios.

5.0 Literature by Vehicle Type

5.1 Overview

The literature review was completed separately for each of 13 different types of commercial vehicles. In most cases, this resulted in more information on these types of vehicles than could be found by searching for categories of commercial vehicles. In the case of most types of trucks, the literature was considerably more robust for larger categories of vehicles (all trucks) or for trucks by weight class (light, medium, and heavy). Most of this literature has been discussed in Section 4.0.

Some of the individual methods and data sources identified in this section have been discussed as part of the review of state of the practice models, data sources or modeling methods. They have also been included here where they are relevant to the individual types of commercial vehicle models.

5.2 School Buses

Home-based school travel is a major cause of traffic congestion. An estimated 20 to 25 percent of traffic in the a.m. peak period on local streets and roads is attributable to school commute trips (STPP, 2000). Effective school bus services will prevent parents from driving their children to school and clogging local roadways during critical peak hours.

There are several useful data sources for school bus trips. The National Highway Traffic Safety Administration (NHTSA, 2002) publishes national statistics on public school buses that are widely cited in school bus literature. The California Air Resource Board (CARB, 1995) estimated the statewide school bus population and vehicle miles traveled by counties as part of its air quality model. Schoolbusfleet.com is an information service of School Bus Fleet magazine. Each year, it conducts a school district survey and a school bus contractor survey, reporting school bus fleet size and passenger load size for top 100 school districts and top 50 school bus contractors. It also reports the number of pupils being transported by school buses and the total route mileage of school buses for each state (SBF, 2002). Another source is the Department of Education for individual states, which usually has a web page with data on school bus numbers and ridership. For example, the Department of Education for the state of Maine[1] reported annual data

[1] http://www.state.me.us/education/const/ed5462001.htm

regarding district-level school bus fleets including the number of buses as well as miles traveled in its school administrative units.

Home-based school is often modeled as a trip purpose for travel demand models in urban areas. However, there are different transportation modes for school trips. The treatment of school bus as a mode choice is complicated because representation of school bus routing and district definition and associated limitations would entail a substantial amount of data collection and network coding; it is also quite difficult to predict the provision of such service and its parameters in the future (PB and Urban Analytics, 1998). Development of school bus vehicle trip movements is taken from survey data and simply growth factored to the future; and there is no origin-destination-specific info on school bus trips. Pima Association of Governments, Arizona (2001) provides summary statistics describing the anticipated growth school bus travel demand for it metropolitan area, where typical weekday school bus trips are expected to increase by approximately 45 percent between 2000 and 2025. There are regional variations for the growth trend of school buses. Purvis (1994) compared results from a 1990 household travel survey to results from surveys conducted in 1965 and 1981, concluding a decline in school bus trips in the San Francisco Bay Area.

5.3 Fixed Shuttle Services

Airport shuttles and commuter vanpools are the major types with a number of available literatures in the category of fixed shuttle service. These modes offer the important benefits of cutting back travel cost and are highly significant for relieving the spatial and temporal distribution of traffic by reducing vehicle trips in heavy traffic zones (such as airports) or reducing rush-hour commute traffic.

Airport shuttle van has emerged as an important transit service competing with demand-responsive, door-to-door shared-ride service to and from airports at nearly half the price. A comparison study of six cities airport ground access is provided in *Intermodal Ground Access to Airports: A Planning Guide* (Bellomo-McGee, 1996). Poole and Griffin (1994) examined the success of airport shuttle services in Los Angeles airport, a pioneer on airport van transit service. Their study provided comprehensive data on the magnitude and distribution of airport shuttle trips in comparison with private automobiles, based on which they calculated the number of autos and auto trips that shuttle vans substituted for. The Office of Transportation Technology, Department of Energy (2000) conducted surveys of shuttle services in major airports, including the Baltimore/Washington International Airport, Dulles International Airport, Reagan National Airport, and Philadelphia International Airport. The annual airline passenger flow data and the magnitude of airport shuttle trips were reported for each airport; but no further data regarding the distribution of trips were collected. There are several studies on airport access model that treats airport shuttle as an access mode to airports. An Airport Passenger Ground Access Model is developed for Sacramento Regional Transit District (DKS-2002) for trips to and from the Sacramento International Airport. Instead of modeling airport as a special trip

generator, airport trips are modeled as a unique trip purpose with its own generation, distribution, and time of travel characteristics. Another airport access model was developed by Cambridge Systematics (1998) for the Portland International Airport based on a set of two passenger surveys that primarily intended as a source for estimation of improved access mode choice and origin probability models.

Vanpooling is also a fixed-route transportation mode using commercial vehicles to carry passengers. Pratt (2000) provided an in-depth analysis on vanpool programs. He presented highly useful data on the characteristics of vanpool trips. He also describes several successful vanpool programs such as the 3M Company Employer-Based Vanpool Program, Golden Gate Vanpool Transportation Demonstration Project, Connecticut's Easy Street Vanpool Program and Pace Vanpool and Subscription Bus Programs in Suburban Chicago. The Puget Sound Region in the state of Washington leads the nation in vanpooling, providing 40 percent of the nation's public vanpools. The Washington State Department of Transportation (2000) conducted a vanpool market study to identify the market characteristics and conditions that contribute to the region's success in vanpool programs. The study assessed existing market share, based on which it projected the future growth opportunities for vanpooling. Cambridge Systematics, Inc. (2002) developed a vanpool model for Puget Sound Regional Council (PSRC) based on a vanpool survey database. The model was used to determine the auto and transit modes from which vanpoolers will shift when new vanpool services are provided. A similar vanpool model was developed by Koppelman et al. (2002) to estimate commuter behavior and future ride sharing intention based on state-preference survey data using a sample of commuters employed in the suburban Chicago area.

5.4 Private Transportation Services

In general, there is quite a lot of literature regarding different aspects of taxis, however most of it is from Western Europe and other non-United States developed countries (Canada and Australia). There is a significant amount of research on the economics of taxi and demand-related issues, primarily on the effects of deregulation of taxis in different places on supply and demand. They are indirectly related to demand, with specific references to policy actions and in some cases include the effects of taxi fare on demand and supply.

There is also a lot of literature on demand responsive transport service using taxis. Most of this literature deals more with the supply side providing ideas and approaches for better utilization than with the demand to such system, but some of them address demand issues. In this regard, there is also a fair amount of literature on ITS and its contribution to taxi service, and on innovative approaches to increase taxi efficiency. Another group of references that have some relevance are mode choice models that include some treatment of taxis.

The best sources regarding taxis are the *Taxi and Livery Statistics* and *Taxi Travel and the 1995 Nationwide Personal Transportation Survey*. However, these do not provide models or methods for estimation. The Hong Kong paper by Yang et al. (2000) is probably the best example for a methodology approach to forecast taxi demand suggesting a simultaneous equation system of passenger demand, taxi utilization and level of service and present the important variables in the models including number of taxis utilized, taxi fare, disposal income. Data from New York City show 80-105 million empty taxi miles annually and a range of $1.02-$1.25 revenue per mile. Gilbert et al. (2002) provide data from few cities regarding the utilization levels of different private transportation systems.

5.5 Paratransit and Social Services

The *APTA Transit Vehicle Data Book* provides data on demand responsive service for many cities. Data include vehicle type and number of vehicles for each agency. However, the only cost item provided is the amount paid to the manufacturer per vehicle. Other than the number of vehicles and their type, there is no data on the level of usage.

The *APTA Public Transportation Fact Book* includes data on operational levels and additional data regarding paratransit usage. For 1999, it reports 100 million unlinked passenger trips, 813 million passenger miles, an average unlinked trip length of 8.1 miles, 718 million of operated vehicles miles, 48 million of vehicle hours, 608 million of vehicle revenue miles and 41 million of vehicle revenue hours. A case study from Charlottesville, VA (Fitzgerald et al., 2000) utilized data from Section 15 and from the local paratransit provider and show an average of 5.02 paratransit trips per month in the city.

The literature regarding paratransit services either discusses some current paratransit systems (see for example Kuimil et al., 1999), reports on the results of a survey of para-transit operators (see for example the report by East-West Gateway Coordinating Council, 1996) or reports on a survey of customers (see for example Densor, 1997). Finally, there is a lot of literature with the logistics operation of paratransit dealing more with the supply side, however as they provide algorithms to better supply the demand they have some relevance to demand as well (see for example Fu, 2002 a and b). However, most of this literature is not relevant to our study.

None of the literature found describe models to support estimate of paratransit vehicles and/or usage, except the Florida one (Stasiak et al., 1998). (Note the full text of this source has not been obtained yet.)

5.6 Rental Cars

There are very limited data available on rental cars. A rental car survey was conducted for the RIAC garage near the T.F. Green airport in Rhode Island. It provided useful data

on annual car rentals, average daily rentals, and maximum daily rental by different rental companies. Forecasts for 2005, 2010, and 2020 were also available in the T.F. Green airport master plan (Landrum & Brown, Inc, 2002). District Five of Florida Department of Transportation (1999) has conducted a rental car survey to obtain data necessary for the development of generation rates for tourist and visitors to enhance the Florida Standard Urban Transportation Model Structure models. Since there are a lot of rental companies located in or near airport, a promising source of rental car data is airport rental car revenue reports. For example, Palm Beach airport releases a monthly report on rental car gross revenue and passenger number during September 2001 and October 2002.[2]

In terms of modeling, most airport access models treat driving as one mode, without distinguishing the difference between driving with a rental car or a driver-owned car. However, the Airport Passenger Ground Access Model for Sacramento's Downtown/ Natomas/Airport Corridor is an exception (Sacramento Regional Transit District, 2002). In this model, driving with a rental car is modeled as a separate mode along five other airport access modes including drive and park. Renting cost, time to/from the terminal, in-vehicle time and as well as parking cost at destination are the attributes being modeled for the rental car mode.

5.7 Fixed-Route Package and Mail Delivery

Some of the literature discusses trends in different areas; however most of these are not from United States sources. Some discuss the problems, planning implications and general trends in urban freight related to some level to delivery services.

There is a lot of theoretical work on the supply side including different routing problems that are of great relevance to delivery services but are not relevant for this study. A lot of these articles deal with routing optimization for delivery services and algorithms for handling issues related to the traveling salesman and the Chinese postman. There is also a new and increasing literature about the effect of e-commerce on freight. Some of this literature also partially addresses the delivery industry.

Morlok et al. (2000) reviewed the revenues and goods delivered by the different major delivery companies in the United States. In 1997, the four carriers that account for well over 90 percent of the United States parcel activity – Airborne, Federal Express (FedEx), United Parcel Service (UPS), and the U.S. Postal Service – had $37.9 billion in transportation revenue. In the U.S. DOT 1977 Commodity Flow Survey, only 3.2 percent of the value of goods shipped went via parcel carriers. But by the latest survey, in 1997, that percentage had grown to 12.3 percent. The survey in 1977 was far less comprehensive than the more recent survey, so it probably overstated the relative importance of parcel carriers.

[2] www.pbia.org/news.htm

There are also a lot of articles about FedEx and UPS in newspaper-type journals like "traffic word" and "American shipper" that existing databases do not provide abstracts for.

5.8 On-Demand Urban Freight Distribution

On-demand urban freight distribution from warehouses to various businesses and consumers has become increasingly competitive in terms of delivery times. As a result of this, urban freight flows to, from, and within an urban area has increased exponentially causing more congestion, and air and noise pollution. This has led to the centralization of warehouses increasing transportation distances. However, in order to improve logistical performance, a better freight transportation system needs to be developed to increase shipment frequencies and handle smaller shipment sizes that usually lead to an increase in the number of stops per hour.

