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16. Abstract Many Metropolitan Planning Organizations (MPOs) have identified the lack of robust and accurate freight data as a major constraint in conducting meaningful freight planning. An in-depth literature review was conducted that covered (1) the most relevant freight issues faced by MPOs, (2) the state-of-the-art methodologies used in urban travel demand forecasting to integrate the passenger and freight components, (3) primary and secondary freight data sources and their strengths and limitations for supporting urban planning activities, and (4) the full spectrum of Intelligent Transportation Systems (ITS) technologies that are considered rich sources of freight data. A <i>Freight Data Needs Survey</i> was administered to U.S. MPOs to assess urban freight data needs given the demographic characteristics of the region, the freight issues MPOs have to deal with, the state-of-the-practice in integrating the freight component into the urban travel demand models (TDMs), freight collection activities at the metropolitan region, the level of deployment of ITS technologies, and the use of archived ITS data to support urban planning activities. Special emphasis was given to <i>cargo data</i>, <i>freight transportation modes data</i>, and <i>terminal/intermodal transfer facilities data</i> because they provide valuable insight into urban freight movements. The results of the survey revealed that, although two-thirds of the responding MPOs are conducting freight planning, only 26% of them have integrated both the passenger and freight components into their TDMs. Among the responding MPOs, 49% to 94% indicated a need for origin-destination patterns, routing details, shipment details, and commodity type information, while cargo data availability varied from 6% to 46%. The percentage of respondents who indicated a need for highway/truck data, rail data, air data, and water data varied between 51% and 100%, while transportation mode data availability ranged between 0% and 40%. Finally, the percentage of respondents who indicated a need for terminal/intermodal transfer facilities data varied between 82% and 97%, while the availability of this data varied from 3% to 18%. These figures point to the substantial need for freight data, especially among the small, mid-size, and mid-large MPOs. It is thus obvious that effective freight planning and wholly informed decisions are still largely limited by a lack of reliable data. Given a lack of funding sources, primary data collection is also not an option for many small to mid-large MPOs. For the future, these MPOs will have to explore innovative and cost effective means to gather an understanding of freight movements. This study showed that data collected by electronic means such as those provided by ITS can be invaluable to urban freight planning.			
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**FREIGHT DATA NEEDS AT THE METROPOLITAN
LEVEL AND THE SUITABILITY OF INTELLIGENT
TRANSPORTATION SYSTEMS IN SUPPLYING
MPOs WITH THE NEEDED FREIGHT DATA**

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ABSTRACT

Many Metropolitan Planning Organizations (MPOs) have identified the lack of robust and accurate freight data as a major constraint in conducting meaningful freight planning. An in-depth literature review was conducted that covered (1) the most relevant freight issues faced by MPOs, (2) the state-of-the-art methodologies used in urban travel demand forecasting to integrate the passenger and freight components, (3) primary and secondary freight data sources and their strengths and limitations for supporting urban planning activities, and (4) the full spectrum of Intelligent Transportation Systems (ITS) technologies that are considered rich sources of freight data. A *Freight Data Needs Survey* was administered to U.S. MPOs to assess urban freight data needs given the demographic characteristics of the region, the freight issues MPOs have to deal with, the state-of-the-practice in integrating the freight component into the urban travel demand models (TDMs), freight collection activities at the metropolitan region, the level of deployment of ITS technologies, and the use of archived ITS data to support urban planning activities. Special emphasis was given to *cargo data*, *freight transportation modes data*, and *terminal/intermodal transfer facilities data* because they provide valuable insight into urban freight movements. The results of the survey revealed that, although two-thirds of the responding MPOs are conducting freight planning, only 26% of them have integrated both the passenger and freight components into their TDMs. Among the responding MPOs, 49% to 94% indicated a need for origin-destination patterns, routing details, shipment details, and commodity type information, while cargo data availability varied from 6% to 46%. The percentage of respondents who indicated a need for highway/truck data, rail data, air data, and water data varied between 51% and 100%, while transportation mode data availability ranged between 0% and 40%. Finally, the percentage of respondents who indicated a need for terminal/intermodal transfer facilities data varied between 82% and 97%, while the availability of this data varied from 3% to 18%. These figures point to the substantial need for freight data, especially among the small, mid-size, and mid-large MPOs. It is thus obvious that effective freight planning and wholly informed decisions are still largely limited by a lack of reliable data. Given a lack of funding sources, primary data collection is also not an option for many small to mid-large MPOs. For the future, these MPOs will have to explore innovative and cost effective means to gather an

understanding of freight movements. This study showed that data collected by electronic means such as those provided by ITS can be invaluable to urban freight planning.

EXECUTIVE SUMMARY

Many MPOs have identified the lack of affordable, useful freight data as a major concern. While national-level commodity flow information is available, it is provided at aggregate levels, limiting its usefulness to metropolitan planning. Because MPOs have access to modest data, planners have little sense of the holistic freight trip and do not know relevant details like origin, commodity characteristics, modes of travel used, routes, transfer points, and destination.

The primary purpose of this study is to identify the ITS opportunities available for improving the efficiency and effectiveness of collecting freight data by MPOs. This requires assessing current data needs and determining whether the use of archived ITS data can provide the desirable data. Special emphasis is given to road freight since it is the predominant mode of urban freight transportation. More specifically, the objectives of this study are to identify (1) data required to conduct meaningful freight planning at the metropolitan level, (2) freight data collected by primary and secondary data sources, (3) needed and available freight data at the metropolitan level, and (4) the ITS technologies that can supply MPOs with the needed freight data

To achieve the specific objectives stated above, three major tasks were identified. First, an in-depth literature review was conducted that covered the following:

- The most relevant freight issues faced by Metropolitan Planning Organizations (MPOs);
- The state-of-the-art in urban travel demand forecasting to integrate the passenger and freight components;
- Data requirements for freight modeling;
- The primary and secondary freight data sources and their strengths and limitations for supporting urban planning activities; and
- The full spectrum of ITS technologies that are rich sources of freight data.

Second, a comprehensive questionnaire was administered to the MPOs to ascertain the following:

- Freight transportation issues faced by MPOs;
- The state-of-the-practice in integrating the freight component into the urban travel demand models (TDMs);

- Freight data available to metropolitan areas, including an assessment of their quality;
- Freight data needed to conduct meaningful freight planning in metropolitan areas, including an assessment of their importance;
- Freight collection activities at the metropolitan level;
- The level of deployment of ITS technologies and the use of archived ITS data to support urban planning activities; and

Finally, the suitability of archived ITS data in supplying MPOs with the needed freight data were identified and presented in tables.

The literature review revealed that freight demand modeling can help MPO planners to understand urban freight patterns and to formulate and evaluate strategies or policies to improve the efficiency of goods movement. In particular, urban freight modeling can shed light on infrastructure, safety, and environmental issues pertaining to the transportation system. This will enable the identification and evaluation of alternative actions based on performance measures obtained through the modeling process. The proposed methodologies in the literature aim to integrate the freight component into the urban travel demand modeling process, taking into consideration the underlying factors that affect the demand for freight.

Several approaches have been suggested to model urban freight demand. A proposed classification categorized these approaches into the structural approach and the direct approach. The structural approach to freight modeling integrates the freight component of the urban transportation system into the standard four-step travel forecasting process and estimates the entire demand for the two components of the system, that is, passengers and freight. The direct approach to freight modeling is a simplification of the structural approach in that it forecasts the freight demand for specific components of the system (i.e., corridor, freight transfer facility, etc.). The structured process can be conducted using two sub-approaches: the vehicle-based approach, which focuses on commercial vehicle trips, and the commodity-based approach, which focuses on commodity flows. The special features of models and techniques embedded in these approaches in terms of its capabilities and freight data requirements make some of them more appealing for application at the metropolitan level.

The vehicle-based approach presents several advantages to the MPOs, such as: (1) highway/truck data is more available than commodity data, (2) truck trips are estimated in the beginning of the modeling process so conversion to truck trips from commodity shipment

volumes is not required, and (3) truck trips are easily combined with passenger car trips for route assignment. However, this approach also has several disadvantages, such as: (1) it provides little or no information about commodities transported between analysis zones, (2) it does not provide any basis for estimating trip end control totals, (3) internal trips made by external truck trips are ignored, (4) few existing models seem to address trip chain patterns, and (5) it has limited capability to analyze policy options such as changes in modal attributes, new freight modes or facilities, new links or pricing measures. On the other hand, a significant advantage of the commodity-based approach is that it is concerned with the movement of commodities (not trucks) that produce the demand for freight movements in that it links the producers and consumers of goods. Therefore, for MPOs to undertake comprehensive urban freight planning, accurate and reliable cargo and highway/truck data are needed.

This study classifies the data required for urban freight planning into five categories as follows: cargo, road transportation, major freight generators and corridors, non-road transportation modes, and economic, land-use, and socio-economic data. This study also identified the relevant attributes for each category. Although the largest share of the urban freight is moving by road, attributes related to other freight transportation modes were integrated into a separate category to account for the multimodal freight activities taking place in metropolitan regions and their impact on the urban freight traffic patterns.

Primary and secondary freight data sources have strengths and limitations for supporting planning activities at the metropolitan level. Surveys can provide the level of detail needed for urban freight planning but they require significant resources. Due to the limited resources at the metropolitan level, surveys are not performed on a regular basis by MPOs. Several public and commercial data sources exist but they do not capture the levels of detail needed for urban freight planning. For example, cargo data and transportation mode data provided in these data sources differ in many aspects, such as (1) level of detail of commodity classification, (2) level of detail of commodity type, (3) level of detail of origin-destination patterns, (4) level of shipment detail, (5) level of routing detail, and (6) level of detail of freight transportation modes. In addition, the usefulness of these databases is limited because the information has not been updated. ITS data is a rich source of freight information but it is limited to the areas covered by the technologies, the existence of an archive Data User Service (ADUS) in the metropolitan

region that supply MPOs with the needed data, and the willingness of carriers to share information with the public planning agencies.

This study lists the best-known ITS technologies for gathering urban freight data. The most popular road-based technologies to gather cargo and road/highway data are inductive loop detectors, sensors, environmental sensor stations, WIM sensor systems, closed circuit TV (CCTV) cameras, and video image detection systems. The most popular vehicle-based technologies to gather cargo and road/highway data are Automated Vehicle Classification (AVC), Automated Vehicle Identification (AVI), Automated Vehicle Location (AVL), cellular phones (probe vehicles), License Plate Matching (LPM), and smart cards.

The *Freight Data Needs Survey*, administered through the Internet between the months of May and June of 2004, provided detailed information which enabled several analyses. The findings of these analyses showed that more than two-thirds of the responding MPOs are conducting freight planning (i.e., 69%), of which 41% were major regions (i.e., regions with more than 0.5 inhabitants) and 28% were minor regions (i.e., regions with less than 0.5 inhabitants). Although the number is lower than the figure reported in the 2003 AMPO Freight Survey (80% from a sampled population of 340 MPOs), it indicates the active role MPOs are taking in dealing with freight transportation issues. In this regard, this study showed that capacity constraints, safety and environmental concerns, system preservation, and operational improvement needs prevail in all metropolitan regions. Although the extent of these issues were not considered, this finding suggests some common freight data is needed to support freight planning activities by all MPOs, regardless of their size.

MPOs are increasingly challenged to consider strategic projects that support local land use, protect the environment and neighborhoods, promote the energy conservation, and advance economic productivity and growth of their regions. With respect to these issues, the analysis showed that pollution levels in 58% of the responding metropolitan regions (i.e., 38 MPOs) persistently exceeded the national ambient air quality standards but only 45% of the MPOs with non-attainment areas are dealing with environmental issues (i.e., 17 MPOs). This finding suggests the need for increasing attention on projects that promote the protection of the environment by MPOs.

MPOs require both reliable freight data and robust analytical tools with which to analyze and evaluate potential freight project impacts. The analysis, however, showed that less than one-

third of responding MPOs have integrated freight components in their TDMs (i.e., 26%), of which 18% were major regions and 8% were minor regions. A lack of freight data can partially explain the limited application of freight modeling in urban areas.

Regarding cargo data available or need in the studied metropolitan regions, of the 65 MPOs that completed the *Freight Data Needs Survey*, 77% indicated they used/needed origin-destination patterns, 75% used/needed routing details, 65% used/needed shipment details, and 60% used/needed commodity classification and commodity type data. In addition, between 49% and 94% of the responding MPOs indicated they need additional detailed data to the various cargo attributes listed. These figures reflect the enormous need for cargo data to facilitate meaningful freight planning at the metropolitan level.

Concerning freight transportation mode data, of the 65 MPOs that completed the *Freight Data Needs Survey*, 82% indicated they used/needed highway/truck data, 74% used/needed rail data, 60% used/needed air data, and 40% used/needed water data. In addition, between 51% and 100% of the responding MPOs indicated they need additional detailed data to the various transportation mode attributes listed. These figures suggest the significant need for transportation mode data that is desirable for urban freight planning.

Concerning terminal/intermodal transfer facilities data, of the 65 MPOs that completed the *Freight Data Needs Survey*, 66% indicated they used/needed these data. Between 82% and 97% of the responding MPOs indicated they need additional detailed terminal and intermodal transfer facilities data. These figures points out the lack of relevant data to assess the impact of terminal/intermodal transfer facilities in the urban travel patterns.

In terms of the quality of the available freight data, most of the MPO respondents assessed the quality of the available cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data as adequate. Among the cargo attributes, commodity classification data was ranked as the most adequate. Among the freight transportation mode attributes, highway/truck mode data was ranked as the most adequate.

In terms of the significant of the needed freight data, most of the MPO respondents expressed that the needed cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data was important. Among the cargo attributes, routing details was ranked as the most important. Among the freight transportation mode attributes, rail mode data was ranked as the most important.

The identified MPOs needs in terms of cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data reveal the limited data MPOs have for freight planning. This study also highlighted the lack of detailed data available to small, mid-size, and mid-large MPOs. It is thus obvious that effective freight planning and informed decisions are still largely limited by a lack of reliable data. Given a lack of funding sources, primary data collection is also not an option for many small- to mid-large MPOs.

Overall, ITS technologies are the most used collection method to gather freight data in the studied MPOs (i.e., 62% of the MPO respondents). This finding points out the ITS opportunities for providing the needed freight data at the metropolitan level. Public and commercial data sources also play an important role in providing MPOs with the needed freight data (i.e., 58% of the MPO respondents are using these data sources). Surveys are the least used collection method in the studied locations. Because these traditional data collection efforts are prohibitively expensive, it seems that only 42% of the MPO respondents have the resources to afford these collection techniques.

From the 40 MPOs that responded they use ITS freight data, only 18 indicated the ITS technologies that provide such freight data. The results show that the large metropolitan regions are using ITS technologies as a rich source of freight information. In fact, only these regions use freight data collected by AVC, CCTV cameras, vehicle tracking and navigation systems, toll tags, AVL, cellular phones, license plate matching, and smart cards. Inductive loop detector is the only ITS technology that is common to all studied locations. Finally, neither WIM technology nor sensors are used to collect freight data in the mid-size metropolitan regions that responded to this survey.

This study assessed the level of deployment of ITS technologies in the studied metropolitan regions. The results reveal that, in general, a higher percentage of MPOs indicated ITS technologies have been deployed in their areas. The ITS technologies are under development in a higher number of smaller metropolitan regions relative to the larger metropolitan regions. As expected, a higher number of large metropolitan regions are already using ITS technologies relative to the other metropolitan regions. Mid-large metropolitan regions seem to be in a break point of ITS deployment between ‘ready for use’ and ‘under development’. Finally, the level of deployment of ITS technologies in the small metropolitan regions is spread out among the inquired levels.

This study assessed the state-of-the-practice in the use of archived ITS data to support freight planning activities at the metropolitan region. In general, most of the MPO respondents do not know whether there is an ADUS in their regions (i.e., 43%). Only 15% of the respondents (i.e., 10 MPOs) pointed out that an ADUS is present in their regions, while 42% (i.e., 27 MPOs) indicated there is not. Furthermore, ADUS mostly prevails in the large metropolitan regions (i.e., 9 large MPOs), and trails off considerably for small metropolitan regions (i.e., 1 small MPO). Available information for the Archive Data User Service (ADUS) from the National ITS Architecture reveals that the most common archived data comes from Arterial Management Systems, Freeway Management Systems, Incident Management Systems, Traffic Management Systems, and Traveler Information Systems. Vehicle Commercial Operations (CVO) has the potential to provide ADUS with freight data, which is currently needed at the metropolitan level. Such an application, however, was not identified in the literature.

Regarding the level of ITS deployment in the metropolitan regions and the MPOs already using ITS freight data, this study shows that over 50% of the MPO respondents are getting data from ITS technologies. Few of these MPOs, however, indicated they use the ADUS to get the needed data. This finding could be explained in part to the fact that 43% of the MPO respondents are unaware if there was an ADUS operating in their regions.

Based on the MPO freight data needs identified in this study and the freight data provided by ITS technologies, this study identified the suitability of ITS in supplying MPOs with the needed data. Tables 1 and 2 point out the level of detailed cargo data and highway/truck data provided by ITS technologies respectively. Since road freight is the predominant mode of urban freight transportation, it is clear that ITS technologies can supply MPOs with the needed highway/truck data. Furthermore, some cargo detailed data can be drawn for ITS applications at the metropolitan level. These freight data can significantly help transportation planners to identify urban freight patterns and the contribution of urban freight vehicles to urban congestion, pavement deterioration, environmental quality, and the economic vitality of their urban areas. On the other hand, few MPOs seem to know about ADUS and the potential of this archived ITS data in supplying them with the needed information.

TABLE 1 ITS Technologies which provide Cargo Detail Data													
Cargo Detail Data		ITS Technologies											
		Inductive loop detectors	WIM sensor systems	Sensors	Environmental sensor stations	CCTV cameras	Video image detection	AVC	AVI CVO Toll Tags	AVL GPS	Cellular phones (probe vehicles)	License Plate Matching (LPM)	Smart Cards
Commodity Type:													
Aggregate categories								✓	✓*				
Hazardous material								✓	✓*				
OD Patterns:													
Commodity O-D patterns								✓	✓	✓	✓	✓	✓
Shipment Details:													
Empty shipments									✓				
Average length of haul									✓	✓	✓	✓	✓
Payload weight (cargo weight)			✓						✓				
Volume									✓				
Mode of transportation									✓				
Routing Details:													
HAZMAT Vehicle routing						✓			✓	✓	✓	✓	✓
Vehicle routing						✓			✓	✓	✓	✓	✓
Interim trip origins and destinations													
Number of stops													
Major routes used						✓			✓	✓	✓	✓	✓

TABLE 2 ITS Technologies which Provide Highway/Truck Detail Data												
Highway/Truck Detail Data		ITS Technologies										
		Inductive loop detectors	WIM sensor systems	Sensors	Environmental sensor stations	CCTV cameras	Video image detection	AVC	AVI CVO Toll Tags	AVL GPS	Cellular phones (probe vehicles)	License Plate Matching (LPM)
Travel time		✓		✓		✓			✓	✓	✓	✓
Average vehicle speed		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Vehicle emission data					✓							
Incident data		✓		✓		✓	✓					
Truck O-D patterns								✓	✓	✓	✓	✓
Trip O-D patterns								✓	✓	✓	✓	✓
Vehicle type		✓	✓	✓		✓	✓	✓				
Traffic volume data		✓	✓	✓		✓	✓	✓				

In the future, these MPOs will have to explore innovative and cost-effective means to gather an understanding of freight sector movements, the impacts on their infrastructure, and what it means to freight planning given limited data. Using Commercial Vehicle Operation (CVO) systems as part of Intelligent Transportation Systems (ITS) can provide a rich source of cargo data such as weight, cargo type, and origin-destination patterns, to mention a few. Because transportation planners have limited resources to collect pertinent primary data, considerable reliance should be placed on the use of advanced information and communication technologies that can be invaluable to urban freight planning.

TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION	1
1.1 Motivation	1
1.2 Problem Statement.....	2
1.3 Research Objectives and Approach.....	3
1.4 Research Approach.....	4
1.5 Report Organization	4
CHAPTER 2 - URBAN FREIGHT TRANSPORTATION	5
2.1 MPOs Freight Challenges.....	5
2.2.1 Infrastructure Challenges.....	5
2.2.2 Safety Challenges	7
2.2.3 Environmental Challenges.....	8
2.2 Freight Urban Demand Modeling.....	9
2.2.1 Characteristics of Freight Movement	9
2.2.2 Approaches for Modeling Urban Freight Demand.....	12
2.2.2.1 Freight Generation and Distribution.....	14
2.2.2.2 Freight Mode Choice	23
2.2.2.3 Freight Route Assignment.....	25
CHAPTER 3 - DATA REQUIREMENTS FOR URBAN FREIGHT PLANNING.....	29
3.1 Freight Data Categories: Attributes and Level of Detail.....	29
3.2 Data Sources for Urban Freight.....	35
3.2.1 Surveys and Traffic Counts	36
3.2.2 ITS Data.....	41
3.2.3 Public and Commercial Data Sources	49
CHAPTER 4 - FREIGHT DATA NEEDS AND SUITABILITY OF INTELLIGENT TRANSPORTATION SYSTEMS IN SUPPLYING MPOs WITH THE NEEDED DATA.....	67
4.1 Findings from In-Persons Interviews	67