Most evaluations and economic assessments of transportation proposals and policies omit a valuation of the time spent in transit for individual items or loads of freight. Knowing about delays, and indeed the practical value of reliability, is useful to shippers and receivers, but this information does not necessarily appear directly in vehicle operating costs and person travel times. As a result, benefits generated by improvements from road investment and traffic management may be understated, and expenditure decisions may be biased towards passenger movements. In order to capture the transit time, an Australian survey of freight shippers was used along with stated preference methods and multinomial logit models to estimate the value of such factors. The estimated value of $1.40 per hour per pallet for metropolitan multi-drop freight services, potentially a substantial value not currently tracked consistently or utilized in transport evaluation procedures in Australia, illustrates the significance of these results (Wigan, 1999).

The 2003 AirCargo World, an online commonwealth business media publication, provides information on warehouses at airports in the United States that store air cargo shipments (Air Cargo World, 2003). The information useful in deriving the magnitude of warehouse delivery commercial vehicles is the warehouse space in square feet, and tonnage of shipment handled in tons on an annual basis.

In a recent study in the Netherlands, a new approach for modeling and evaluation of urban goods distribution called the 'GoodTrip' was developed that estimates good flows, urban freight traffic and its impacts (Boerkamps, 2000). In this model, the logistical chain links activities of consumers, supermarkets, hypermarkets, distribution centers and producers. Based on consumer demand, the GoodTrip model calculates the volume per goods type in every zone. The goods flows in the logistical chain are determined by the spatial distribution of activities and the market shares of each activity type – consumer, supermarket, hypermarket, distribution center, etc. This attraction constraint calculation starts with consumers and ends at the producers or at the city borders. A vehicle loading algorithm then assigns the goods flows to vehicles. A shortest route algorithm assigns all tours of each transportation mode to the corresponding infrastructure networks. This

results in logistical indicators, vehicle mileage, network loads, emissions, and finally energy use of urban freight distribution.

5.9 On-Demand Package Delivery

The magnitude and distribution of commercial vehicles involved in on-demand product and package delivery is often triggered by tele-shopping or e-commerce. Tele-shopping or shopping on-line has led to the rapid growth in the e-commerce industry for business-to-business (B2B) and business-to-consumer (B2C) transactions. This in turn lead to more sources of product supply and more package delivery with an emphasis on fast, guaranteed delivery that leads to trucks carrying only partial loads. Also an increase in computerized logistics has paved the way for a variety of goods to be in trucks, warehouses, and stores everywhere.

A recent study (Niles, 2001) indicates that about 32 million households purchased $10 billion worth in goods on-line in the year 2000 in United States. The number of Internet household users was estimated to grow up to 44 million in 2002. Though the volume of Internet shopping is still very small in comparison to $2 trillion dollars of annual retail spending, it is approaching 10 percent of catalog shopping volume where people order by mail or phone. One research firm estimates that online shopping will account for six percent of all United States retail sales in 2003.

A research team from University of Texas, Austin, (Whinston, 2001) investigated the productivity of numerous dot-coms and made a distinction between two types of dot-com companies – digital and physical. Digital dot-coms are Internet-based companies such as Yahoo, EBay and America Online, whose products and services are digital in nature and are delivered directly over the Internet. By contrast, the physical dot-coms sell physical products (e.g., books, CDs, toys) that are shipped to consumers. It was found that nearly 80 percent of the physical dot-coms held and managed inventory, and handled packaging and shipping processes by themselves (B2C), citing customer service excellence as the primary reason. By contrast, the digital products companies manage inventory directly through their websites and related applications and mostly B2B transactions. Some of the vital statistics of typical dot-coms are shown below (Whinston, 2001):

Publicly Traded Digital Dot-Coms: 1998-1999

Variable	1998	1999	Change
Average revenue	$7,658,801	$22,533,672	+194.0%
Average number employees	126	225	+78.0%
Revenue per employee	$60,614	$100,255	+65.0%
Average gross income	$3,574,871	$9,205,196	+157.0%
Gross profit margin	46.7%	40.9%	-5.8%

Publicly Traded Physical Dot-Coms: 1998-1999

Variable	1998	1999	Change
Average revenue	$11,739,416	$48,456,957	+313.0%
Average number employees	129	353	+174.0%
Revenue per employee	$91,003	$137,272	+51.0%
Average gross income	$2,641,952	$10,765,578	+307.0%
Gross profit margin	17.8%	21.0%	+3.2%

The U.S. Census Bureau provides information on a quarterly basis about e-commerce in the United States (U.S. Census, 2002). The nationwide statistics include e-commerce value of shipments in the manufacturing sector, e-commerce sales in the merchant wholesale trade and retail trade, e-commerce revenue in service industries, and e-commerce sales by merchandise line through e-shopping and mail-order.

In order to get an estimate of the number of commercial vehicles that are involved in on-demand package delivery, a set of factors have to be developed to convert e-commerce revenue and sales to trucks. The potential variables that would enter into developing these factors are number of household Internet users in a typical urban area, e-commerce revenue generated per household, and percentage of e-tailing when compared to total retail sales.

5.10 Construction Transport

This category of commercial vehicles is primarily involved in transporting construction equipment and materials to the construction site, and is usually heavy trucks. The magnitude of this class of commercial vehicles in an urban area largely depends on the size and duration of the construction project. For instance, the construction of a multi-storied building will involve transporting large construction equipment as well as huge amounts of building material, whereas, a highway project will most likely include transporting large quantities of material than equipment. The distribution of construction-related commercial vehicles will largely depend on the location of the construction site and the proximity of quarries and warehouses that supply building material.

In a recent diversion dam replacement project in Northern California, the magnitude and directional variation of trips associated with construction of the proposed project was assessed based on an analysis of vehicle trip generation using an estimate of the required construction-related workforce (State Water Resources Control Board, 2002). The construction of the proposed project was expected to occur over an estimated eight-month period with a total construction workforce of 40 workers. The implementation of the proposed project would also generate several daily heavy truck trips for transporting material and equipment over the eight-month construction period. The following table provides an estimate of the total number of construction relation vehicle trips that would be generated by the proposed project:

Construction Vehicle Trip Generation

Vehicle Origin	Distribution of Local Workforce	Average Daily Workforce[a]	Average Daily Vehicle Trips[b]	Daily Peak-Hour Vehicle Trips[c]
Reno				
Construction workers	100%	40	80	40
Heavy trucks	100%	10-20	20-40	3-6
Total	**100%**	**50-60**	**100-120**	**43-46**

[a] Average daily workforce includes 100 percent of the construction workers and an estimate of the average daily number of heavy truck trips generated by the proposed project over the eight-month construction period.

[b] Vehicles and trucks accessing the construction area generate two daily trips (one inbound and one outbound).

[c] Peak-hour trip generation is based on 50 percent of the resultant daily passenger vehicle generation and 15 percent of the daily heavy truck generation.

Assuming a worst-case scenario, the transportation analysis assumes that each of the 40 workers would drive a separate vehicle to the project construction area, making two trips per day or one round trip from home to the construction area and back. Construction equipment and materials deliveries would occur throughout the day. Therefore, construction of the proposed project would result in a total of approximately 100-120 vehicle trips per day on average an estimated 43-46 total vehicle trips per day during the peak a.m. or p.m. period. Additionally, it is estimated that construction-related activities would include the use of several types of equipment including backhoes, scrapers, water trucks, pickup trucks, and front loaders. It is assumed that equipment would be stored on construction area and would not result in a substantial increase in the overall daily project trip generation. Parking for construction personnel and visitors would be provided in an area on or adjacent to the project construction area.

The American Road and Transportation Builders Association (ARTBA) publishes a monthly report in ARTBA's Transportation Builder Magazine that highlights price trends, employment data and contract awards for the transportation construction industry at the state-level in the United States (Economics and Research, 2002). The number and value of contracts by state are provided in this magazine for airports, bridges and tunnels, docks, piers and wharves, highways, and railways. It also provides transportation construction contractor employment data by transportation sector and the prices of building materials like concrete and asphalt.

The magnitude of construction equipment delivery commercial vehicles can be derived from the number and value of contracts awarded to various statewide construction projects. Urban area statistics can be estimated by assuming a set of factors per construction contract award in a similar way to the diversion dam replacement project mentioned above. ARTBA provides employment data per construction contract which will give an indication of the workforce needed for the proposed project, and the value of contract awarded will give an estimate of the size and duration of the project. In addition to this, assumptions have to be made in order to convert state-level statistics to a typical urban area.

5.11 Fixed-Route Public Utilities Services

Information regarding public utilities appears either in newspaper articles or in local authorities' web sites regarding their trash collection programs. Numerous local authorities have such web sites; however most of them do not describe the coverage, and the vehicles utilized. They are primarily directed to provide residents with instructions and time of collections. However, some web sites contain information on coverage, frequency of collection and time of collection enabling some estimate of trash collection vehicle utilization. Other public utilities that may be covered in such sites include leaf collection and snow removal. For example, the County of Fairfax currently provides refuse collection

and recycling service to approximately 39,000 residential homes per week; as well as seasonal vacuum leaf collection service to about 18,000 of these residences.[3] The County provides household refuse and recycling collection once a week to homes located in established Sanitary Districts. The County also provides vacuum collection of leaves from the curb three times each season. The City of Columbus Department of Public Service, Refuse Collection Division collects trash from more than 280,000 households.[4] The City uses trucks with mechanical arms to collect trash from 98 percent of residents once a week.

5.12 On-Demand Public Safety Services

This category includes vehicles for Police, Fire, Building Inspections, and Tow Trucks. Providing public safety services has become one of the primary responsibilities of urban governments and most of the vehicles under this category are either owned or managed by them. Many of the sources in this category are related to speed, response time, or shortest route to emergencies, and there are not many articles that estimate vehicle trip rates, vehicle miles of travel, or any other model-related parameters. Thus, we have come across several articles on emergency vehicles routing and route optimizations, and only a very few of them are useful for our study.

Washington State DOT conducted a survey of 5,000 tow truck trips from August 2000 to January 2001 (Nee et al., 2001). This survey includes: 1) Number of motorist contacted, 2) Distribution by time, 3) Distribution by location, 4) Method of detection and notification, 5) Frequency of false alarms, 6) Type of incidents, 7) Lane blockage, and 8) Response time. These data are available and could be used to estimate the tow truck demand in urban area. A theoretical model was developed by Daskin (1984) to estimate the locations, dispatching, and routings for emergency services vehicles. This article formulates a multi-objective model that simultaneously determines the number of vehicles to deploy and their locations, and identifies the appropriate dispatch policy and the routes vehicles should use in traveling to emergency locations.

In Illinois, a linear model was used to estimate the number of police officers required for traffic services (Raub, 1987). The dependent variable in this model was the time annually spent policing and the independent variables were volumes in vehicle miles and population.

There is an efficient routing of service vehicles process using GeoRoute software. GeoRoute is an arc routing software package that includes a route optimization module based on the GENIUS traveling salesman problem heuristic, and many companies

[3] http://www.co.fairfax.va.us/gov/dpwes/trash/collection_cc-main.html

[4] http://refuse.ci.columbus.oh.us/

including USPS use this software for solving their routing optimization problems. The author has used GeoRoute software and optimized routes for garbage collection and for snow plowing operations.

5.13 On-Demand Trades and Services

Plumber, electrician, telephone/cable installation, and repair service vehicles are under the trades and services category. Vehicles under this category are on-demand, service-types and a visible number of them can be seen on urban streets. Although these vehicles make up a small percentage of all vehicles, they have a significant effect on safety, environmental and operations efficiency. In most cases they stop, blocking a lane, and make other drivers slow down. Unfortunately, there were not too many sources for literature available in this category.

Sears and Roebucks hired an outside consultant, AMEC, and conducted a survey in 2001 for their carry-in repair network (Docherty et al., 1999). Sears maintains cost and operational data for their products. AMEC collected and organized these data for analysis. They used GIS to visualize the special distribution of data on product demand, unit repair and unit transport cost. They also used network optimization program SAILS (Strategic Analysis of Integrated Logistics Systems) for this study. SAILS uses a mixed integer linear programmed approach, specially designed to solve large-scale multi-echelon network optimization problems. The echelons for this study are: repair facilities, repair facilities warehouses, cross-deck facilities, and access points.