4.1.1 Houston-Galveston Area Council (H-GAC)	68
4.1.2 North Central Council of Governments (NCTCOG)	69
4.2 <i>Freight Data Needs Survey: Content and Administration</i>	70
4.3 General Information and Freight Activity in the Studied Locations	72
4.4 Freight Planning and Challenges in the Responding Metropolitan Regions	74
4.5 Freight Urban Demand Modeling in the Responding Metropolitan Regions	76
4.6 Assessment of Freight Data Availability and Needs in the Responding Metropolitan Regions	77
4.6.1 Assessment of Cargo Data	78
4.6.1.1 Availability and Need for Cargo Attribute Data	78
4.6.1.2 Level of Detailed Cargo Data Available and Needed	80
4.6.1.3 Level of Detailed Cargo Needed as a Function of MPO Size	81
4.6.1.4 Level of Detailed Cargo Available as a Function of MPO Size	83
4.6.2 Assessment of Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Data	86
4.6.2.1 Availability and Need for Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Attribute Data	86
4.6.2.2 Level of Detailed Transportation Mode Data Available and Needed ...	88
4.6.2.3 Level of Detailed Transportation Mode and Terminal/Intermodal Transfer Facilities <i>Needed</i> as a Function of MPO Size	90
4.6.2.4 Level of Detailed Transportation Mode and Terminal/Intermodal Transfer Facilities <i>Available</i> as a Function of MPO Size	92
4.6.3 Quality of the Available Freight Data	93
4.6.4 Significance of the Needed Freight Data	95
4.7 Freight Data Collection Methods	97
4.8 Suitability of Intelligent Transportation Systems in Supplying MPOs with the Needed Data	103
CHAPTER 5 – CONCLUSIONS	111
5.1 Findings from the Literature Review	111

5.2 Findings from the <i>Freight Data Needs</i>	114
REFERENCES	119
APPENDIX A	123

LIST OF FIGURES

Figure 2.1 Structural Approach for Urban Freight Demand Modeling	13
Figure 3.1 Primary and Secondary Freight Data Sources	36
Figure 3.2 Surveys and Traffic Counts: Approaches and Techniques	37
Figure 3.3 Primary Freight Data Source: ITS Data	43
Figure 4.1 Freight Planning in the Studied Metropolitan Regions.....	74
Figure 4.2 Freight Transportation Issues in the Studied Metropolitan Regions.....	75
Figure 4.3 Environmental Issues Consideration in Metropolitan Regions.....	76
Figure 4.4 Freight Component in the Travel Demand Model in the Studied Metropolitan Regions	77
Figure 4.5 Cargo Attribute Data Used or Needed by MPO Size.....	80
Figure 4.6 Transportation Mode and Terminal/Intermodal Transfer Facility Data Used or Needed by MPO Size	87
Figure 4.7 Quality of the Available Cargo Attributes	94
Figure 4.8 Quality of the Available Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Attributes	95
Figure 4.9 Significant of the Needed Cargo Attributes	96
Figure 4.10 Significant of the Needed Transportation Modes and Terminal/Intermodal	97
Figure 4.11 Freight Collection Methods Used in the Studied Locations as a Function of the MPO Size.....	99
Figure 4.12 ITS Technologies in the Studied Regions to Collect Freight Data as a Function of the MPO size	101
Figure 4.13 Public and Commercial Data Sources Used by the Studied Regions to Populate Freight Databases	102
Figure 4.14 Level of Deployment of ITS Technologies in the Studied Locations as a Function of the MPO Size	104
Figure 4.15 Existence of Archive Data User Service (ADUS) in the Studied Locations as a Function of the MPO Size	105

LIST OF TABLES

Table 2.1	Summary of Strategic Projects for Improving Freight Infrastructure Performance.....	7
Table 2.2	Summary of Strategic Measures for Improving Safety.....	8
Table 2.3	Market Sectors of Urban Freight.....	12
Table 2.4	Growth Factor Models.....	15
Table 2.5	Least-Square Regression Models for Trip Generation.....	17
Table 2.6	Trip Generation Rates.....	19
Table 2.7	Gravity Models for Freight Distribution	21
Table 3.1	Cargo Attributes and Level of Detail Relevant for Urban Freight Planning.....	30
Table 3.2	Road Transportation Mode Attributes and Level of Detail Relevant for Urban Freight Planning	31
Table 3.3	Major Freight Generator and Corridor Attributes and Level of Detail	32
Table 3.4	Non-Road Transportation Mode Attributes and Level of Detail.....	33
Table 3.5	Economic, Land-use, and Socio-economic Data Relevant for Urban Freight Planning.....	34
Table 3.6	Advantages and Disadvantages of Truck Travel Surveys and Traffic Count Techniques.....	38
Table 3.7	Advantages and Disadvantages of Video Surveillance and GPS Receiver.....	48
Table 3.8	Comparison of AVI versus Loop Detectors and GPS for the collection of Travel Time	49
Table 3.9	Categories and Subcategories of Secondary Data Sources	50
Table 3.10	Public and Commercial Data Sources	51
Table 3.11	Freight Data Provided by the Airport Activity Statistics of Certified Route Air Carrier.....	52
Table 3.12	Freight Data Provided by the Commodity Flow Survey (CFS)	53
Table 3.13	Freight Data Provided by the Freight Analysis Framework (FAF).....	54
Table 3.14	Freight Data Provided by the Freight Commodity Statistics.....	55
Table 3.15	Freight Data Provided by the Freight Transportation and Logistic Service.....	55
Table 3.16	Freight Data Provided by the Fresh Fruit and Vegetable Shipments	56

Table 3.17 Freight Data Provided by the LTL Commodity and Market Survey.....	57
Table 3.18 Freight Data Provided by the Nationwide Truck Activity and.....	58
Table 3.19 Freight Data Provided by the North American Truck Survey.....	59
Table 3.20 Freight Data Provided by the Port Import/Export Reporting Service	59
Table 3.21 Freight Data Provided by the Rail Waybill Sample	60
Table 3.22 Freight Data Provided by the State Estimate of Truck Traffic.....	60
Table 3.23 Freight Data Provided by the Reebie TRANSEARCH®.....	61
Table 3.24 Freight Data Provided by the Transborder Surface Freight Data.....	62
Table 3.25 Freight Data Provided by the U.S. Air Freight Origin Traffic Statistics.....	63
Table 3.26 Freight Data Provided by the U.S. Import/Export of Merchandise.....	64
Table 3.27 Freight Data Provided by the Vehicle Inventory and Use Survey	65
Table 4.1 <i>Freight Data Needs Survey</i> : Survey Content	71
Table 4.2 <i>Freight Data Needs Survey</i> : Response Rate.....	71
Table 4.3 Distribution of the MPO Size in the Studied Locations	72
Table 4.4 Air Quality in the Studied Metropolitan Regions.....	73
Table 4.5 Freight Transportation Modes and Transfer Facilities	73
Table 4.6 Cargo Attributes Available or Needed in the Studied Metropolitan Regions (based on the 65 surveyed MPOs	79
Table 4.7 Cargo Detail <i>Available</i> or <i>Needed</i> in the Studied Metropolitan Regions.....	81
Table 4.8 Cargo Detail <i>Needed</i> in the Studied Metropolitan Regions	83
Table 4.9 Cargo Detail <i>Available</i> in the Studied Metropolitan Regions	85
Table 4.10 Transportation Mode Attributes Available or Needed in the Studied Metropolitan Regions (based on the 65 surveyed MPOs).....	86
Table 4.11 Transportation Mode and Terminal/Intermodal Transfer Facilities Detail <i>Available</i> or <i>Needed</i> in the Studied Metropolitan Regions (based on valid responses)	89
Table 4.12 Transportation Modes and Terminal/Intermodal Transfer Facilities Detail <i>Needed</i> in the Studied Metropolitan Regions (based on valid responses).....	91
Table E 4.13 Transportation Modes and Terminal/Intermodal Transfer Facilities Detail <i>Available</i> in the Studied Metropolitan Regions (based on valid respondents).....	93

Table 4.14 Freight Data Collection Methods in the Studied Metropolitan Regions (based on the 65 surveyed MPOs)	98
Table 4.15 Number of Metropolitan Regions that use Archive ITS Data to Support Freight Planning Activities	105
Table 4.16 Relationships among ITS level of deployment in the Studied Locations and MPOs Users	106
Table 4.17 ITS Technologies which provide Cargo Detail Data	107
Table 4.18 ITS Technologies which Provide Highway/Truck Detail Data.....	108

CHAPTER 1 – INTRODUCTION

1.1 MOTIVATION

Transportation planning has traditionally suffered from a lack of reliable information regarding the operation of the transportation system and decision-making factors considered by travelers and shippers. This lack of information is strongly related to the cost and complexity of obtaining the required data. Data gaps are primarily found in three areas: socio-economic data for analyzing trip generation; traffic monitoring databases for evaluating environmental impacts; and commodity origin-destination data to both assign inter-city freight movements by truck and determine trip-generation factors for intra-urban truck movement¹. Moreover, the results of a freight survey conducted in March 2003 by the Association of Metropolitan Planning Organizations (AMPO) showed that, although Metropolitan Planning Organizations (MPOs) are addressing freight issues in their jurisdictions (80% include freight in their Long Range Transportation Plan), the most cited resource needed is more comprehensive data (by 80% of the respondents) to ensure effective freight planning².

The multimodal transportation planning concept, endorsed in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the 1990 Clear Air Act Amendments (CAAA), and then strengthened by the Transportation Equity Act for the 21st Century (TEA 21) of 1998, changed the course of transportation planning from an isolated to a coordinated and integrated process. Multimodal transportation activities undertaken by MPOs and state departments of transportation strive for equilibrium between transport demand and supply consistent with community goals³. That is, transportation plans, in addition to providing mobility and accommodating trip-making processes, should support local land use, protect the environment and neighborhoods, promote energy conservation, and advance economic productivity and growth. Thus, state and local governments are confronted with a rapidly changing focus and set of constraints as they provide mobility for both people and goods. Reliable data for freight planning is more difficult to obtain because the changing focus to achieve greater integration among freight transportation modes has added considerable complexity and additional requirements to the planning process. In fact, reliability and

predictability are an integral part of freight transportation in an era of tightly integrated operations and just-in-time inventories.

The providers of the U.S. freight transportation network are committed to providing efficient and reliable movement of goods to ensure the economic prosperity of the nation. According to Federal Highway Administration (2002)⁴, over 15 billion tons of goods, worth over \$9 trillion, were moved in 1998. Seventy-one percent of the total tonnage, which represents 80% of the total value of U.S. shipments, was moved by truck; and these trends will continue in 2010 and 2020. That is, the trucking industry will continue to dominate domestic freight transportation modes. Despite the increasing importance of freight transportation to the U.S. economy, public agencies continue to devote few resources to analyzing and forecasting good movements compared to those devoted to passenger travel planning. In fact, freight flow data at the local level is practically non-existent. However, data collected by electronic means, such as data collected by Intelligent Transportation Systems (ITS) technologies, could be used to gather information on urban truck patterns.

The ITS data collected in a number of major urban areas in the U.S. can improve the quality and quantity of information required to conduct freight planning⁵ and can be used to integrate passenger and freight demand in travel demand models. For example, such ITS technologies as loop detectors, automatic vehicle classification (AVC) equipment, automatic vehicle identification (AVI) equipment, and closed-circuit television cameras (CCTV), among others, can closely monitor the number, type, and identity of trucks and other vehicles moving on the highway system. In addition, Commercial Vehicle Operation (CVO) systems can provide a rich source of freight information, from cargo type and weight to origin-destination patterns, to mention a few. Since transportation planners have limited resources to collect pertinent primary freight-planning data, considerable reliance has been placed on the use of aggregate secondary sources. ITS data represents a disaggregated data source that can be invaluable to freight planning. Several stakeholder groups, including MPOs and state departments of transportation, have expressed an interest in the use of ITS data to support freight planning activities⁶.

1.2 PROBLEM STATEMENT

Many MPOs have identified the lack of affordable, useful freight data as a major concern. While national-level commodity flow information is available, it is provided at aggregate levels,

limiting its usefulness to metropolitan planning. Generally, MPOs have access to modest data on truck volumes, trip origins and destinations, and commodities being transported⁷. Consequently, planners have little sense of the holistic freight trip and do not know relevant details like origin, commodity characteristics, modes of travel used, routes, transfer points, and destination. This lack of widely available data makes it difficult to make informed decisions about freight transportation needs around which to formulate projects⁸.

Resources required by MPOs to conduct freight planning can be categorized as: staff resources, private sector participation, funding resources, and data and analytical tools. Effective freight planning relies on the availability of good freight flow data as well as on the development of appropriate tools with which to analyze and evaluate potential freight project impacts. However, the lack of consistent freight data sets has hampered modeling efforts. The lack of models underscores the need for freight analysis and forecasting. Without detailed data on local commodity flows, MPOs find it difficult to conduct even rudimentary freight planning⁹.

1.3 RESEARCH OBJECTIVES AND APPROACH

The primary purpose of this study is to identify the ITS opportunities available for improving the efficiency and effectiveness of collecting freight data by MPOs. This requires assessing current data needs and determining whether the use of archived ITS data can provide the desirable data. Special emphasis is given to road freight since it is the predominant mode of urban freight transportation. More specifically, the objectives of this study are to identify:

1. Data required to conduct meaningful freight planning at the metropolitan level;
2. Freight data collected by primary and secondary data sources;
3. Needed and available freight data at the metropolitan level; and
4. The ITS technologies that can supply MPOs with the needed freight data.

At the conclusion of this study, planners and decision makers at the metropolitan level will be able to recognize opportunities to extract freight data from ITS applications in their regions. As data collection and model development are closely interrelated, the availability of new information could support the construction of new analytical models and provide a much better assessment of the effects of transportation system changes proposed by planners and decision makers.

1.4 RESEARCH APPROACH

To achieve the specific objectives stated above, three major tasks were identified. First, an in-depth literature review was conducted that covered the following:

1. The most relevant freight issues faced by MPOs;
2. Urban travel forecasting practices and data requirements for freight modeling;
3. Available public and commercial freight data sources and their strengths and limitations for supporting planning activities at the metropolitan level; and
4. The full spectrum of ITS freight data available.

Second, a comprehensive questionnaire was administered to MPOs to ascertain freight data used and needed at the metropolitan regions. This questionnaire focused on the freight issues confronting these organizations, data collection methods, and analytical tools currently used by MPOs to forecast freight transportation demand in their regions. Finally, relationships between freight data needs and available ITS freight data were identified and presented in tables. This report is organized around these major tasks.

1.5 REPORT ORGANIZATION

A chapter is dedicated to each major activity conducted in this study. Chapters 2 and 3 present the findings from the literature review. Chapter 2 points out the relevant planning issues MPOs have to contend with, the underlying factors that affect the demand for freight, and the approaches to model urban freight demand. Chapter 3 presents the data requirements for urban freight planning and freight data sources. Chapter 4 presents and discusses the results of the *Freight Data Needs Survey* in terms of freight issues at the metropolitan level, freight data currently used and needed by MPOs, the perceived quality of the available data and importance of the needed data, collection methods, the state-of-the-art practice in the use of ITS data to fill much-needed freight data gaps, and how the ITS data can address the freight data needs of MPOs. The final chapter summarizes the findings of this study and provides possible areas to extend present work in this field.

CHAPTER 2 – URBAN FREIGHT TRANSPORTATION

MPOs are responsible for identifying future transportation needs in their planning areas and programming the federal funds for such projects and programs. This objective is achieved primarily through the development of a long-range transportation plan that provides a multi-modal investment strategy for meeting the mobility needs of people and goods over the next 20 years and secondarily through a short-range transportation improvement program which prioritizes improvement projects for federal funding. Due to the significant and continued growth of freight activities in metropolitan areas, MPOs today are challenged to integrate the movement of people and freight in their demand models to analyze the impact of domestic and through passengers and freight traffic in their areas. This chapter reviews (1) relevant planning issues MPOs have to contend with due to infrastructure constraints and safety and environmental concerns, (2) the underlying factors that affect the demand for freight, and (3) the proposed approaches to forecast freight transportation demand at the metropolitan level.

2.1 MPOs FREIGHT CHALLENGES

Demand for freight movements is growing at a faster rate than personal travel in many metropolitan areas. Several factors have spurred this growth. The deregulation of the trucking, rail, and air industry since 1975 has significantly reduced the operating costs of these modes, thus promoting the entry of new carriers, services, and routes. The growth in containerization revolutionized cargo shipping and freight logistics in the 20th century, resulting in the internationalization of supply chains. The liberalization of trade policies, such as the Pacific Rim Trade and the North American Free Trade Agreement (NAFTA), and the use of advanced information and communication technologies have resulted in significant changes in U.S. freight movement patterns. Furthermore, total freight tonnage carried by all modes (truck, rail, water, and air) is thus expected to grow by nearly 70% by 2020¹⁰. Therefore, transportation systems will have to be upgraded to meet the increased demand.

2.2.1 Infrastructure Challenges

For the most part, the freight traffic growth will be handled by the existing intermodal transportation system, essentially the existing main transportation routes, intermodal connectors,

and intermodal/multimodal facilities and terminals. Intermodal/multimodal facilities and terminals refer to airports, seaports, inland ports, and rail yards. Usually, the weakest links in the supply chain have been the ports and terminals because of the unreliability of highways and rail access to these facilities. Both trucks and intermodal rail operators, for instance, are frequently caught in and contribute to congestion, diminishing the reliability and predictability of the intermodal service for shippers and receivers. To relieve bottlenecks at ports, planning authorities have proposed, for example, to increase the capacity of access routes. Usually access roads to ports do not have the capacity to handle high volumes of truck traffic, partly because these roads were originally designed for much lower truck sizes and weights than those currently permitted. On the other hand, the expansion of these connectors has usually encountered resistance from neighborhoods, which argue that the movement of trucks through residential areas pollutes the air, increases noise, and reduces highway safety. This situation challenges MPOs to formulate projects that provide seamless and end-to-end intermodal travel for passengers and goods, while, at the same time, reducing fuel consumption and negative environmental impacts on adjacent neighborhoods.

Capacity and congestion problems will continue to persist along these connectors because international, national, regional, and local supply chains and distribution networks prevail. Freight traffic, and in particular road hauling, are a major source of congestion and pavement deterioration in urban areas. It was estimated that 4.5 billion hours of highway delays occurred in 68 urban areas in 1999¹¹. No single solution exists to this serious problem. Remedying congestion-related problems requires a combination of various strategic projects pertaining to capacity enhancements, system preservation, operational improvements, and demand management. Table 2.1 summarizes some of the potential investments that a metropolitan region could make to deal with freight infrastructure issues. Even though the list provided in Table 2.1 is not exhaustive, it illustrates the data MPOs need to analyze the most common freight issues at the metropolitan level.

**TABLE 2.1 Summary of Strategic Projects for Improving
Freight Infrastructure Performance**

CAPACITY ENHANCEMENT
Truck lane facilities
Access roads to rail intermodal yards
Alleviating rail freight bottlenecks
Landside access to airports and seaports
Reconfiguration of terminals
Restore abandoned rail lines
System Preservation
Pavement rehabilitation
Bridge rehabilitation
Maintenance and rehabilitation of rail tracks
Maintenance and rehabilitation of terminals
Dredging port channels
Operational Improvements
Dedicated truck routes
Routing restrictions for heavy loads
Improved management of inbound truck and container traffic at terminals
Improved mobility of trucks exiting terminal gates by adjusting street traffic signals
Managing curb space for freight deliveries
Traffic surveillance to provide motor carries with real-time information on incidents, weather, congestion, and other traffic conditions
Emergency management and incident response systems for truck routes
Demand Management
Tolls/Value pricing/Congestion pricing
Peak and off-peak delivery for freight

2.2.2 Safety Challenges

Safety concerns are mainly attributable to the increasing volume of freight and passenger traffic sharing the same transportation infrastructure, and the presence of safety hazards, such as highway-rail grade crossings, low-clearance bridges, and hazardous material shipments, to mention a few. Accidents involving trucks and passenger cars present more severe consequences to car occupants than accidents involving only passenger cars. In fact, figures from 2002 reveal that 4,542 fatal accidents involved large trucks and 79% of these fatalities happened to occupants of passenger cars¹². In addition, truck accidents that result in closed or

blocked highways have a significant economic impact due to traffic delays and environmental damage. At the metropolitan level several measures have been proposed to minimize the risk of accidents between trucks and cars and the associated consequences (i.e., injuries, fatalities, damage to property, damage to the environment, and traffic delays). Some of these measures are summarized in Table 2.2.

TABLE 2.2 Summary of Strategic Measures for Improving Safety

Dedicated truck-only lanes
Grade separation for existing at-grade highway-railroad crossings
At grade separation through signalization
Highway geometry improvements
Structural vertical clearance for truck movements
Structural vertical clearance for double stacking and railroad electrification
Dedicated routes for hazardous materials shipment
Bridge weight restrictions
Prohibiting trucks to travel through neighborhoods
Geometric and operational improvements at intersections
Provide pre-trip information to safer travel routes
Roadside devices
Road geometry warnings

Strategic projects for improving freight infrastructure performance, such as those mentioned in Table 2.1, also contribute to enhancing transportation safety.

2.2.3 Environmental Challenges

Adverse environmental impacts of freight movements in major urban areas include a decline in air quality, noise pollution, and wetland deterioration. Most of these adverse impacts are associated with the movement of trucks. First, even though nearly all transportation modes rely on the burning of fossil fuels, diesel-powered heavy duty trucks produce significant amounts of pollutant emissions, especially particulate matter (PM) and nitrogen oxides (NOx), which affect air quality negatively. Second, trucks traveling through neighborhoods and rail lines running adjacent to residential areas pollute the environment with noise. Finally, the potential impact of accidents involving hazardous material spills, for example, can cause substantial ecological damage to wetlands. In response to these environmental concerns, MPOs have increased their attention toward projects that promote the preservation of natural resources and the environment. Strategic projects and safety measures for improving freight infrastructure, as

mentioned in Tables 2.1 and 2.2, contribute to the protection of air quality and wetlands, and to the prevention of noise pollution. For example, projects to improve landside access to airports and seaports decrease congestion and thus reduce idling emissions and fuel consumption. It should be noted, however, that these benefits are usually somewhat offset by increased truck traffic.

In conclusion, the most adverse social and environmental impacts of freight movements occur in major urban areas. Freight vehicles are an important cause of urban congestion and pavement deterioration. Truck movements through urban areas also raise safety and environmental concerns. Several measures, however, can be implemented in response to these issues. These types of issues present special challenges for the MPOs, which are responsible for the efficient operation of their transportation systems. Recognizing all these issues is important to understand and model freight patterns and their implications in urban areas.