GeoRoute is a multi-purpose graphical tool for applications requiring a network representation of streets in urban and rural areas (Gendreau et al., 1995). The network requires information about street-to-street connectivity, one-way streets, street types, and illegal turns at intersections. This structure is adapted to routing and scheduling problems for various types of delivery and public works vehicles. GeoRoute links to real-time traffic information and the routing algorithm considers two kinds of costs in calculating the cost of a trip: Drive and Turn. "Drive costs" are based on cost per unit distance of travel. For example, the average speed on a freeway is faster than the average speed on a downtown city street. Turn costs are not directly related to distance, but are based on the turn angle. For example, it typically takes longer to make a U-turn than to bear slightly to the right. GeoRoute is an arc routing software package that includes a route optimization module based on the GENIUS traveling salesman problem heuristic. In addition, GeoRoute can support multimodal transportation routing when it is included in the map-data.

Another method for computer-based routing and scheduling methods to improve the management of daily movements of vehicles and crew in regional service activities were reviewed (Beetle, 1989). Computer software and its application by a major commercial banking institution in Philadelphia have been presented as a case study. At that time the bank deployed about 200 automatic teller machines and the crews of the bank had to visit

all the machines everyday. Computer programs were written and traffic was assigned to the highway network which consisted of nodes and links.

5.14 On-Demand Outside Sales and Services

Under the outside sales and services category, we were looking for literature on realtors, door-to-door sales, and public services relations vehicles. In this category, we also could not find many useful articles.

Jim McLaughlin and Scott Greene (2000) at Los Angeles County Metropolitan Transportation Authority (LAMTA) concentrated on the MTA's role in coordinating health and human services transportation. A list of about 30 public transportation programs is discussed in the article. MTA and Access Services, Inc. (ASI) estimated that 1,300 dedicated vehicles and 1,400 taxis are operated within the County by 200 public and non-profit organizations. In 1999, there were a total of 4,204,270 trips, 6.8 miles trip length, and operating costs equal $62,300,868.

Federal office buildings in Washington, D.C. are typical of many large office complexes, particularly those of state governments. Federal warehouse operations have characteristics similar to those of large distribution centers. Spielberg and Smith (1981) wrote about the results of a survey of goods and service vehicle trips to federal facilities in the Washington metropolitan area. By using a combination of onsite observation and driver interviews, data on arrival and departure times, vehicle characteristics, trip purpose, origin of trips, and nature and size of load were obtained, analyzed, and used to develop planning guidelines.

Appendix A

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Appendix B

Detailed References by Commercial Vehicle Type

Detailed References by Commercial Vehicle Type

Section 5.2	**School Buses (1)**
2. *Title*	*School Bus Crashworthiness Research Report*
3. *Author*	Research and Development, National Highway Traffic Safety Administration (NHTSA)
4. *Year of Study*	April 2002
5. *Source*	http://www-nrd.nhtsa.dot.gov/departments/nrd-11/SchoolBus/SBReportFINAL.pdf
6. *Objective/Purpose*	A report on school bus-related fatalities
7. *General/Literature Review*	
8. *Location/methods/models*	
9. *Type of vehicle or service*	School bus
10. *Magnitude of vehicles/ trip rates*	Every year, the nation's 450,000 public school buses travel more than 4.3 billion miles to transport 23.5 million children to and from school and school-related activities (more than 10 billion student rides annually). It also has data on annual school bus production from 1995-2000, by types (A-D)
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	National-level data
13. *Level of temporal detail*	Year 2002
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This report provides important national-level information regarding the total number of public school bus, travel mileage as well as the total number of riders on an annual basis. The statistics are widely cited in highway fatality studies.

Section 5.2	**School Buses (2)**
2. *Title*	*On-Road Motor Vehicle Activity*
3. *Author*	California Air Resources Board
4. *Year of Study*	1995
5. *Source*	http://www.arb.ca.gov/research/resnotes/notes/95-9.htm
6. *Objective/Purpose*	This work provides data for improving several segments of the database that is used to calculate the Air Resources Board's mobile source emissions inventory:
7. *General/Literature Review*	
8. *Location/methods/models*	Statewide Bureau of Automotive Repair (BAR) Smog Check program data of 1991 (January-December) and 1993 (January-June) were used in conjunction with DMV vehicle registration data to develop county-specific mileage accumulation rates for autos, light-duty vehicles, and medium-duty vehicles; For bus activity, the investigator reviewed publicly available data on, and developed a methodology for, characterization of transit bus fleets and their activity, by county.
9. *Type of vehicle or service*	School bus
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	California Highway Patrol safety inspection data provided the basis for the work on school buses. The statewide school bus population is 23,900. Annual school bus VMT is 317 million statewide or 13,000 per bus. Diesel buses account for a large majority of the statewide school bus population (81 percent) and VMT (84 percent). Gasoline buses account for most of the remaining fleet and vehicle miles traveled. Over half of the statewide bus population is made up of buses over 33,000 pounds GVW and these buses account for more than half the statewide school VMT. For school buses, mileage accumulation rates (MAR) are higher for light heavy-duty buses (16,000 miles per year) than for heavy heavy-duty buses (12,500 miles per year). Contractor school buses exhibit considerably higher MARs (19,000) than either public school buses (13,000) or private school buses (9,200). The median age of contractor buses is considerably less than that of public school buses (4 years versus 11 years). The school bus mileage accumulation rate does not decrease with vehicle age.
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is an example of statewide estimation of school bus fleet size and VMT using highway patrol safety data.

Section 5.2	**School Buses (3)**
2. Title	*SBF's Top 100 School District Fleets of 2002*
3. Author	School Bus Fleet
4. Year of Study	2002
5. Source	http://www.schoolbusfleet.com/STATS/PDF/TOP100_2002.PDF
6. Objective/Purpose	
7. General/Literature Review	
8. Location/methods/models	
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	Bus fleet size and passenger load size for top 100 school districts
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	This article summarizes the top 100 school districts fleet and might be useful for our study.

Section 5.2	**School Buses (4)**
2. Title	*SBF's Top 50 Contractor Fleets of 2002*
3. Author	School Bus Fleet
4. Year of Study	2002
5. Source	http://www.schoolbusfleet.com/STATS/PDF/SBF6TOP50.PDF
6. Objective/Purpose	
7. General/Literature Review	
8. Location/methods/models	
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	Bus fleet size and passenger load size for top 50 school bus contractors
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	This article summarizes the top 50 school districts fleet and might be useful for our study.

Section 5.2	**School Buses (5)**
2. *Title*	*SBF's Annual School District Survey – 2000*
3. *Author*	School Bus Fleet
4. *Year of Study*	2000
5. *Source*	http://www.schoolbusfleet.com/contractor2000.cfm
6. *Objective/Purpose*	
7. *General/Literature Review*	
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Respondents reported that approximately one out of five students who are eligible for transportation choose not to ride the bus. The breakdown of school districts reporting eligible non-riders shows that, of the 218 school districts that responded to this question, about 41 percent (89) reported that 0 to 10 percent of their eligible riders do not take the bus. About 23 percent (50) said that their percentage ranged from 11 to 20 percent. Eleven school districts reported that 50 percent or more of their eligible students did not regularly ride the bus.
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Based on the statistics from this survey, we can estimate the approximate percentage of eligible students who are actually riding school buses

Section 5.2	**School Buses (6)**
2. Title	*2001-2025 Regional Transportation Plan*
3. Author	Pima Association of Governments, Arizona
4. Year of Study	2001
5. Source	http://www.pagnet.org/TPD/RTP/rtp2025/march2001/
6. Objective/Purpose	The transportation plan provides a 25-year vision for a balanced, multimodal, sustainable transportation system for eastern Pima County, including the need for a shuttle to transport school kids
7. General/Literature Review	
8. Location/methods/models	
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	Provides several summary statistics describing the anticipated growth in travel demand (including school bus) for the metropolitan area. Typical Weekday school bus trips are expected to increase from 82,386 to 119,054, approximately 45 percent growth between 2000 and 2025. Trips by automobile are expected to increase from 2.8 to 4.5 million per day, while trips by transit are expected to increase from 65,000 to 108,300 per day.
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	Forecasting to 2025
16. Facility-specific (airport, seaport)	
17. Importance to our study	School bus is a very brief section in this report. However, it provides important information on the growth rate of school bus trip in comparison with other modes

Section 5.2	**School Buses (7)**
2. Title	*Draft Model Specifications for the Houston-Galveston Region*
3. Author	Parsons Brinckerhoff Ltd (PB) in affiliation with Midwest System Sciences, urban Analytics, RSM Services, Inc.
4. Year of Study	1998
5. Source	http://www.hgac.cog.tx.us/transportation/pdfs/travelsurveys/draft_specs.pdf
6. Objective/Purpose	
7. General/Literature Review	The treatment of school bus travel is considerably more complicated and does not easily lend itself to inclusion in the model choice model. Representation of school bus routing and district definition and associated limitations would entail a substantial amount of data collection and network coding. It is also quite difficult to predict the provision of such service and its parameters in the future. Therefore, school bus travel can either be represented by decreasing the person trip matrix by a constant (global) percentage to reflect the absence of school bus trips, or a base year trip matrix could be constructed (with a reasonable level of smoothing at the zonal level) from survey data and used to modify the person trip matrix.
8. Location/methods/models	
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	It provides a brief overview about how school bus trips are accounted for in trip table estimation.

Section 5.3	**Fixed Shuttle Services (1)**
2. *Title*	*Traveler Response to Transportation System Changes, Interim Handbook*
3. *Author*	Richard H. Pratt
4. *Year of Study*	2000
5. *Source*	http://gulliver.trb.org/publications/tcrp/tcrp_webdoc_12.pdf
6. *Objective/Purpose*	
7. *General/Literature Review*	
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Vanpooling was doubling each year in the 1974 to 1980 period, reaching on the order of 15,000 vanpools in the United States. However, with cheaper gasoline and periodic changes in large-employer trip reduction requirements, vanpooling has declined since. In total, there are 8,500 vanpools or more in operation in the United States as of 1998-1999, roughly half of all vanpools are now third-party operated, with the rest split between employer and owner-operator vanpools.
11. *Distribution of vehicles/ trip length/VMT*	Typical vanpooler sacrifices 10 to 12 minutes of travel time compared to driving alone, trading time off against other attributes such as reduced travel cost and stress Vanpooling accounts for 0.2-0.3 percent of all journey to work travel nationally Vanpool mode share increases ranging from 70 percent to a triple tripling of usage have been reported in response to substantial or total fare subsidy All vanpool program trip length averages fall within the range of 26-42 miles one-way (compared to the national average of just over 10 miles for solo auto driver commute trips, and 5 miles for the average unlinked transit trip). Vanpool passengers tend to have socioeconomic profiles more like auto commuters than transit riders
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is the most comprehensive document that provides in-depth analysis on commuters' response to vanpool programs and quantifying vanpooling impacts. It also describes several successful vanpool programs such as the 3M Company Employer-Based Vanpool Program, Golden Gate Vanpool Transportation Demonstration Project, Connecticut's Easy Street Vanpool Program and Pace Vanpool and Subscription Bus Programs in Suburban Chicago

Section 5.3	**Fixed Shuttle Services (2)**
2. *Title*	*PSRC Travel Model Improvement (Draft Report)*
3. *Author*	Cambridge Systematics, Inc
4. *Year of Study*	2002
5. *Source*	
6. *Objective/Purpose*	Develop a vanpool model to determine the auto and transit modes from which the vanpoolers shift when new vanpools are provided.
7. *General/Literature Review*	
8. *Location/methods/models*	Puget Sound Region, Washington
9. *Type of vehicle or service*	Vanpool
10. *Magnitude of vehicles/ trip rates*	The ridership factor (average passenger number for each van) is 7.04 for Kitsap county, 8.56 for Pierce county and 8.63 for Snohomish county
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	The vanpool model was estimated based on a vanpool survey database for King County that has information vanpool service inventory and commuters' prior modes, and vanpool surveys for Kitsap, Pierce and Snohomish counties that have data on vanpool inventory but do not have information on prior modes.
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	In Seattle, travel surveys on existing vanpooling trips and inventories of the vanpool services were used to evaluate vanpool market.