2.2 FREIGHT URBAN DEMAND MODELING

Freight demand modeling can help MPO planners to understand urban freight patterns and to formulate and evaluate strategies or policies to improve the efficiency of goods movement. In particular, urban freight modeling can shed light on infrastructure, safety, and environmental issues (such as those discussed in the previous chapter) pertaining to the transportation system. This procedure will enable planners to identify and evaluate alternative actions based on performance measures obtained through the modeling process. The proposed methodologies in the literature aim to integrate the freight component into the urban travel demand modeling process, taking into consideration the underlying factors that affect the demand for freight.

2.2.1 Characteristics of Freight Movement

The factors influencing the demand for freight are more complex than those influencing the demand for passengers^{13,14}. The most relevant factors can be categorized as follows: number of and characteristics of the decision makers, diversity of commodities, origin-destination patterns, data on freight cost, units for freight movements, and variety of activities at the urban level. These factors are briefly discussed below.

First, freight transportation services are provided by private enterprises that involve more decision makers than in the movement of passengers. Some of the decision makers are: the *firms*

or *individuals* sending and receiving the goods, the *shippers* and *receivers* organizing the consignments and modes, the *carriers* undertaking the movement, and *several other companies* responsible for transshipment, storage, and terminal facilities. These decision makers determine whether or not a particular shipment is made and, if so, when, by what transportation mode, what shipment size, and by what route.

Second, the range and diversity of commodities, in terms of their characteristics, values, and time sensitivity, determines the most suitable freight vehicle in which commodities should be transported. Commodities transported range from food products to petroleum products, textile goods, building and construction materials, and machinery, to mention a few. The characteristics of these commodities make some freight vehicles more appropriate than others for their transportation. For example, refrigerated containers are used to transport perishable commodities while security vehicles are used to move expensive items, such as money destined for banks. This variability in matching freight modes with commodity characteristics is greater for freight than for passenger modes and people. Furthermore, time value exhibits a much wider range for freight than for passengers, adding more complexity to the freight modeling process¹⁵.

Third, because of the wide range of commodities, freight movements as well as their origins and destinations are much more complex than even the most detailed segmentation of passengers (e.g., by person type or trip purpose). Goods movement is always a function of derived demand from economic activities and relationships between suppliers at the origins and consumer demand at the destinations. In other words, the origin and destination patterns of a given product will be determined by the location of primary supply sources, other inputs needed to finish the product, and the location of manufacturers, distribution centers, retailers, and markets for that product. In addition, seasonal factors and consumer tastes play an important role in changing goods movement patterns.

Fourth, while information about transportation cost for passengers is well-known, it is very problematic to get reliable data on freight cost. Several factors affect freight cost but the two most significant are drivers' wages and the fuel price [REF]. Also, both freight carriers and shippers believe that the disclosure of freight charges could undermine their competitiveness so this information is kept confidential in an effort to strengthen their position with respect to their competitors.

Fifth, because freight movements are described in various units (value, weight, volume), planners have to deal with data transformation during the modeling process. This process sometimes may not represent the actual freight patterns at the urban level because many goods are transported by pick-up and delivery vehicles handling assorted cargo so that there is not a clear relationship between shipment characteristics (e.g., value, weight, volume) and truck characteristics¹⁶. Some models, however, estimate average vehicle payload factors by commodity (also known as truck conversion factors) to determine the number of truck trips on the road at certain times of day. However, this approach does not produce high-quality information on trip ends if many of these trips have chained trip segments¹⁷. Another problem persists if freight movements at the urban level are expressed in value units (e.g., dollars), and have to be transformed into truck trips. Even if the average value per ton were known at the urban level, this transformation would be complicated by the fact that a given monetary value transported between an origin-destination pair may be the result of several shipments and load types¹⁸.

Sixth, although nearly all freight in urban areas is moved by trucks, it is a very complex system because of the following factors:

1. It is part of a logistic chain that links private equipment, services, and facilities, but it operates in a public environment (i.e. right of way is public).
2. Freight trips can be direct or chained. In the former, trips are usually made by large trucks delivering full loads (i.e., full-truckload or FTL) to a single destination and traveling longer distances. In the latter, trips are usually made by light trucks or other types of pick-up and delivery vehicles handling mixed freight and parcels (i.e., less-than-truckload or LTL) and traveling very short distances.
3. Some freight trips have to use designated routes due to the nature of the commodities transported (e.g., for heavy trucks and hazardous materials).

To deal with the complexity of urban freight transport, D'Este¹⁹ recommends partitioning the freight market into several *sectors* that are similar in terms of type of commodities transported, type of load, vehicle types, route flexibility, and trip characteristics (see Table 2.3).

TABLE 2.3 Market Sectors of Urban Freight

Market Sector	Truck Type	Commodity	Load Type	Route	Trip Type
Courier	Small	Mixed	LTL	Variable	Very complex linked trips
General Courier	Intermediate size	Mixed	LTL or FTL	Variable	Simple or linked trips
Specialist commodities	Large	Specific	FTL	Regular	Mostly simple trips
Oversized or hazardous	Large	Specific	FTL	Fixed	Simple trips
External	Large	Mixed or specific	FTL	Regular	Simple trips

Source: D'Este (2000)

From the previous discussion, it is obvious that the underlying factors that affect the demand for freight provide unique challenges to MPOs and other public planning agencies responsible for ensuring that the transportation system meets community standards in terms of efficiency, safety, and environmental protection. According to D'Este (2000)²⁰, in particular, urban freight modeling can shed light on such issues as:

- the contribution of freight vehicles to urban congestion and pavement deterioration;
- the environmental and social impacts of urban freight vehicles;
- urban freight-distribution patterns;
- the role of urban freight operations in the overall supply chain;
- the role of urban freight movements in contributing to the economic vitality of the urban area;
- the competition and demand of different freight modes; and
- the impacts of regulatory policies that affect the urban freight system.

Because the most appropriate mode of freight transportation at the urban level is *truck-based transportation*, approaches to integrate truck travel into the travel forecasting process should take into consideration its multifaceted aspects.

2.2.2 Approaches for Modeling Urban Freight Demand

Several approaches have been suggested to model urban freight demand. A proposed classification categorized these approaches into the structural approach and the direct approach²¹. The structural approach to freight modeling integrates the freight component of the urban

transportation system into the standard four-step travel forecasting process (i.e., freight generation, freight distribution, freight mode choice, and freight route assignment) and estimates the entire demand for the two components of the system, -- passengers and freight²². The direct approach to freight modeling is a simplification of the structural approach in that it forecasts the freight demand for specific components of the system (i.e., corridor, freight transfer facility, etc.).

The structured process, as shown in Figure 2.1, can be conducted using two sub-approaches: (1) the **vehicle-based approach**, which focuses on commercial vehicle trips, and (2) the **commodity-based approach**, which focuses on commodity flows. Freight generation is concerned with estimating the number of freight movements produced by and attracted to each analysis zone in terms of the amount of goods (e.g., consignments, tonnage, etc.) or the number of vehicles required to transport the goods (e.g., truck trips, trips by vehicle type, etc). Freight distribution links vehicle trip ends (i.e., origins and destinations) or commodity flow ends (i.e., origins and destinations) between analysis zones, including external zones. Freight distribution is essentially a destination-choice model that produces a vehicle trip or commodity origin-destination matrix or table. Freight mode choice is concerned with predicting commodity flows (e.g., volume) from the available freight transportation modes between all origin-destination pairs. Finally, freight-route assignments estimate which routes will be taken by freight vehicles to transport commodities between each origin and each destination.

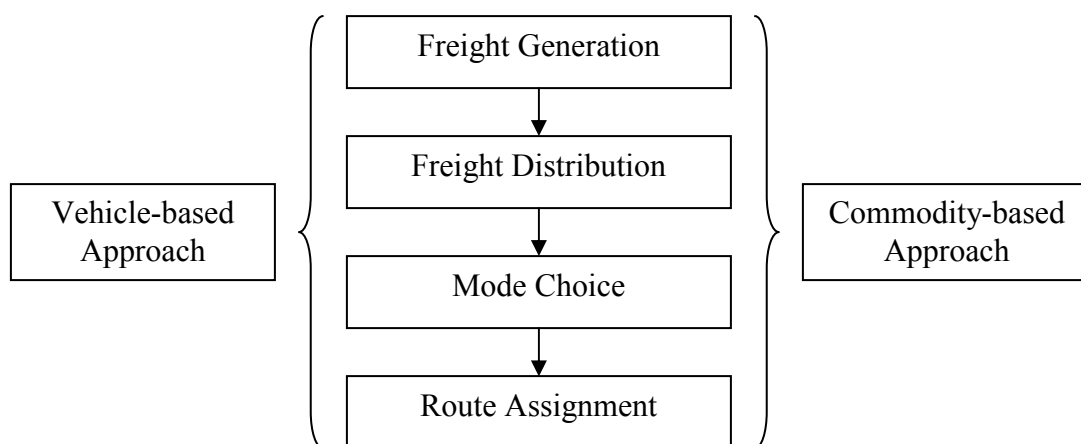


FIGURE 2.1 Structural Approach for Urban Freight Demand Modeling

The special features of models and techniques embedded in these approaches in terms of its capabilities and freight data requirements make some of them more appealing for application at the metropolitan level. This subject is the topic of the following subsections.

2.2.2.1 Freight Generation and Distribution. According to Pendyala (2002)²³, the movement of goods is generated from different trip purposes which can be broadly classified as:

- movement of goods directly from producers to consumers;
- movement of goods through multi-channel distribution chains that involves warehousing operations; and
- movement of goods from one mode to another (i.e., transshipment or intermodal movements).

In the structural approach, freight traffic generation and distribution are often thought of as separate steps, but whether this is actually the case depends on the available data. These two steps are combined when commercial vehicle trips and commodity data are available. In contrast, if data are missing, freight generation and distribution are treated separately. In this case simulation techniques are used to estimate the vehicle trips or commodity flow matrix in the base year. Several types of matrices can be estimated as part of the freight generation and distribution steps, ranging from a single origin-destination matrix that represents vehicle trips or commodity flows between analysis zones in the base year, to several matrices that represent vehicle trips or commodity flows between analysis zones in future years. In either case, freight distribution patterns can be classified in three separate categories:

- origin and destination within the study area (internal trips);
- origin or destination outside of the study area (internal to external trips or external to internal trips); and
- origin and destination outside of the study area (external trips).

Some of the most popular techniques to develop demand-generation models for freight are **growth factor methods**, **regression techniques**, and **generation rates**. For freight distribution, the most commonly used techniques are the **Gravity Model** and the **linear programming approach**.

Growth factor methods forecast changes in the demand for freight based on changes in *freight traffic data* or *economic indicators* following the model structures presented²⁴ in Table 2.4. Some of the most common economic variables used for these models are: *value of output*

(measured in constant dollars) and *volume shipped* (measured in pounds, tons, etc.) for commodity types or groups, *employment* and *earnings* by industrial sector, *output per employee*, *population*, and *personal income*. The computation of the annual growth factor (f) for the freight demand variable to be forecasted requires historical trend data that are generally available at the urban level. However, factors that potentially could change the demand for freight, such as commodity values, transportation costs, and competition between freight transportation modes, to mention a few, are ignored in the model structure. In addition, the model structure implies there is a relative constant growth rate in the demand for freight transportation equal to the percentage change in the corresponding independent variable (i.e., truck trip volumes or economic indicators). In reality such a relation cannot be assumed; the underlying factors change over time and not all of them follow the same trends²⁵. As a result, MPOs generally use these models to estimate the freight demand for external trips²⁶.