Section 5.3	**Fixed Shuttle Services (3)**
2. *Title*	*Puget Sound Regional Vanpool Market Study*
3. *Author*	Washington State Department of Transportation
4. *Year of Study*	2000
5. *Source*	http://www.wsdot.wa.gov/mobility/TDM/vpexsm.pdf
6. *Objective/Purpose*	To assess the current vanpool market and recommend future growth opportunities for vanpooling in the Puget Sound Region. It identified a number of market characteristics and conditions that contribute to the region's success with vanpooling and produced a new picture of commuter attitudes, behaviors, and potential mode shifts.
7. *General/Literature Review*	
8. *Location/methods/models*	Puget Sound Region
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	This region leads the nation in vanpooling, providing 40% of public vanpools in the nation (with 1250 public vanpools and 200 private vanpools by 1999). There are 2% of commuters now regularly taking advantage of this commute option. For commuters who travel more than 20 miles each way, vanpool has reached a 7% market share (in comparison, transit has a 13% share). Vanpooling has continued to grow steadily ever since. It experienced a growth of more than 60% between 1995 and 1999. Growth in this system has averaged 121 vans and 1200 commuters each year. It is estimated that public vanpools eliminate 11,000 vehicles and 22,000 trips every year; vanpools in the region reduce travel mileage of SOVs by 2.7 million miles annually.
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This article includes important statistics on vanpool market.

Section 5.3	**Fixed Shuttle Services (4)**
2. Title	*Market Research Evaluation of Actions to Reduce Suburban Traffic Congestion: Commuter Travel Behavior and Response to Demand Reduction Actions*
3. Author	F.S. Koppelman, J.L. Schofer, C.R. Bhat and R. Gremley
4. Year of Study	2002
5. Source	
6. Objective/Purpose	A vanpool model was developed to provide information about the effect on vanpool propensity of difference in the proposed services based on state-preference survey data.
7. General/Literature Review	
8. Location/methods/models	Commuter behavior and future ride sharing intentions using a sample of commuters employed in the suburban Chicago area
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	SP survey
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	In Chicago, stated preference surveys of travelers were collected to determine the fleet of proposed vanpool services.

Section 5.4	**Private Transport Services (1)**
2. *Title*	*Elasticities for Taxicab Fares and Service Availability.*
3. *Author*	Schaller, B (Schaller Consulting, USA)
4. *Year of Study*	1999
5. *Source*	TRANSPORTATION. 1999/08. 26(3) pp. 283-97 (8 Refs.)
6. *Objective/Purpose*	Examine the effects of taxi fare increases on trip demand and the availability of taxi service
7. *General/Literature Review*	The paper mentioned a 1978 study funded by the U.S. DOT sought to estimate fare elasticities in 24 cities using time series data for periods that encompassed a fare increase and a 1990 cross section study of 26 Canadian cities.
8. *Location/methods/models*	New York City Regression models are developed for fares, fare revenue and cab availability measured by total taxi industry mileage operated without passengers. Revenue per mile can be used to estimate empty taxi rides. Some what if scenarios are simulated using the estimated models.
9. *Type of vehicle or service*	Taxi
10. *Magnitude of vehicles/ trip rates*	The elasticity of trip demand with respect to fares is estimated to be -0.22; the elasticity of service availability with respect to the taxi fare is 0.28; and the elasticity of service availability with respect to total supply of service is near 1.0.
11. *Distribution of vehicles/ trip length/VMT*	Provide trends during the years, but in percentage changes from year to year. Provide figures for adjusted revenue per mile that vary from $1.02 to $1.25 during these years. Total empty taxi miles vary from 80-105 Million during these years.
12. *Level of special detail*	
13. *Level of temporal detail*	Taximeter and odometer reading were available from 1990 to 1996 (3 data points per year per taxi)
14. *Data sources*	A unique time series dataset from New York City including fare revenue and service availability. Fare revenue and service availability are estimated from taximeter and odometer readings gathered during taxicabs inspections (each cab is inspected 3 times a year) A total of 89,000 data points
15. *If forecasts are included*	Only estimates to compare with actual including some what if scenarios. No future year forecasts are available.
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	The model for total taxi industry mileage operated without passengers can be very useful to cover the empty taxi rides. The paper provides the important variables to model taxi revenue per mile (economic activity, taxi fare, transit fare) (can provide estimate of passenger miles) and taxi empty trips (economic activity, taxi fare, supply)

Section 5.4	**Private Transport Services (2)**
2. Title	*A macroscopic Taxi Model for Passenger Demand, Taxi Utilization and Level of Services*
3. Author	Hai Yang, Yan Wing Lau, Sze Chun Wong, Hong Kam Lo
4. Year of Study	2000
5. Source	Transportation, 27(3): 317-340,
6. Objective/Purpose	Develops a simultaneous equation system of passenger demand, ***taxi*** utilization, and level of services based on a ***taxi*** service situation found in the urban area of Hong Kong over the last 10 years.
7. General/Literature Review	A set of variables is introduced including number of licensed ***taxis***, ***taxi*** fare, disposable income, occupied ***taxi*** journey time as exogenous variables and daily ***taxi*** passenger demand, passenger waiting time, ***taxi*** availability, ***taxi*** utilization and average ***taxi*** waiting time as endogenous variables.
8. Location/methods/models	Hong Kong, The different variables are coupled together through a system of nonlinear simultaneous equations whose parameters are estimated from survey data. Models are developed for: passenger waiting time, percentage of occupied taxis, vacant taxi headway, daily taxi passenger trips, and taxi waiting time.
9. Type of vehicle or service	Taxi
10. Magnitude of vehicles/ trip rates	From overseas so not of interest, however in Hong Kong 15250 urban taxis carry more than one million trips per day. In some areas of Hong Kong taxis form about 25% to 60% of the traffic stream overall.
11. Distribution of vehicles/ trip length/VMT	
12. Level of special detail	
13. Level of temporal detail	Every minute between 7:00 a.m. and 7:00 p.m. on weekdays.
14. Data sources	Roadside observations surveys and taxi stand surveys are conducted yearly gathering information regarding passenger/taxi waiting time at operative taxi stands and percentage of occupied/vacant taxis and taxi headway on some major selected road locations.
15. If forecasts are included	Predicts level of taxi service and conduct sensitivity analysis for the introduction of any new taxi policies. Forecasts are made for the years 86-95 to compare with observed data. Forecasts are made for different policy variables
16. Facility-specific (airport, seaport)	
17. Importance to our study	This is from overseas but methodological relevant, and also provides the important variables for modeling taxi.

Section 5.4	**Private Transport Services (3)**
2. *Title*	*The Role of the Private-for-Hire Vehicle Industry in Public Transit,*
3. *Author*	Gilbert, G., Cook, T., Nalevanko A., and Everett-Lee, L.
4. *Year of Study*	2002
5. *Source*	TCRP Report 75, TRB,
6. *Objective/Purpose*	To compile relevant information on the private-for-hire (PHV) industry and how it can best be incorporated into public transportation services and to engage the PHV and transit industries in the consideration of service collaboration.
7. *General/Literature Review*	The report include 1) definitions of the nature and scope of the PHV industry; 2) description of the salient characteristics of the industry; 3) provision of whatever information is available on these salient characteristics. There is a literature review mentioning among others a 1981 and 1986 national taxicab survey. Include some relevant statistics about the type of service provided and coverage. The second part of the report present a more detailed case study of 8 urban areas.
8. *Location/methods/models*	National. Detailed case studies from: Ann Arbor, DuPage County, IL; Huston, Los Angeles, Montgomery County, MD., Portland, Seattle and the Wisconsin State.
9. *Type of vehicle or service*	Taxicabs, shuttles, limousines, and jitneys
10. *Magnitude of vehicles/ trip rates*	The survey included 29,551 sedans, 2,788 mini-vans, 3,948 vans, 1078 mini buses, and 1,494 buses. Examples from the case studies: Ann-Arbor average annual one-way trips: ADA Paratransit – 39,000 night rides, guaranteed ride home – 147,700. Los Angeles – ADA paratransit: 1.7 million trips There are such data to all 8 case studies. Data also includes passengers per service hour, average weekday ridership, and some financial data.
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	Provide only general statistics
14. *Data sources*	A national survey of PHV. 677 PHV operators responded to the survey (only a 5.6% response rate)
15. *If forecasts are included*	No
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	The report and the literature review have some relevant statistic.

Section 5.4	**Private Transport Services (4)**
2. *Title*	*Taxi and Livery Statistics* and *Taxi Travel and the 1995 Nationwide Personal Transportation Survey*
3. *Author*	Webster, A.L.
4. *Year of Study*	1997
5. *Source*	http://www.geocities.com/CapitolHill/Congress/6777/taxi.html and http://www.geocities.com/CapitolHill/Congress/6777/npts95.pdf (only introduction and table of contents are available on line)
6. *Objective/Purpose*	Present statistics on taxi cab usage nationwide
7. *General/Literature Review*	Include many statistical data about taxis in the United States.
8. *Location/methods/models*	Nationwide
9. *Type of vehicle or service*	Taxicabs
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	Various sources. The second report is based mostly on analysis of the 1995 NTPS.
15. *If forecasts are included*	No
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	There is relevant statistics. We should obtain the reports.

Section 5.5	**Paratransit and Social Services (1)**
2. *Title*	*The effect of education programs on paratransit demand of people with disabilities.*
3. *Author*	Fitzgerald, J., Shaunesey, D. and Stern, S.
4. *Year of Study*	2000
5. *Source*	*Transportation Research Part A: Policy and Practice,* 34, 261-285.
6. *Objective/Purpose*	Describe a passenger education program to encourage responsible use of paratransit by people with disabilities, evaluate the effects of the education program and to provide some cost/benefit analysis of it. However, it includes some interesting statistics.
7. *General/Literature Review*	Includes some data and general trends of paratransit services for people with disabilities in different areas from the United States.
8. *Location/methods/models*	Charlottesville, VA. An econometric model for number of trips as a count data model where the number of trips in month t for person I, is modeled as a Poisson random variable.
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Average number of trips per month is 5.02 with high variance.
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	Data are available from May 97 to April 98. The analysis is monthly.
14. *Data sources*	From FTA Section 15, included are data from 209 demand response systems located in cities of no more than 400,000 people. Other data used in the analysis include: 1) the local paratransit provider administrative records providing information on each trip taken providing information of trips taken per month and characteristics of the individual taking trips; 2) Charlottesville Transit Service administrative records including information on each person applying for the paratransit service.
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Provide some data on paratransit usage from a United States city.