TABLE 2.4 Growth Factor Models

1. Based on Historical Traffic Trends $T_i = T_2 f_i^{Y_n - Y_2} \quad \text{and} \quad f_i = \left(\frac{T_2}{T_1} \right)^{\frac{1}{Y_2 - Y_1}}$ where: T_i = future freight traffic (i.e. number of trucks trips) in year n for zone i f_i = annual growth factor for zone i T_1, T_2 = freight traffic (i.e. number of truck trips) in years 1 and 2 respectively for zone i Y_2, Y_1 = years 1 and 2 respectively Y_n = future year n
2. Based on Economic Indicators $T_i = T_b f_i^n \quad \text{and} \quad f_i = \left(\frac{I_2}{I_1} \right)^{\frac{1}{Y_2 - Y_1}}$ where: T_f = future freight traffic (for a specific commodity or industrial group) in year n for zone i f_i = annual growth factor for zone i T_b = freight traffic (for a specific commodity or industrial group) in the based year b for zone i I_1, I_2 = value of economic indicators in years 1 and 2 respectively Y_2, Y_1 = years 1 and 2 respectively n = number of years in the forecasted period

Source: Adapted from Cambridge Systematic (1996)

Regression techniques estimate freight demand based on the socio-economic and land-use characteristics of the analysis zones, such as *population*, *number of households*, *income*, and *employment*, *floor area*, and *land* by land-use type (i.e., Standard Industrial Classification or SIC). Regression techniques include least square regression models, which are generally linear, and category or cross classification analysis, which assumes no particular functional form for the relationship between the response (i.e., dependent) and the explanatory (i.e., independent) variables. Table 2.5 shows, first, the functional form of the least-square regression model; second, commodity-generation models based on data from Melbourne (Australia); and third, vehicle-generation models based on data from North-East Illinois/North-West Indiana (U.S.).

Generation rates can be developed based on truck trip data or commodity flow data. The vehicle-based approach uses *land use data* to estimate the number of truck trips that are produced by and are attracted to each analysis zone. Land uses are categorized as the origins and destinations of freight movements that reflect the intensity of production and consumption activities between zones. The most common input data is *number of households* and *employment by land use* in each analysis zone. The Quick Response Procedure²⁷, for example, provides default trip rates for three classes of commercial vehicles and four employment categories or land use (see Table 2.6). These rates were developed as part of the Phoenix urban truck travel model study²⁸. Some regions have already adjusted these default rates. For example, the I-75 North-South Transportation Initiative Truck Model²⁹ multiplied the default values by factors of 0.952 for single-unit trucks with six or more tires and 0.683 for combination trucks (see Table 2.6). Given these trip rates, the demand for freight in a region can be forecasted based on the number of households and employment by land use in each analysis zone within the study area.

TABLE 2.5 Least-Square Regression Models for Trip Generation

1. Model Structure

$$T_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \dots + e_i$$

where:

T_i = freight traffic (commodity volumes or truck trips) generated from zone i

x_{ni} = the value of the n^{th} explanatory variable observed for zone i

β_o = a constant

β_k = coefficients which represent the numerical effect on trip generation that would result from a unit increase in the variable x_{ni}

e_i = residual

2. Commodity-Generation Models based on data from Melbourne, Australia

Source: Ogden (1978)

Commodity (k)

Q_k

Food and Agriculture

$-3.91 + 0.0894 \ x_{2i} + 0.0158 \ x_{9i} \quad (R^2 = 0.65)$

Building Materials

$333 + 0.0957 \ x_{4i} + 0.138 \ x_{8i} \quad (R^2 = 0.44)$

Petroleum Products

$-731 + 0.0798 \ x_{2i} + 0.146 \ x_{4i} \quad (R^2 = 0.67)$

where:

Q_k = volume (e.g., ton) of commodity k attracted to or produced by zone i

x_{1i} = white collar employment in zone i

x_{2i} = blue collar employment in zone i

x_{4i} = manufacturing employment in zone i

x_{8i} = population in zone

x_{9i} = number of households in zone i

3. Vehicle-Generation Models based on data from NE Illinois/NW Indiana, U.S.

Source: Cambridge Systematics, 1996

T_l

Commercial Vehicle

Manufacturing
(SIC: 20-39)

Transportation, Communication,
Utilities (SIC: 40-49)

4-Tire

$253.8 + 2.1 \ y_1$

$279.3 + 7.77 \ y_2$

6+ Tire Single Unit

$257.6 + 5.11 \ y_1$

6+ Tire Combination Unit

$271.6 + 2.3 \ y_1$

$390.4 + 10.5 \ y_2$

All 6+ Tire

$529.2 + 7.41 \ y_1$

All

$730.6 + 9.78 y_1$

$1,384.1 + 10.3 \ y_2$

$(R^2 = 0.25 \text{ to } 0.58)$

$(R^2 = 0.21 \text{ to } 0.65)$

where:

T_l = daily commercial vehicle trips by land use l

y_1 = employment at manufacturing sites

y_2 = employment at transportation, communication, and utilities sites

The commodity-based approach uses *economic data* and *input-output* tables to estimate commodities produced and consumed in each analysis zone³⁰. This approach represents the economic activities and the relationships between producers and consumers that generate the basic demand for goods and services. Generally this approach starts with a known region-to-region commodity flow table and disaggregates inbound and outbound flows to the analysis zones based on economic data that reflects the intensity of production and consumption activities in those zones. Economic data may include, for example, *levels of industrial production* and *employment in the producing and consuming industries*. In this case the commodity to be shipped is known and, based on the economic relationships (derived from economic data) among zones, it is possible to link goods movements from producers to consumers. This approach requires commodity shipment volumes or tonnage to be converted into truck trips. It is achieved using simple methods, such as the average vehicle payload factors by commodity, or more complicated methods, such as empty trip models³¹. Factors to convert annual tonnage into annual trucks were developed from the Vehicle Inventory and Usage Survey (VIUS). In addition, Cambridge Systematic has developed conversion factors using Reebie-based commodity flow data and the VIUS data³².

Procedures to estimate trip generation rates for major intermodal/multimodal facilities and terminals have also been developed. These procedures highlight the importance of providing accurate estimates of the number of trips generated at the facility based on land use and economic activity data to capture the total demand for freight transportation³³. Such data include: *land area, floor area, number of employees, commodity types produced and consumed, shipment characteristics (e.g., value, weight, volume) produced and consumed, location of the markets for the commodities produced and consumed, sizes and capacities of the vehicles serving the facility, average daily truck activity by truck classification, modes available, frequency and scheduling of shipments, storage and handling operations at the facility, and geometric and operational characteristics of the access roads*.

TABLE 2.6 Trip Generation Rates

1. Quick Response Procedure Source: Cambridge Systematics (1996)				
Commercial Vehicle Trips Destinations (or Origin) per Unit per Day				
Employment Category	Four-tire vehicle	Single-unit trucks with six or more tires	Combinations	Total
Agriculture, Mining, and Construction	1.110	0.289	0.174	1.573
Manufacturing, Transportation, Communication, Utilities, and Wholesale Trade	0.938	0.242	0.104	1.284
Retail Trade	0.888	0.253	0.065	1.206
Office and Services	0.437	0.068	0.009	0.514
Households	0.251	0.099	0.038	0.388
2. Adjusted Truck Trip Generation Rates Source: Gliebe (2003)				
Commercial Vehicle Trips Destinations (or Origin) per Unit per Day				
Employment Category	Single unit trucks with six or more tires		Combinations	
Agriculture, Mining, and Construction	0.275		0.119	
Manufacturing, Transportation, Communication, Utilities, and Wholesale Trade	0.230		0.071	
Retail Trade	0.241		0.044	
Office and Services	0.065		0.006	
Households	0.094		0.026	

The **Gravity Model** is the most popular technique for modeling trip distribution. Gravity models use measures of impedance (i.e., resistance to movement), accessibility (i.e., ease of movement), scaling constants, and other calibration constants to account for imperfect correlation between the model and observed values. An important model assumption concerns how to deal with the effects of time. The easiest assumption is that time has no effect on the calibration constants. Several functional forms of the Gravity Model are found in the literature. Table 2.7 shows the origin-constrained Gravity Model presented in the Quick Response Procedure³⁴, a destination-constrained Gravity Model based on inter-zonal commodity flows³⁵, and a commodity Gravity Model with an exponential deterrence function presented by Ortúzar *et al.*³⁶. As can be seen in Table 2.7, the deterrence functions involve generalized measures of

travel time and *distance* or *transportation costs* because vehicle trips or commodity flows distributed between the zones disregard the links between economic activities that generate and attract freight movements. The model is thus appropriate to model state-to-state commodity flows as well as regional and local freight movements that are heavily influenced by trip distance or cost³⁷. At the urban level, the distribution of some freight movements may, however, not be solely related to distance or cost. Instead, measures of zonal attractiveness for the commodities should be included in the model.

The Gravity Model should follow an iterative process so the number of vehicle trips or commodity flows ending in a given zone match the desired number of destinations. As mentioned before, trip impedance variables (i.e., friction factors) can include *travel time*, *distance*, and *generalized transportation costs*. The model is calibrated by comparing the *trip length distribution* (TLD) and the *average trip length* to the observed values. The TLD describes how freight demand declines relative to the impedance variable. While the commodity-based models use commodity TLD, vehicle-based models typically use vehicle TLD in their respective distribution models. This assures uniformity with the previous step of trip generation modeling. Because travel time and distance among analysis zones and trip length distribution by commercial vehicle types are generally known at the urban level, this model is widely used by MPOs. As a result, Gravity Models have been generally applied to vehicle trips rather than commodity flows at the metropolitan level. This is in part due to the lack of commodity flow data to calibrate the model. However, if commodity flow and truck flow origin-destination matrixes were available, vehicle TLD and commodity TLD could be estimated for various commodity groups and/or types of vehicles, which could shed light on the formulation of destination choice models by trip purpose (i.e., from producers to consumers, through multi-channel distribution chains, and among transportation modes) and economic sectors (e.g., agriculture/forestry/fishing, mining, construction, transportation/communications, manufacturing, gas and sanitary services, wholesale trade, retail trade, services, etc.) at the metropolitan level. Current freight distribution models have other limitations that are pointed out in the following three paragraphs.