Section 5.5	**Paratransit and Social Services (2)**
2. Title	*Paratransit Productivity Enhancement Trough Service Simulation Phase II Report: Model Development.*
3. Author	Stasiak-RT; Turner-PA; Pendyala-R; Polzin-SE
4. Year of Study	1998
5. Source	Florida Department of Transportation, Office of Research, P.O. Box 1029, Gainesville, FL, 32602, USA
6. Objective/Purpose	develop a simulation capability to be used to evaluate various paratransit service delivery and characteristics and policies
7. General/Literature Review	A number of demographic, socioeconomic, technical, and institutional trends have increased public attention paid to paratransit services. This has spurred a great deal of interest in determining how to effectively and efficiently serve this growing market. The genesis of the research stems from an earlier effort to identify literature addressing the theoretical maximum productivity of paratransit operations in a given demographic environment. Virtually no operations research or simulation work that addressed this topic was found in the literature or known to experts that were contacted. It became obvious that no systematic evaluation of paratransit productivity issues had ever been carried out using an urban simulation model or optimization approach. Thus, this research effort was undertaken to develop such a capability through a multi-step process involving an urban land use and transportation network, a paratransit trip generation model, and a service delivery model consisting of a vehicle dispatching algorithm. The overall framework was modeled after the simulation efforts common in the 1970s that used network simulation models to test various urban forms and fixed route transit delivery scenarios to evaluate energy efficiency and productivity.
8. Location/methods/models	Florida Simulation
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	Need to get the full text to finalize

Section 5.5	**Paratransit and Social Services (3)**
2. *Title*	*Social Service Transportation Assets in the St. Louis, Missouri Area*
3. *Author*	East-West Gateway Coordinating Council
4. *Year of Study*	1996
5. *Source*	ftp://ftp.ewgateway.org/library/sst.pdf
6. *Objective/Purpose*	This is a survey of paratransit operators in the St. Louis, Missouri Area, providing statistics about their assets and trips provided.
7. *General/Literature Review*	
8. *Location/methods/models*	St. Louis, Missouri
9. *Type of vehicle or service*	29 different agencies including transportation only service, transportation as key service, and transportation as support service. Type of services included are: Elderly/persons with disabilities, prescribed day care, and medical trips.
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	For 1995, 431 vehicles were surveyed, making 1,764,588 trips (annual data), 1,589,077 vehicles hours, with average of 1.11 trips per vehicle hour, and 341 monthly trips per vehicle. Some additional data based on the 29 agencies that responded to the questionnaire: Total monthly one-way trips (unreported by 5 agencies): 147,049 Lowest monthly trip level reported: 36 Highest monthly trip level reported: 765 The data are further break down by type of providers.
12. *Level of special detail*	
13. *Level of temporal detail*	Data are provided only at annual and monthly levels.
14. *Data sources*	Survey of operators including the purpose for which transportation was provided, service area, service hours, unused vehicle miles, rider eligibility, type of service, fees/fares, trip frequency, operating and capital budget and more.
15. *If forecasts are included*	No
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Present some actual data of paratransit services that may be of interest.

Section 5.5	**Paratransit and Social Services (4)**
2. *Title*	*APTA 2001 Public Transportation Fact Book*
3. *Author*	APTA
4. *Year of Study*	2001
5. *Source*	52nd edition, produced by Member Service Department, Information Services Group
6. *Objective/Purpose*	Provides national-level transit data. The data include demand responsive services.
7. *General/Literature Review*	
8. *Location/methods/models*	Nationwide
9. *Type of vehicle or service*	Information on buses and vans
10. *Magnitude of vehicles/ trip rates*	Data for 1999: Operating expense (table 25): 1420 Million dollars Unlinked passenger trips (Table 26) 100 million Active passenger vehicles 31,800
11. *Distribution of vehicles/ trip length/VMT*	Data for 1999: Passenger miles (table 30): 813 million Average unlinked trip length (table 39): 8.1 miles Vehicles miles operated (table 42): 718 million Vehicles hours (Table 43): 48 million Vehicle revenue miles (Table 45) 608 million Vehicle revenue hours (Table 45) 41 millions
12. *Level of special detail*	
13. *Level of temporal detail*	Data are provided only at annual levels.
14. *Data sources*	Various sources from DOT, FTA, and APTA surveys.
15. *If forecasts are included*	No
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Present some actual data of paratransit services that may be of interest.

Section 5.5	**Paratransit and Social Services (5)**
2. Title	*Fact Book 2002 – Paratransit and Contracting Division*
3. Author	Taxicab, Limousine and Paratransit Association
4. Year of Study	2002
5. Source	
6. Objective/Purpose	Present facts regarding paratransit
7 General/Literature Review	No literature review
8. Location/methods/models	Nationwide, based on a questionnaire of 23 members of the paratransit and contracting division
9. Type of vehicle or service	Sedan, van, and minibus. Show distribution of revenue by services, the largest is medical (34.7%) followed by transit agencies (17.7%) and city/ county (15.4%), other social services (11%) and private health care (9.5% in addition to the medical).
10. Magnitude of vehicles/ trip rates	Average annual mile per vehicle 36,563, annual hours per vehicle 2,124 (this info is also available by type of vehicle: sedan, van and minibus)
11. Distribution of vehicles/ trip length/VMT	Average trip length 8.71 miles and 0.7 hours. (This info is also available by type of vehicle: sedan, van, and minibus.)
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	Questionnaire of 23 members of the paratransit and contracting division
15. If forecasts are included	No
16. Facility specific (airport, seaport)	
17. Importance to our study	Show relevant statistics. There is more statistics in the reports.

Section 5.5	**Paratransit and Social Services (6)**
2. Title	*Fact Book 2002 – Limousine and Sedan Division*
3. Author	Taxicab, Limousine and Paratransit Association
4. Year of Study	2002
5. Source	
6. Objective/Purpose	Present facts regarding limousine and sedan services.
7. General/Literature Review	No literature review
8. Location/methods/models	Nationwide, based on a questionnaire of 34 members of the Limousine and Sedan division
9. Type of vehicle or service	Sedans, limousine, passenger vans, mini coach, and buses. Show distribution of revenue by services, the largest is airport transfers (55.4%) followed by other (16%) and hotel/resort (9.1%), nights on the town (9%) and weddings (6.6%).
10. Magnitude of vehicles/ trip rates	Average annual mile per vehicle vary by type of vehicle (sedans 54,194, vans 23,000-39,000, etc. Average number of trips per week by vehicle type (sedans- 44, vans 4-19, Limo- 2-15, bus – 7.
11. Distribution of vehicles/ trip length/VMT	Average minimum number of hours per booking vary by type of vehicle (sedans 1.7 hrs, limo 2.9-3.3 hrs, vans 2.5-3 hrs, bus 4.8 hrs)
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	Questionnaire of 34 members of the Limousine and Sedan division
15. If forecasts are included	No
16. Facility specific (airport, seaport)	
17. Importance to our study	Show relevant statistics. There is more statistics in the reports.

Section 5.5	**Paratransit and Social Services (7)**
2. Title	*Fact Book 2002 – Taxicab Division*
3. Author	Taxicab, Limousine and Paratransit Association
4. Year of Study	2002
5. Source	
6. Objective/Purpose	Present facts regarding taxi services.
7. General/Literature Review	No literature review
8. Location/methods/models	Nationwide, based on a questionnaire of 87 members of the Taxi division
9. Type of vehicle or service	Taxi. Show distribution of services by revenue (private individuals 34.8%, private companies 11.4%, airport 10.3%, social service agencies 9.5%, hotel and hospitals 7% each, transit authorities and city/county 6% each.
10. Magnitude of vehicles/ trip rates	Annual miles per taxi 54,214. Annual trips per taxi 6,040. annual passengers per taxi 7,913.
11. Distribution of vehicles/ trip length/VMT	Average distance per taxi trip 5.8 miles. Average passengers per trip 1.31. Average CBD to airport trip 15.5 miles.
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	Questionnaire of 87 members of the taxi division
15. If forecasts are included	No
16. Facility specific (airport, seaport)	
17. Importance to our study	Show relevant statistics. There is more statistics in the reports.

Section 5.6	**Rental Cars (1)**
2. Title	*T.F. Green Airport Master Plan Update*
3. Author	
4. Year of Study	2002
5. Source	
6. Objective/Purpose	There is one section in the master plan update that is about rental car facilities near the airport. The T.F. Green airport master plan intends to consolidate all rental car activities to eliminate the need for shuttle service to off-airport locations, free up garage space in the RIAC garage for passenger parking and reduce on-airport and Post Road rental car traffic.
7. General/Literature Review	
8. Location/methods/models	
9. Type of vehicle or service	Rental cars
10. Magnitude of vehicles/ trip rates	RIAC Rental Car Survey (September 2000) conducted by RIAC garage near the airport. Useful data include rental car needs as provided by rental car companies: 1) annual car rentals, 2) average daily rentals, and 3) maximum daily rental
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	Forecasts for 2000, 2005, 2010 and 2020
16. Facility-specific (airport, seaport)	Airport rental car facilities
17. Importance to our study	It would be very useful to acquire the detailed rental car survey, if it is available.

Section 5.6	**Rental Cars (2)**
2. *Title*	*Regional Study on Tourism/Commuter Trips (a PowerPoint Presentation for Workshop #2)*
3. *Author*	Florida Department of Transportation – District Five
4. *Year of Study*	October, 1999
5. *Source*	www.tei-us.com/tourindex/work2.pdf
6. *Objective/Purpose*	The presentation talked about five types of travel characteristic surveys, including Hotel/Motel Survey, Major Attractions Survey, Airport Survey, Rental Cars Survey, and Roadside Origin/Destination Survey. The objective of the surveys is to provide travel data for the enhancement of Florida DOT, District Five's Florida Standard Urban Transportation Model Structure models, to obtain data necessary for the development of generation rates for tourist, visitors and commuter trips; to obtain statistics necessary for the development of external station data; and to develop data that can be used for other purposes such as tourist/visitor demographic profiles, travel characteristic information and summarize traffic problems.
7. *General/Literature Review*	
8. *Location/methods/models*	
9. *Type of vehicle or service*	Rental cars
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is a workshop presentation talking about the importance of different survey types (including a Rental Car Survey) and how they can be used to improve existing models; but it does not have any real data in the presentation itself. It would be very useful if we can acquire the actual rental car survey method and results.

Section 5.6	**Rental Cars (3)**
2. Title	*Palm Beach International Airport Monthly Rental Car Gross Revenue With Passenger Data*
3. Author	
4. Year of Study	
5. Source	www.pbia.org/news.htm
6. Objective/Purpose	Report monthly rental car gross revenue and passenger for the rental companies located in or near the airport
7. General/Literature Review	
8. Location/methods/models	
9. Type of vehicle or service	Rental cars
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	Monthly report during the period 09/2001-10/2002
14. Data sources	
15. If forecasts are included	No
16. Facility-specific (airport, seaport)	Airport
17. Importance to our study	It gives us a good example of the source for rental car passenger data

Section 5.6	**Rental Cars (4)**
2. Title	*Travel Demand Forecasting: service and patronage impact assessment methodology report. Prepared for Sacramento Regional Transit District*
3. Author	DKS under subcontract to Parsons Brinckerhoff Quade & Douglas, Inc.
4. Year of Study	2002
5. Source	Sacramento Regional Transit District (RT)
6. Objective/Purpose	An Airport Passenger Ground Access Model is developed to estimate the mode-to-airport choice based on a state preference survey.
7. General/Literature Review	
8. Location/methods/models	Location: The model is developed for Sacramento's Downtown/Natomas/Airport (DNA) Corridor. Model: Rental car is one out of six airport access modes being modeled: Drive and park, rental car, get picked up/dropped off, taxi/shuttle van, public transit, and other courtesy van/dedicated hotel van. 1) Renting cost, 2) time to/from the terminal, 3) in-vehicle time, and 4) parking cost at destination are the attributes being modeled for the rental car mode.
9. Type of vehicle or service	
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	State Preference Survey
15. If forecasts are included	
16. Facility-specific (airport, seaport)	
17. Importance to our study	Most airport access models treat driving as one mode, without distinguishing the difference between driving with a rental car or a driver-owned car. The airport access model driving with a rental car as a separate mode with different attributes from the drive and park mode.

Section 5.7	**Fixed-Route Package and Mail Delivery (1)**
2. *Title*	*GoodTrip a New Approach for Modeling and Evaluation of Urban Goods Distribution*
3. *Author*	BOERKAMPS-J (Delft University of Technology, the Netherlands); BINSBERGEN -VAN-A (The Netherlands Research School for Transport, Infrastructure and Logistics, the Netherlands)
4. *Year of Study*	2000
5. *Source*	URBAN TRANSPORT SYSTEMS. PROCEEDINGS FROM THE 2ND KFB RESEARCH CONFERENCE IN LUND, SWEDEN, 7-8 JUNE, 1999 (BULLETIN 187). 2000. (187:01) pp. 229-39
6. *Objective/Purpose*	This paper describes the GoodTrip model that estimates goods flows, urban freight traffic, and its impacts. It is from overseas but with relevant methodology.
7. *General/Literature Review*	This paper discusses the theory and application of the model, which is based on logistical chains. Livability and accessibility of urban areas are influenced by freight traffic resulting from logistical choices in the supply chain, like warehouse location, delivery frequencies, and vehicle type and routing. To support decision-making it is necessary to model these choices and their effects, in current and future situations. GoodTrip is a tool to evaluate different concepts of freight distribution from both a societal as economical viewpoint, by using geographical, economical, and logistical data. Model output discriminates clearly between different alternative freight distribution concepts. The modeling results comply with empirical data and real life experience.
8. *Location/methods/models*	Overseas including a case study for the City of Groninger. In GoodTrip the logistical chain links activities of consumers, supermarkets, hypermarkets, distribution centers and producers. Based on consumer demand, the GoodTrip model calculates the volume per goods type in meters cubed in every zone. The goods flows in the logistical chain are determined by the spatial distribution of activities and the market shares of each activity type – consumer, supermarket, hypermarket, distribution center, etc. This attraction constraint calculation starts with consumers and ends at the producers or at the city borders. A vehicle-loading algorithm then assigns the goods flows to vehicles. A shortest route algorithm assigns all tours of each transportation mode to the corresponding infrastructure networks. These results in logistical indicators, vehicle mileage, network loads, emissions and finally energy use of urban freight distribution
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is an overseas paper but with a methodology that may be of interest.

Section 5.7	**Fixed-Route Package and Mail Delivery (2)**
2. *Title*	*Postal and Delivery Services Delivering on Competition*
3. *Author*	Edited by: Michael A. Crew *Graduate School of Management, Rutgers University, Newark, NJ, USA* Paul R. Kleindorfer *The Wharton School, University of Pennsylvania, Philadelphia, USA*
4. *Year of Study*	2002
5. *Source*	Book Series: *Topics In Regulatory Economics And Policy*, Volume 44 Kluwer Academic Publishers, Boston
6. *Objective/Purpose*	This is a book covering different aspects of postal and delivery services including a chapter on demand analysis in postal services.
7. *General/Literature Review*	This is an indispensable source of information and analysis on the current state of the postal and delivery sector. It offers current insight into strategy, regulation as well as the economics of this sector. Issues addressed include international postal policy, the universal service obligation, regulation, competition, entry, the role of scale and scope economies, the nature and role of cost and demand analysis in postal service, productivity, interaction of law and economics, human resources, transition and reform issues.
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Center for Research in Regulated Industries' (CRRI) 10th Conference on Postal and Delivery Economics held in Potsdam, Germany on June 5-8, 2002 and this book is based on the Conference proceedings. This book might include important statistics on package delivery.

Section 5.7	**Fixed-Route Package and Mail Delivery (3)**
2. *Title*	*The Parcel Service Industry in the U.S.: Its Size and Role in Commerce*
3. *Author*	Morlok-EK; Nitzberg-BF; Balasubramaniamm-K; Sand-ML
4. *Year of Study*	2000
5. *Source*	University of Pennsylvania, Philadelphia, School of Engineering and Applied Science, Mid-Atlantic Universities, Transportation Center; Pennsylvania State University, Research Office Building, University Park, PA, 16802-4710, USA
6. *Objective/Purpose*	This report provides an overview of parcel service industry and its importance to United States commerce.
7. *General/Literature Review*	This report looks at the revenues and goods delivered by the different major delivery companies in the United States. In 1997, the four carriers that account for well over 90% of the United States parcel activity – Airborne, Federal Express (FedEx), United Parcel Service (UPS), and the U.S. Postal Service – had $37.9 billion in transportation revenue. This exceeded the domestic transportation revenue of all major freight modes except trucking. Another way of looking at the size of the parcel industry is to examine the goods it delivers. In the BTS' 1977 Commodity Flow Survey, only 3.2% of the value of goods shipped went via parcel carriers. But by the latest survey, in 1997, that percentage had grown to 12.3%. The authors believe there are fundamentally two reasons why parcel service has become so important in recent years. One consists of changes in the way goods and services are produced and distributed in our economy – globalization, customized mass production, lean inventory management, rapid customer response, and growth in e-commerce, among others. The other is parcel service itself, which is at the vanguard of transportation service modernization with such features as differentiated time-definite service options, intermodal service, in-transit visibility, and data integration with the management systems of customers. Thus parcel service is a major element of the transportation infrastructure of the nation. It is essential for modern commerce. And current trends suggest that parcel service will assume an even more significant role in the future.
8. *Location/methods/models*	The whole country
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	The paper provides statistics about the delivery industry. May be helpful to describe the size of the industry.

Section 5.8	**Urban Freight Distribution (1)**
2. *Title*	*Valuing Long-Haul and Freight Travel Time Reliability*
3. *Author*	Wigan, M., N. Rockliffe, T. Thoresen and D. Tsolakis, Oxford Systematics, Monash University, Australia
4. *Year of Study*	1999
5. *Source*	http://www.bts.gov/publications/jts/v3n3/paper6/6wigan.pdf
6. *Objective/Purpose*	To estimate value of time spent in transit for individual items or loads of freight
7. *General/Literature Review*	Delays during transit time – loading goods into trucks from warehouses Valuation of time lost at transit is important to shippers and receivers which otherwise is not included in the vehicle operating costs and person travel times Paper-based on contextual stated preference methods and MNL models used to estimate the value of such factors from an Australian survey of freight shippers in 1998
8. *Location/methods/models*	1998 Data from survey of freight shippers in Australia; stated preference survey methods; multinomial logit models to estimate value of time
9. *Type of vehicle or service*	Three freight market segments – (a) intercapital freight truck load (FTL) (b) metropolitan FTL (c) metropolitan multi-drop
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	Australian freight shippers
13. *Level of temporal detail*	Annual figures
14. *Data sources*	Stated preference data derived from freight shippers
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Importance of valuation of time spent in transit at warehouses Provides benefits in evaluating accurate freight travel times

Section 5.8	**Urban Freight Distribution (2)**
2. *Title*	*Air Cargo World Online – Commonwealth Business Media Publication*
3. *Author*	Air Cargo World, Washington, D.C.
4. *Year of Study*	2002
5. *Source*	http://www.aircargoworld.com/directories/2003_ad/
6. *Objective/Purpose*	
7. *General/Literature Review*	Provides information of airports across the world for the year 2001 Has information on almost all airports in the USA Information on air cargo in terms of freight tonnage, size of airport warehouses, air cargo traffic Number of carriers and proximity to other modes like rail, road, water
8. *Location/methods/models*	All airports across USA
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Size of warehouses at all airports in the USA (square feet) Cargo space (acres, square feet) Number of air service carriers Traffic and tonnage (tons) Number of aircraft movements Availability of foreign trade zone, special services/facilities, U.S. Customs Distance (in miles) to connecting transportation modes – rail terminal, ocean port, interstate highway, truck terminal
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	2001 Annual figures
14. *Data sources*	Air Cargo freight data at airport warehouses
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	Airports across USA
17. *Importance to our study*	Freight tonnage at all airport warehouses will be useful to derive truck traffic to and from airports Size of warehouses also useful to estimate warehouse truck traffic

Section 5.8	**Urban Freight Distribution (3)**
2. *Title*	*Freight Impacts on Ohio's Roadways – Final Report*
3. *Author*	Cambridge Systematics Inc.
4. *Year of Study*	2002
5. *Source*	http://www.dot.state.oh.us/planning/Studies/Freight/freight_default.htm
6. *Objective/Purpose*	Provide Ohio DOT with a clear picture of existing and future freight movements on Ohio's macro-highway corridors Assess the impact that future changes in the freight system and freight movement may have on Ohio's roadways
7. *General/Literature Review*	Ohio statewide transportation plan – *Access Ohio* Development of a comprehensive, statewide, travel demand forecasting model, which includes a sophisticated freight-planning capabilities
8. *Location/methods/models*	State of Ohio
9. *Type of vehicle or service*	All truck types by weight
10. *Magnitude of vehicles/ trip rates*	Truck flows in tons from, to and through the state of Ohio Truck flows in tons from and to warehouses in Ohio
11. *Distribution of vehicles/ trip length/VMT*	Distribution of truck flows and truck ton flows – inbound, outbound and internally in Ohio Origins and destinations of all truck trips in Ohio
12. *Level of spatial detail*	Freight flows that originate, end and go through the state of Ohio
13. *Level of temporal detail*	Daily and annual truck flows in the year 2000
14. *Data sources*	2000 Reebie TRANSEARCH county-to-county commodity flow database
15. *If forecasts are included*	2010 and 2020 commodity flow forecasts included
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Freight tonnage at warehouses will be useful to derive truck traffic Number of truck trips by weight at warehouses

Section 5.9	**On-Demand Package Delivery (1)**
2. *Title*	*Technology and Transportation – The Dynamic Relationship*
3. *Author*	Niles, J., Discovery Institute, Seattle, WA
4. *Year of Study*	2001
5. *Source*	http://www.discovery.org/articleFiles/PDFs/NilesTelecomReport.pdf
6. *Objective/Purpose*	Impact of telecom on transportation, including travel substitution, travel stimulation, and travel modification Survey and analysis of how telecom affects movement of people and goods
7. *General/Literature Review*	Report discusses how telecom tends to modify the location of homes, businesses, and other generators of activity in the Cascadia corridor (British Columbia, Washington and Oregon)
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	United States Internet users and consumer goods purchased online from 1996 to 2002 Percentage of total households who used the Internet for shopping Consumer goods purchased in millions ($$)
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	Annual figures
14. *Data sources*	
15. *If forecasts are included*	Forecasts of Internet users for 2001 and 2002 Forecasts of consumer goods purchased online in 2001 and 2002 (in millions of dollars)
16. *Facility-specific (airport, seaport)*	Internet-based companies
17. *Importance to our study*	Report discusses more about the impacts of telecom on travel and movement of goods Discusses the advantages of telecommuting and its effect on transportation Only statistic relevant to our study is "United States Internet users and consumer goods purchased online from 1996 to 2002"

Section 5.9	**On-Demand Package Delivery (2)**
2. *Title*	*Dot-Coms and Productivity in the Internet Economy*
3. *Author*	Whinston, A., A. Barua, J. Shutter, G. Wilson and J. Pinnell, University of Texas Research Team, Austin, TX
4. *Year of Study*	2001
5. *Source*	http://www.internetindicators.com/prod_rept.html
6. *Objective/Purpose*	Investigating the Internet economy indicators – the dot-com companies and their productivity
7. *General/Literature Review*	Two types of dot-com companies identified – digital and physical Digital dot-coms are Internet-based companies such as Yahoo, EBay and America Online Physical dot-coms sell physical products such as books, CDs, toys, etc., that are shipped to consumers
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Average revenue ($$) in 1998 and 1999 Average number of employees and revenue per employee in 1998 and 1999 Average gross income ($$) and gross profit margin (%) in 1998 and 1999 Comparative statistics of above mentioned variables across publicly traded digital and physical dot-coms
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	Annual figures
14. *Data sources*	
15. *If forecasts are included*	Forecasts of Internet users for 2001 and 2002 Forecasts of consumer goods purchased online in 2001 and 2002 (in millions of dollars)
16. *Facility-specific (airport, seaport)*	Internet-based companies
17. *Importance to our study*	Statistics relevant to our study are average annual revenues ($$) of dot-coms, number of employees and revenue per employee in 1998 and 1999 across the United States

Section 5.9	**On-Demand Package Delivery (3)**
2. *Title*	*The Challenge of E-Logistics*
3. *Author*	Jardine Logistics Group
4. *Year of Study*	2001
5. *Source*	http://www.info.gov.hk/digital21/eng/milestone/download/fiec_jardine.pdf
6. *Objective/Purpose*	Investigating the growth of e-commerce in the future
7. *General/Literature Review*	E-commerce overview B2B B2C Impact of e-commerce by industry type
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	B2C e-Tailing revenue in 1999 ($$) Number of shipping packages in 2000 B2B revenue statistics – 1998 to 2004 B2B commerce conducted over the Internet by industry category
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	Annual figures
14. *Data sources*	
15. *If forecasts are included*	B2C revenue in 2004 ($$) Residential package delivery in 2003
16. *Facility-specific (airport, seaport)*	Internet-based companies
17. *Importance to our study*	Revenue statistics of B2C and B2B e-commerce conducted over the Internet in the United States