TABLE 2.7 Gravity Models for Freight Distribution

1. Gravity Model in the Quick Response Procedure

Source: Cambridge Systematics (1996)

$$T_{ij} = \frac{O_i D_j F_{ij}}{\sum_{j=1}^n D_j F_{ij}}$$

where:

- T_{ij} = commercial vehicle trips (volume) from origin zone i to destination zone j
 O_i = total commercial vehicle trips originating at zone i
 D_j = total commercial vehicle trips destined at zone j
 F_{ij} = friction factor for trip interchange between origin zone i and destination zone j
 n = number of analysis zones within the study area
 i, j = analysis zone indexes

2. Commodity Distribution Model

Source: Ogden (1978)

$$Q_{ij}^k = \frac{O_i^k D_j^k d_{ij}^{-b}}{\sum_{j=1}^n \left(O_i^k d_{ij}^{-b} \right)}$$

where:

- Q_{ij}^k = volume (e.g., ton) of commodity k moved from origin zone i to destination zone j
 O_i^k = total production of commodity k in zone i
 D_j^k = total attraction of commodity k in zone j
 d_{ij} = airline distance between zone i and zone j
 b = calibration constant
 i, j = analysis zone indexes

3. Commodity Distribution Model

Source: Ortúzar *et al.* (1990)

$$T_{ij}^k = A_i^k B_j^k O_i^k D_j^k \exp\left(-\beta^k C_{ij}^k\right)$$

where:

- T_{ij}^k = volume (e.g., ton) of product k moved from origin zone i to destination zone j
 A_i^k, B_j^k = balancing factors
 O_i^k = supply for commodity k at zone i
 D_j^k = demand for commodity k at zone j
 β_k = calibration parameters
 C_{ij}^k = generalized transportation costs per volume of commodity k between zones i and j
 k = commodity type index
 i, j = analysis zone indexes

First, destination choice models for freight trip chains are a critical shortcoming in many urban freight models³⁸. For example, the commodity-based approach focuses on movement of goods directly from producers to consumers, so it tends to overlook freight movements that involve multi-channel distribution chains (e.g., wholesalers, warehousing operations) as well as transshipment and intermodal movements, which are important components of freight movement patterns in metropolitan areas. As a result, freight trip chaining behavior is not adequately modeled. There is also a need to characterize distribution chains by commodity type and develop truck trip generation rates, tour lengths, number of stops per tour, and typical shipment sizes. Shipment details such as *value, weight, volume, size, mode of transportation, average tour length, number of stops per tour, and load type (i.e., LTL or FT)*, are needed to enhance destination choice models. This is more critical for local truck movements than for long-haul movements. In the case of long-haul movements, the relationship between producer and consumer results in truck trips being made by large vehicles, minimizing trip chains. For local truck movements, however, there is a wider range of trip purposes and vehicle types so that trip chaining is a significant factor.

Second, MPOs have to deal with whether to develop freight destination choice models for different vehicle types (i.e., truck size), or allocate shipments to vehicles of different sizes in a variation of the mode choice or modal diversion model³⁹. Once commodity flows between origins and destinations have been determined, freight volumes have to be converted to truck trip origin-destination patterns using average payload factors by vehicle types. For some industries and commodities, such a relation is straightforward because the links connecting them are clear. However, many urban goods are moved by pick-up and delivery vehicles handling assorted cargo, making the relationship between vehicle loadings and vehicle capacities very complex⁴⁰. If average vehicle payload factors for urban cargo can be determined, segregating trucks of different sizes for destination modeling purposes provides an opportunity to capture the factors that influence destination choice, which are not well captured in models that do not consider activities at trip ends. Moreover, *truck size* is an important variable for determining congestion, air quality, and road wear associated with truck traffic in urban areas⁴¹.

Third, some MPOs have developed separated destination choice models for external and internal truck trips. This is due to (1) different data collection methods and data sets are used to estimate the models, and (2) the factors that influence destination choice in long-haul movements

differ from those that influence local truck movements. However, the external collection surveys do not capture the internal trips made by commercial vehicles leaving or entering the study area so that internal and external models seem to be disconnected⁴². Improvements to the data collection methods are needed to provide the missing data.

The **Linear Programming** (LP) transportation model is a flow optimization technique that produces optimal assignments of origin quantities to destinations. An inherent constraint that must be present in this model is that the sum of the origin quantities must equal the destination demands. The objective function of the freight distribution model is to satisfy a given demand from a given supply at minimal monetary cost. The model does not attempt to reflect the pattern shown by the vehicle trip or commodity origin-destination matrix or table, but set about to improve the pattern according to the objective function. A simple formulation of this transportation problem can be written as follows:

$$\begin{aligned}
 & \text{Minimize } Z = \sum_{ij} T_{ij} C_{ij} \\
 & \text{subject to : } \quad \sum_i T_{ij} = D_j \dots \text{ demand constraint} \\
 & \quad \quad \quad \sum_j T_{ij} = O_i \dots \text{ supply constraint} \\
 & \text{where : } \quad T_{ij} = \text{total freight traffic from origin zone } i \text{ to destination zone } j \\
 & \quad \quad C_{ij} = \text{total haulage cost from origin zone } i \text{ to destination zone } j \\
 & \quad \quad O_i = \text{total trips originating at zone } i \\
 & \quad \quad D_j = \text{total trips destined at zone } j
 \end{aligned}$$

More advanced formulations of the transportation model may involve more sophisticated constraints,⁴³ such as non-linear costs, time constraints, and minimum shipment size constraints, to mention a few. No application of LP at the urban level was found in the literature review.

2.2.2.2 Freight Mode Choice. Mode choice has traditionally been considered irrelevant at the urban level because most of the freight movements occurring are by truck. However, to determine the impact of (a) freight moved by different truck types, (b) truck access requirements of multimodal facilities, (c) changes in modal shares (generally between truck and rail) due to the development of new intermodal/multimodal facilities or terminals, and (d) transportation congestion management (TCM) policies, more refined and sensitive models are

needed in many metropolitan areas. This section points out the most common applications of mode choice models at the metropolitan level as well as the strength and limitation of the available approaches.

According to Pendyala⁴⁴ (2002), there are two general approaches to freight mode choice models for urban planning. First, **traditional mode choice models** have been used to predict future volumes of freight traffic due to economic and trade growth, thereby estimating the impact of freight movements on the existing infrastructure. The second application focuses on the estimation of the amount of freight traffic that diverts to other modes due to changes in modal service attributes (e.g., transit time, transit cost) or policy changes (e.g., congestion pricing, maximum weight by truck class). This application is known as modal diversion analysis. However, the current models cannot capture the impacts on mode choice due to the construction of new intermodal/multimodal facilities or terminals⁴⁵. This type of analysis has become popular at the metropolitan level in recent years.

Modal diversion models can be aggregated or disaggregated. Disaggregated models focus on the factors that affect individual shipments or an individual shipper's choice, such as total logistic costs, shipment characteristics by transportation mode, and service quality attributes. Logistic costs include *inventory carrying costs while goods are in transit, insurance costs for loss and damage claims, drayage costs, and various other handling and processing costs*. Shipment characteristics (by mode and commodity) include *value, size, time-sensitivity, and shipment distance*. Service quality attributes include *on-time delivery, frequency and scheduling of shipments, reliability, damage-free delivery, and ability to expedite*. Mode choice is often treated using a Multinomial Logit Model (MLM). As opposed to the aggregate approach, these models allow for policy analysis impacts on modal shifts for specific commodities and corridors at a highly disaggregated level. However, these models are not widely used for urban planning because it is difficult to obtain and update the required data.

Aggregate models concentrate on the factors that influence the combined share of groups of commodities or shippers. These models use aggregate data from commodity flow databases, modal traffic databases, and macroeconomic data. The variables often included in these models are *transit cost* and *transit time* by commodity type. It is also difficult to obtain reliable data for the estimation of these parameters. The model uses the logit function to estimate the relative

mode share by mode as a function of the explanatory variables is used. Transit time is of special interest to MPOs because it allows for the evaluation of the impact of congestion and delays on mode choice as well as the potential impact of modal facility improvements that increase throughput or reduce delays.

Another approach for freight mode choice is a **network model** in which modal attributes are included for each network link and therefore mode choice and route can be selected simultaneously. Although a network type model has been used in California for a single commodity⁴⁶, it seems there are not many applications at the metropolitan level. Some modelers have proposed the integration of the mode choice/equipment choice and route assignment components in network models. Again, no application has been found in urban transportation modeling. This approach suggests simulating optimum truck size distributions for pick-up using standard routing and schedule models applied in the private sector. However, the requirements in terms of data seem to prevent the use of this technique for urban planning.

2.2.2.3 Freight Route Assignment. The previous steps provide an origin-destination truck trip matrix determined either from commodity origin-destination patterns or estimates directly from truck trips. From the latter, the estimation of the number of vehicles using the road network is straightforward because it only involves the road modes (i.e., passenger cars and truck types). Three basic approaches exist: the all-or-nothing assignment, the incremental assignment, and the multipath assignment. The first approach involves assigning all trips along the shortest route between each origin and each destination without considering congestion. The second approach involves allocating a limited number of trips at a time tied to the cheapest available route, updating after each allocation the new travel costs on each link as a result of the allocation. The third approach is an extension of the incremental approach but at any stage of the allocation process all trips from an origin are assigned to different routes between the origin and each destination, which is not necessarily the least cost route. Assignment iterations are generally based on a prescribed set of volume-delay functions, which determine how link travel time varies with the volume-to-capacity ratio.

The assignment approaches seem analogous to the passenger car, but intrinsic truck traffic characteristics and issues need to be considered in this step. First, due to physical impediments or regulatory considerations on specific links of the network, the network available

for trucks and passenger cars may not be identical. For example, road grades, overhead clearances, intersection geometrics, traffic control devices, and axle limit regulations may result in some routes being prohibited for trucks. Therefore, the modeling process should consider the road network available for trucks (as well as for passenger cars) based on *link attributes*, including *vehicle types allowed on each link*. It should also reflect the presence of *truck-only routes or lanes* and *designated hazardous routes*.

Second, peak hour traffic for trucks is noticeably different from passenger cars. Therefore, it is recommended to develop *time period factors* for truck classes as part of the assignment process.

Third, trucks typically contribute more to road congestion than passenger cars. Trucks are usually converted to passenger cars using *passenger car-equivalent factors* (i.e., PCEs) when running volume-delay functions. Default values of PCEs are given in the Highway Capacity Manual⁴⁷. Another approach to account for the impact of trucks on urban congestion is to develop volume-delay functions that vary with the percentage of trucks in the traffic stream.

Fourth, *travel time reliability* is an important factor in route choice for trucks. This is especially important for just-in-time services and drayage movements. This factor could be measured in terms of the standard deviation in travel times on a route but there are few or no sources of data on travel time variability⁴⁸.

From the previous discussion, it can be noted that the vehicle-based approach presents several advantages to the MPOs: (1) highway/truck data is more available than commodity data; (2) truck trips are estimated in the beginning of the modeling process so conversion to truck trips from commodity shipment volumes is not required; (3) empty truck trips can be modeled; and (4) truck trips are easily combined with passenger car trips for route assignment. However, this approach also has several disadvantages, such as: (1) it provides little to no information about commodities transported between analysis zones; (2) it does not provide any basis for estimating trip end control totals; (3) internal trips made by external truck trips are ignored; (4) few existing models seem to address trip chain patterns; and (5) it has limited capability to analyze policy options, such as changes in modal attributes, new freight modes or facilities, new links or pricing measures. A significant advantage of the commodity-based approach is that it is concerned with the movement of commodities (not trucks) that produce the demand for freight movements in that it links the producers and consumers of goods. Therefore, for MPOs to undertake

comprehensive urban freight planning, accurate and reliable commodity and truck data is needed. Furthermore, because data collection and model development are closely interrelated, the findings presented in this section regarding urban travel models provide the basis for the data requirements for urban freight planning.