Section 5.9	**On-Demand Package Delivery (4)**
2. *Title*	*Retail E-Commerce Sales in Third Quarter 2002 Were $11.1 Billion, up 34.3 Percent from Third Quarter 2001, Census Bureau Reports*
3. *Author*	Scheleur, S. and C. King, Unites States Department of Commerce, NEWS, Washington, D.C.
4. *Year of Study*	2002
5. *Source*	http://www.census.gov/mrts/www/ecom.pdf
6. *Objective/Purpose*	Monthly retail trade and food services – service sector statistics, U.S. Census Bureau
7. *General/Literature Review*	Quarterly reports on United States retail e-commerce sales in billions of dollars Monthly Retail Trade Survey (MRTS)
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Retail e-commerce sales estimates for 1999 to 2002 by quarter
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	Quarterly figures
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	Retail trade only
17. *Importance to our study*	Revenue statistics of retail e-commerce industry in the United States

Section 5.9	**On-Demand Package Delivery (5)**
2. *Title*	*Measuring the Electronic Economy, E-Stats, U.S. Census Bureau*
3. *Author*	U.S. Census Bureau
4. *Year of Study*	2002
5. *Source*	http://www.census.gov/eos/www/papers/estatstables.pdf
6. *Objective/Purpose*	Providing information on a quarterly basis about e-commerce in the United States.
7. *General/Literature Review*	
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	United States Manufacturing – Total and E-commerce value of shipments ($$) for 1999 and 2000 United States Merchant Wholesale Trade – Total and E-commerce sales ($$) for 1999 and 2000 United States Merchant Wholesale Trade – Total, E-commerce and EDI (electronic data interchange) Sales ($$) for 2000 United States Selected Service Industries – Total, E-commerce Revenue ($$) for 1999 and 2000 United States Retail Trade – Total and E-commerce Sales ($$) for 1999 and 2000 United States Electronic Shopping and Mail-order Houses – Total and E-commerce Sales by Merchandise Line for 1999 and 2000
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	All USA
13. *Level of temporal detail*	Quarterly and annual statistics
14. *Data sources*	2000 Annual Survey of Manufactures 2000 Annual Trade Survey 2000 Service Annual Survey 2000 Annual Retail Survey
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	Retail, wholesale, service industries
17. *Importance to our study*	Revenue statistics of retail, wholesale and service e-commerce industry in the United States

Section 5.10	**Construction Transport (1)**
2. *Title*	*Number of Contracts, Value of Contracts Awarded*
3. *Author*	Economics and Research, American Road and Transportation Builders Association
4. *Year of Study*	2002
5. *Source*	http://www.artba.org/economics_research/recent_statistics/by_the_numbers/by_the_numbers.htm
6. *Objective/Purpose*	
7. *General/Literature Review*	Transportation Construction By the Numbers – Monthly report as featured in ARTBA's Transportation Builder Magazine; highlights price trends, employment data and contract awards for the transportation construction industry
8. *Location/methods/models*	
9. *Type of vehicle or service*	
10. *Magnitude of vehicles/ trip rates*	Value ($$) of construction contracts awarded by State and Facility (airport, bridges and tunnels, docks, piers and wharves, highways and railways) Number of contracts awarded by Facility Number of contracts awarded by State Transportation construction contractor employment by facility type
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	State-level data
13. *Level of temporal detail*	Monthly reports
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	All facilities
17. *Importance to our study*	From the value and number of contracts by facility and State and from construction employment, construction equipment transporters tonnage can be computed using factors

Section 5.10	**Construction Transport (2)**
2. *Title*	*Farad Diversion Dam Replacement Project, Environmental Impact Report*
3. *Author*	State Water Resources Control Board, California
4. *Year of Study*	2002
5. *Source*	http://www.waterrights.ca.gov/EIR/text/Ch12-Trans.pdf
6. *Objective/Purpose*	To provide environmental and regulatory background necessary to analyze traffic issues To evaluate potential traffic impacts associated with project construction
7. *General/Literature Review*	Construction vehicle trip generation – workforce and construction equipment
8. *Location/methods/models*	2002 data from an environmental impact report (EIR) on a construction project in Sacramento, California
9. *Type of vehicle or service*	Heavy trucks – used in transporting construction equipment and materials
10. *Magnitude of vehicles/ trip rates*	Average daily workforce Average daily vehicle trips – construction workers and heavy trucks Daily peak-hour vehicle trips – transporting workforce and equipment and material deliveries
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	Confined to the project area
13. *Level of temporal detail*	Daily vehicle trips
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	Construction equipment and material deliveries in an urban area construction worksite

Section 5.11	**Public Utilities Services (1)**
2. *Title*	*Routing Public Service Vehicles*
3. *Author*	Marks, DH; Stricker, R
4. *Year of Study*	1971
5. *Source*	ASCE Journal of the Urban Plan and Develop Div, Vol. 97, No. UP2, PROC PAPER 8573, pp. 165-178
6. *Objective/Purpose*	An overview of the problem arising in planning such services as trash collection, snow plowing, and street cleaning.
7. *General/Literature Review*	An analysis is made of the trash collection and snow plowing problems for the city of Cambridge, MA. And differences between the real world problems and the theoretical model are explored. A brief description is given of several existing algorithms used to solve vehicle routing problems. A literature review and description of available methods is presented. A sample routing problems for the city of Cambridge is worked using an algorithm.
8. *Location/methods/models*	Cambridge, MA.
9. *Type of vehicle or service*	Trash collection, snow plowing
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of special detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is again a more methodology paper, however it is on the applied side of the methodological papers. I do not have the source yet, but I doubt how helpful it will be.

Section 5.12	**Public Safety Services (1)**
2. Title	*Evaluation of the Service Patrol Program in the Puget Sound Region*
3. Author	Jennifer Nee and Mark E. Hallenbeck, Washington State Transportation Center (TRAC), University of Washington, Seattle.
4. Year of Study	August 2000 to January 2001
5. Source	Washington State DOT and U.S. DOT, FHWA Research Project T1803, Task 37 http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00921453&STARTROW=1&CFID=87145&CFTOKEN=15535947
6. Objective/Purpose	In 1998, the Washington State Service Patrol Study Steering Committee provided additional towing services to improve incident removal from the most congested sections of Puget Sound area freeways. The primary goal of a Service Patrol is to provide quick response to incidents and clear roadways as rapidly as possible in high-volume areas during peak traffic volumes. The committee also recommended an evaluation of the system to determine and compare the effectiveness of the service modes, specifically, the Washington State Patrol, contracted tow operators, WSDOT tow trucks operated on the floating bridges, and privately sponsored motor assistance vehicles such as that of the AAA. The purpose of this report is to examine different methods of service delivery and to provide lessons learned for future implementation.
7. General/Literature Review	
8. Location/methods/models	I-5, I-90 and SR 520, I-405 in Seattle, SR 16 and I-5 in Tacoma,
9. Type of vehicle or service	Tow Trucks
10. Magnitude of vehicles/ trip rates	During the six months study period, 5,000 Service Patrol assists or contacts occurred on the patrolled segments on I-5, I-405, SR 16, floating bridge on I-90 and SR 520. The types of incident data included are: 1) Number of motorist contacted, 2) Distribution by time, 3) Distribution by location, 4) Method of detection and notification, 5) Frequency of false alarms, 6) Type of incidents, 7) Lane blockage, and 8) Response time.
11. Distribution of vehicles/ trip length/VMT	Distribution of vehicles are available from the survey data as shown above.
12. Level of special detail	Seattle urban area
13. Level of temporal detail	Six months from August, 2000 – January, 2001
14. Data sources	5,000 tow truck calls survey data
15. If forecasts are included	No
16. Facility-specific (airport, seaport)	No
17. Importance to our study	Although the study is not directly related to our objective, this study did a detailed survey of the tow trucks request call and these survey data might be helpful to our study.

Section 5.12	**Public Safety Services (2)**
2. Title	Location, Dispatching, and Routing Models for Emergency Service with Stochastic Travel Times
3. Author	*Mark S. Daskin, Northwestern University*
4. Year of Study	1984
5. Source	UC, BERKELEY, INSTITUTE FOR TRANSPORTATION STUDIES 15071957 http://199.79.179.82/sundev/detail.cfm?ANNUMBER=00419626&STARTROW=11&CFID=87145&CFTOKEN=15535947
6. Objective/Purpose	This article formulates a multi-objective model that simultaneously determines the number of vehicles to deploy and their locations and identifies the appropriate dispatch policy and the routes vehicles should use in traveling to emergency locations.
7. General/Literature Review	Urban governments are primarily responsible for providing emergency services, which includes emergency medical services, fire, and police protection. In all three cases, performance is often rated along two dimensions: 1) speed with which the system can response to emergencies, and 2) the ability of the responding personnel to handle the situation once they arrive on the scene. This paper was concern with response time and with means of reducing it.
8. Location/methods/models	A multi-vehicle response-time model with stochastic travel times was developed.
9. Type of vehicle or service	Emergency vehicles, Ambulances
10. Magnitude of vehicles/ trip rates	
11. Distribution of vehicles/ trip length/VMT	
12. Level of special detail	
13. Level of temporal detail	
14. Data sources	No data available
15. If forecasts are included	Model can be used for the future year demand estimates
16. Facility-specific (airport, seaport)	Emergency locations, for example, accident locations
17. Importance to our study	This articles developed a theoretical model to assign emergency vehicles on the routes. It does not include any survey, however it does include a 21-node network for testing the model.

Section 5.12	**Public Safety Services (3)**
2. Title	*Projecting Police Traffic Enforcement Workload: An Empirical Analysis*
3. Author	Richard A. Raub, Illinois State Police
4. Year of Study	1987
5. Source	Transportation Quarterly, Volume 42, Issue 2, 04/00/1988
6. Objective/Purpose	A study is reported that has found that police can estimate the **number of officers required for traffic services** using external sources. Historical data are not required. A clear relationship has been shown to exist between independent and dependent variables. This analysis showed very strong relationships between historic workload and independent variables such as volume of traffic and rural population. Workload is defined as the number of hours spent annually on police services. Included in the workload is traffic enforcement, motorist assistance, removal of abandoned vehicles, and traffic control. Volume is measured by vehicle miles. Rural population is the number of persons living outside incorporated municipalities. As traffic increases, there is more opportunity for traffic services. More violations will be seen during a given period; more motorists will require assistance.
7. General/Literature Review	
8. Location/methods/models	Illinois Regression equation was developed which estimates annual hours spent policing as follows: $t_i = 51.8 + 4.257V - 0.0002V^2$ (for Controlled Access Highway) $t_s = 11.7 + 5.2127V - 0.00172V^2$ (for Primary Highway) $t_r = 294.6 + 9.483R + 2235.0A$ (for Rural Highway) Where: t = Time in hours annually spent policing, V = Volume in vehicle miles (000's), R = Rural population (000's) A = ADT (000's)
9. Type of vehicle or service	Police Vehicle
10. Magnitude of vehicles/ trip rates	Total vehicles
11. Distribution of vehicles/ trip length/VMT	VMT
12. Level of special detail	Illinois State
13. Level of temporal detail	1985 to 1986
14. Data sources	Number of incidents by type and time required to handle, Illinois State Police department
15. If forecasts are included	No
16. Facility-specific (airport, seaport)	No
17. Importance to our study	This paper estimates time in hours annually spent policing and VMT for policing. This regression equation might be useful for our study. This analysis showed very strong relationships between historic workload and independent variables such as volume of traffic and rural population. Workload is defined as the number of hours spent annually on police services. Included in the workload is traffic enforcement, motorist assistance, removal of abandoned vehicles, and traffic control. Volume is measured by vehicle miles.

Section 5.13	**Trades and Services (1)**
2. Title	*The Redesign of Sears Carry-in Repair Network*
3. Author	M. Docherty, President, itoi logistics Inc,. M. Good, President, Product Repair Services, J. Perl, Director, Innovative Logistics Solutions, Inc., and L.M. Scovell, Executive Vice President, itoi logistics Inc.
4. Year of Study	1999
5. Source	2001 Annual Conference Proceedings, Council of Logistics Management 2001 Annual Conference.
6. Objective/Purpose	This paper discusses the redesign of Sears and Roebucks and Company's Product Repair Services. It covers the approach to the design, data collection and analysis, network optimization, the integrated network strategy, shuttle routes and schedules, discrete simulation modeling, and the design's implementation.
7. General/Literature Review	Sears' Product Repair Service and Sears Logistics Service department hired outside consultant AMEC to form a project team with its internal resources for the redesign of the carry-in repair network. Network optimization program SAILS (Strategic Analysis of Integrated Logistics Systems) was applied for this work. SAILS uses a mixed integer linear program approach, specifically designed to solve large-scale multi-echelon network optimization problems. The echelons are: Repair facilities, Repair facilities warehouses, Cross-Dock facilities, and Access points.
8. Location/methods/models	Nationwide
9. Type of vehicle or service	Sears' repair trucks
10. Magnitude of vehicles/ trip rates	N/A in the paper, but they talked about the demand estimates. So, information might be available in the original report.
11. Distribution of vehicles/ trip length/VMT	N/A in the paper, but they talked about the demand estimates. So, information might be available in the original report.
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	Sears maintains cost and operational data for their products. Authors of this article collected and cleaned these data for analysis. They used GIS to virtualize the spatial distribution of data on product demand, unit repair and unit transport costs.
15. If forecasts are included	Yes
16. Facility-specific (airport, seaport)	Repair centers
17. Importance to our study	If we can collect the original report and the data they have used, we can do further analysis and use the same technique for other products.

Section 5.13	**Trades and Services (2)**
2. Title	*Efficient Routing of Service Vehicles*
3. Author	Gendreau, M.; Laporte, G., Yelle SY. Montreal University, Canada
4. Year of Study	1995
5. Source	Montreal University, P.O. Box 6128, Station A, Montreal, Canada
6. Objective/Purpose	GeoRoute is an arc routing Software package that includes a route optimization module based on the GENIUS traveling salesman problem heuristic. The territory under study is represented by a directed graph in which arcs correspond to streets. The system also introduces artificial arcs to account for street crossings, street changes, and turns. This report describes experiments performed using GeoRoute to determine optimal routes for **garbage collection and for snow plowing operations** on 30 street networks. The experiments tested various values of penalties in order to arrive at conventional packages of penalties for use in various situations. The results help GeoRoute users select sets of penalties without having to ponder a large set of possible parameters.
7. General/Literature Review	
8. Location/methods/models	Montreal, Canada GeoRoute is a routing software and USPS and many other companies use this package for their traveling salesman optimization. The author applied the software and uses different costs/penalties to optimize a 30 street network. As a case study he determined optimum routes for GARBAGE COLLECTION and SNOW PLOWING OPERATIONS.
9. Type of vehicle or service	Garbage collection and Snow Plowing Trucks
10. Magnitude of vehicles/ trip rates	N/A
11. Distribution of vehicles/ trip length/VMT	
12. Level of spatial detail	
13. Level of temporal detail	
14. Data sources	
15. If forecasts are included	N/A
16. Facility-specific (airport, seaport)	
17. Importance to our study	This article discussed about the application of GeoRoute software package for optimizing traveling salesman problem. The author uses different costs/penalties for links and intersections to determine optimum routes for garbage collection and for snow plowing operations.

Section 5.13	**Trades and Services (3)**
2. *Title*	*Computer-Based Routing and Scheduling in Metropolitan Regions*
3. *Author*	George R. Beetle, President, George Beetle Company, 533 Arbutus St., Philadelphia, PA 19119.
4. *Year of Study*	1988/1989
5. *Source*	ASCE-Journal of Transportation Engineering
6. *Objective/Purpose*	The purpose of this paper is to describe the computer-based methods to improve the management of daily movements of vehicles and crews in regional service activities. Data requirements and the need to account for traffic volumes in routing decisions are elaborated. A set of 12 application programs written for use by schedulers, dispatchers, or operating managers is used as a point of reference in the discussion. A case history illustration taken from collection operations in regional banking is also recounted.
7. *General/Literature Review*	Computer software and its application by a major commercial banking institution in Philadelphia have been presented as a case study. At that time the bank deployed a total of some 200 automatic teller machines and the crews of the bank had to visit all the machines everyday. Twelve application programs were written over a period of four months and installed in the bank's offices. Traffic were assigned to the highway network which consists of nodes and links.
8. *Location/methods/models*	Philadelphia
9. *Type of vehicle or service*	Sales man's vehicle
10. *Magnitude of vehicles/ trip rates*	N/A
11. *Distribution of vehicles/ trip length/VMT*	N/A
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	This is a theoretical article and discussed about the problems faced by schedulers, dispatchers, or operating managers during traffic congestion, weather, highway accidents. They discussed about a software program that considers all these problems and reroutes vehicles.

Section 5.14	**Outside Sales and Services (1)**
2. *Title*	*Defining the MTA Role in Coordinating Community-Based Service in Los Angeles County*
3. *Author*	Jim McLaughlin and Scott Greene, Los Angeles County Metropolitan Transportation Authority, Los Angeles, CA
4. *Year of Study*	1999-2000
5. *Source*	Information Center Manager American Public Transportation Association 1666 K St. NW 11th Floor/Washington, D.C. 20006 jolivetti@apta.com 202 496 4807 (phone) 202 496 4326 (fax)
6. *Objective/Purpose*	This paper concentrates on the MTA role in coordinating health and human services transportation for incorporation into the county-wide transit master plan begun as part of the long-range transportation plan process. The public transport elements of the long-range plan envisions multiple tiers of service, including commuter, heavy and light rail, bus rapid transit, and other buses operating on high-demand corridors, traditional inter- and intra-jurisdictional local services, and Community-Based Transportation Services (CBTS). The transit master plan will address policies to improve coordination of CBTS with specific implementation potentially guided by five-year business plans.
7. *General/Literature Review*	The Transportation and Human Services Executive Council approved development of a strategic plan for coordinating public transportation and health and human services transportation, including examining existing programs. MTA and Access Services, Inc. (ASI) estimated that 1,300 dedicated vehicles and 1,400 taxis are operated within the County by 200 public and non-profit organizations, funded for specific client populations by health and human services organizations.
8. *Location/methods/models*	Los Angeles County
9. *Type of vehicle or service*	Social Service Vehicles
10. *Magnitude of vehicles/ trip rates*	A listing of 30 public transportation programs are shown in the article. Table includes passenger trips, average trip length, and operating costs. For financial year 1999 there are total 4,204,270 trips, 6.8 miles trip length, and operating costs equal $62,300,868.
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	Los Angeles County MTA
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	

Section 5.14	**Outside Sales and Services (2)**
2. *Title*	*Service and Supply Trips at Federal Institutions in Washington, D.C., Area*
3. *Author*	Spielberg, F; Smith, SA
4. *Year of Study*	1981 (?)
5. *Source*	Transportation Research Record No. 834, pp. 15-20, 1981
6. *Objective/Purpose*	Federal office buildings in Washington, D.C., are typical of many large office complexes, particularly those of state governments. Federal warehouse operations have characteristics similar to those of large distribution centers. The results of a survey of goods and service vehicle trips to federal facilities in the Washington metropolitan area are presented and suggest specific guidelines for the planning and operation of similar facilities. Data were collected on vehicle trips that involved a service or supply function at 10 federal facilities in the Washington area. By using a combination of onsite observation and driver interviews, data on arrival and departure times, vehicle characteristics, trip purpose, origin of trip, and nature and size of load were obtained, analyzed, and used to develop planning guidelines (Authors)
7. *General/Literature Review*	
8. *Location/methods/models*	Washington, D.C.
9. *Type of vehicle or service*	Service and supply vehicles
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	

Section 5.14	**Outside Sales and Services (3)**
2. *Title*	*The Development of an Urban Commercial Vehicles Travel Model and Heavy-Duty Vehicle Emissions Model for the Atlanta Region*
3. *Author*	Thorntorn, M., R. Guensler, and O. Schropp
4. *Year of Study*	1998
5. *Source*	Published in CD-ROM of the Proceedings of the 77th Annual Meeting of the Transportation Research Board; Washington, D.C., January 2002
6. *Objective/Purpose*	The purpose of this paper is to provide an overview of the development of a commercial vehicles travel model set up for ARC, the Metropolitan Planning Organization (MPO) for the Atlantic Region, and the Georgia Tech emissions model. The development of the Atlanta commercial vehicle and truck model set was divided into three basic phases. The data collection phase which identifies data elements and formulation of a survey instrument. The data collection phase which identifies data elements and formulation of a survey instrument. The second phase consisted of the development of the truck trip generation and the trip distribution models. The final phase is the integrated heavy-duty vehicle emissions module.
7. *General/Literature Review*	The commercial vehicle survey was conducted by NuStats International for the ARC in the spring of 1996. Participating businesses were assigned a travel day. Drivers were asked to record all trips made for the specific 24-hour period. In total 347 firms of the 814 eligible firms contacted, were recruited to participate in the study. Of the 814 eligible firms, 152 firms (19%) provided completed trip logs.
8. *Location/methods/models*	Atlanta
9. *Type of vehicle or service*	All types of commercial vehicles
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	Data were used to develop four-step travel demand model
12. *Level of special detail*	Atlanta region including the following counties: Clayton, Cherokee, Cobb, Dekalb, Douglas, Foyette, Fulton, Gwinnett, Henry, Rockdale, and Atlanta.
13. *Level of temporal detail*	1996
14. *Data sources*	The CV survey was accomplished through a survey of business that operate commercial vehicles. This survey was conducted in 1996 and might be available from Atlanta Regional Commission.
15. *If forecasts are included*	Yes, the data have been used in the forecasting model
16. *Facility-specific (airport, seaport)*	No
17. *Importance to our study*	The survey form includes purpose of trips, which includes 1) Delivery, 2) Pick-up, 3) Maintenance, 4) work-related, 6) Driver needed, 7) Return to base, 7) Other.

Section 5.14	**Others**
2. *Title*	*1995 National Personal Transportation Survey*
3. *Author*	FHWA
4. *Year of Study*	1995-1996
5. *Source*	http://www-cta.ornl.gov/npts/1995/Doc/index.shtml
6. *Objective/Purpose*	Trip purpose coded in the NTPS survey are: Work Work-related Return to work Family and Personal Business – Shopping – Medical or Dental – Take someone somewhere – Pick up someone – Other family and personal business School; Religious activity Social and Recreational – Vacation – Visit friends and relatives – Out to eat – Other social and recreational Return home Other Trip Modes Coded Automobile, Van, Sport utility vehicle, Pickup truck, Other truck, RV (recreational vehicle), Motorcycle, Other POV, Bus, Amtrak, Commuter train, Streetcar/trolley, Subway/elevated rail, Airplane, Taxicab, Bicycle, Walk, School bus, Other non-POV, Legitimate skip, Not ascertained.
7. *General/Literature Review*	
8. *Location/methods/models*	Nationwide
9. *Type of vehicle or service*	All
10. *Magnitude of vehicles/ trip rates*	
11. *Distribution of vehicles/ trip length/VMT*	
12. *Level of spatial detail*	
13. *Level of temporal detail*	
14. *Data sources*	
15. *If forecasts are included*	
16. *Facility-specific (airport, seaport)*	
17. *Importance to our study*	