CHAPTER 3 – DATA REQUIREMENTS FOR URBAN FREIGHT PLANNING

The significant and continued growth in freight movements in metropolitan areas is challenging MPOs to obtain better data with which to analyze the impact of domestic and through passengers and freight traffic in their areas. This chapter reviews (1) the data requirements for urban freight planning; and (2) freight data provided by primary and secondary data sources.

3.1 FREIGHT DATA CATEGORIES: ATTRIBUTES AND LEVEL OF DETAIL

According to federal mandate, MPOs are responsible for developing and maintaining databases to predict and monitor economic, demographic, and travel conditions in their areas. MPOs can identify their future transportation needs and formulate projects to respond to those needs based on the information contained in such databases. Data collection is also important to support the development of new or better analytical models. In general, required data for urban freight planning can be classified into five categories:

1. Cargo
2. Road transportation
3. Major freight generators and corridors
4. Non-road transportation modes
5. Economic, land-use, and socio-economic data

This study identifies the relevant attributes for each category (see Tables 3.1 to 3.6). It should be noted that, although the largest share of the urban freight is moving by road, attributes related to other freight transportation modes have been integrated in a separate category to take into account the multimodal freight activities taking place in metropolitan regions and their impact on urban freight traffic patterns.

**TABLE 3.1 Cargo Attributes and Level of Detail Relevant
for Urban Freight Planning**

Attribute	Level of Detail
Commodity Classification	Formal classification system (i.e. Standard Industrial Classification Code (SIC), Standard Transportation Commodity Codes (STCC), Harmonized System (HS), Standard International Trade Classification (SITC), North American Industry Classification System (NAICS))
	Other classification system (e.g., economic sectors)
Commodity Type	Aggregate categories (e.g., bulk, break-bulk, neo-bulk, container)
	Hazardous materials (HAZMAT)
	Empty vs. non-empty
Origin-Destination Patterns	States
	National Transportation Analysis Regions (NTARs)
	Counties
	Metropolitan Statistical Areas (MSA)
	Business Economic Areas (BEAs)
	Zip codes
	Shipper detail (names and locations)
	Traffic Analysis Zone (TAZ)
	U.S. Customs for exit/entry
Shipment Details	Value
	Weight
	Volume
	Size
	Mode of transportation
	Average tour length
	Number of stops per tour
	Time-sensitivity
	Load type (i.e., FTL or LTL shipments)
	Empty shipments
Routing Details	Major routes used
	Number of stops
	Interim trip origin and destinations
	Vehicle routing
	HAZMAT vehicle routing

TABLE 3.2 Road Transportation Mode Attributes and Level of Detail Relevant for Urban Freight Planning

Attribute	Level of Detail
Highway/Truck Mode	Truck type (formal FHWA class/State class)
	Truck size categories (e.g., heavy, medium, light)
	Average vehicle speed
	Vehicle emission data
	Incident data
	Traffic volume
	Commodity type
	Payload weight (i.e., cargo weight)
	Truck Origin-Destination patterns
	Trip Origin-Destination patterns
	Average tour length
	Number of stops per tour
	Number of truck stops for LTL shipments
	Travel time
	Transit time
	Travel time reliability
	Line-haul costs
	Drayage costs
	Transit cost
	Quality of service (e.g., on-time delivery, reliability, frequency and scheduling of shipments)

Attribute	Level of Detail
Network Data	Link attributes (e.g., road grade, overhead clearance, intersection geometric, traffic control devices, axle limit regulations, vehicle type/class allow, pavement condition)
	Truck-only routes
	Designated hazardous routes

Attribute	Level of Detail
Cross Border Data	Origin-Destination patterns
	Commodity type
	Shipment attributes (i.e., value, weight, volume)
	Freight modes attributes
	Stop/Delay data
	Rail-grade crossing safety data
	Department of Public Safety (DPS) Inspection data

TABLE 3.3 Major Freight Generator and Corridor Attributes and Level of Detail Relevant for Urban Freight Planning

Attribute	Level of Detail
Terminal and Intermodal Transfer Facilities	Commodity types produced and consumed
	Cargo types produced and consumed
	Shipment attributes (i.e., value, weight, volume)
	Location of the markets for the commodities produced and consumed
	Freight modes serving the facility
	Service attributes of available modes (e.g., frequency and scheduling of shipments)
	Storage and handling operations at the facility
	Volumes of trucks entering or exiting the facility
	Sizes and capacity of the vehicles serving the facility
	Average daily truck activity by truck classification
	Geometric and operational characteristics of access roads
	Travel time contours around the facility
	Congestion-related delays on access roads
	Length of queue on access roads
	Incident rates on access roads to the facility
Major Freight Corridors	Commodity types moving along the corridor
	Shipment attributes (i.e., value, weight, volume)
	Truck types using the corridor
	Trip purpose (intraurban, intrastate, interstate, etc.)
	Geometric and operational characteristics of roads
	Road network bottlenecks
	Road network deficiencies
	Access conditions to terminals and intermodal transfer facilities along the corridor
	Parking conditions of terminal and transfer facilities located along the corridor
	Residential areas along the corridor

TABLE 3.4 Non-Road Transportation Mode Attributes and Level of Detail Relevant for Urban Freight Planning

Attributes	Level of Detail
Rail Mode	Origin-Destination patterns
	Commodity type
	Equipment details (e.g., car type)
	Shipment attributes (i.e., value, weight, volume)
	Routing data
	Travel time
	Drayage costs
	Hazardous materials
	Ramp-to-ramp costs
	Stop/delay data
	Quality of service (e.g., on-time delivery, reliability, frequency and scheduling of shipments)
Water Mode	Origin-Destination patterns
	Commodity type
	Equipment details (e.g., car type)
	Shipment attributes (i.e., value, weight, volume)
	Routing data
	Travel time
	Drayage costs
	Hazardous materials
	Port-to-port costs
	Quality of service (e.g., on-time delivery, reliability, frequency and scheduling of shipments)
Air Mode	Origin-Destination patterns
	Commodity type
	Shipment attributes (i.e., value, weight, volume)
	Routing data
	Travel time
	Drayage costs
	Hazardous materials
	Air freightage
	Quality of service (e.g., on-time delivery, reliability, frequency and scheduling of shipments)

TABLE 3.5 Economic, Land-use, and Socio-economic Data Relevant for Urban Freight Planning

Attributes	Level of Detail
Economic Data	Value of output for commodity type
	Volume shipped for commodity type
	Employment by industrial sector
	Earnings by industrial sector
	Output per employee
	Personal income
Land Use Data (by industrial sector or SIC)	Employment
	Floor areas
	Land
Socio-economic data	Employment
	Population
	Number of households
	Income

The freight data described above can be used by the MPOs for several purposes. Some of the most relevant applications of freight data at the urban level, adapted from a list developed by Lau (1995)⁴⁹, are as follows:

1. Urban freight travel model development
 - Trip generation rates;
 - Distribution chains by commodity types;
 - Origin-destination pattern analysis;
 - Local and freeway route assignments;
 - Congestion and speed simulations;
 - Travel time analysis;
 - Truck fleet distribution analysis;
 - Analysis impact of toll facilities; and
 - Spatial and temporal analysis.
2. Freight Corridor Analysis
 - Evaluate corridor management proposals for freight impacts;

- Provide information on truck travel patterns to formulate traffic management plans during construction and reconstruction works; and
 - Evaluate impact of truck route reassignments or closures.
3. Air Quality Analysis
 - Estimate truck emissions.
 4. Terminal and Intermodal Facilities Planning
 - Trip generation rates for major freight generators;
 - Planning for terminal and intermodal transfer facilities;
 - Facilitate seaport and airport planning;
 - Facilitate airport planning; and
 - Understand competition and demand of different freight modes.
 5. Truck restrictions and enforcement
 - Route restriction analysis;
 - Regulation and enforcement analysis; and
 - Truck driver safety programs.

As the following section illustrates, different kinds of collection techniques and data sources have been used by MPOs to obtain data to support their freight planning activities.

3.2 DATA SOURCES FOR URBAN FREIGHT

Data sources available for urban freight planning can be classified into primary and secondary data sources (see Figure 3.1). Primary data sources include **surveys** to gather information from survey respondents, **traffic counts** that generally are part of traditional traffic monitoring programs, and **ITS technologies** capable of collecting freight data. Secondary data sources include information available in **public and commercial data sources**.

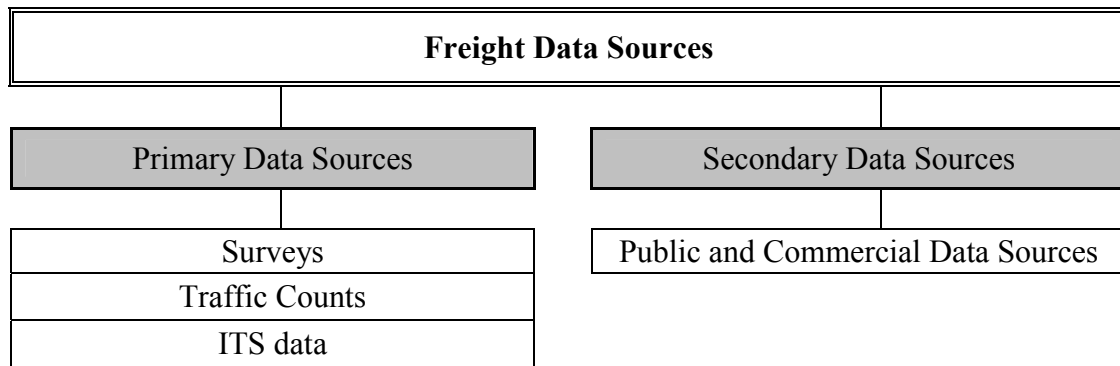


FIGURE 3.1 Primary and Secondary Freight Data Sources

3.2.1 Surveys and Traffic Counts

Figure 3.2 shows the best known approaches and techniques under two of the primary data sources categories. **Survey techniques** generally provide the following freight data: *vehicle classification* (i.e., truck type), *commodity type*, *cargo type*, *truck origin-destination patterns*, *trip origin-destination patterns*, *trip purpose*, *cargo transfer options*, *average tour length*, and *number of stops per tour*. Surveys are usually accompanied by traffic counts, which provide necessary information to expand the sample data like *traffic volumes*, *vehicle classification*, and *vehicle speeds*. As indicated before, this information can be gathered by automated, electronic, video or manual means. Although more accurate and desirable, primary data collection activities are both expensive and time consuming. As a result, the use of secondary data sources to populate freight databases is becoming increasingly popular at all levels of transportation planning.

A number of literature sources are available that contrast the **truck travel surveys** and **traffic counts techniques**, except for Internet surveys. Relevant to this study are the works by Lawson, *et al*⁵⁰ (2002), Fischer, *et al*⁵¹ (2001), and Lau⁵² (1995), which point out the advantages and disadvantages of these techniques (see Table 3.6). The latter study presents the findings from a comprehensive review of truck travel surveys conducted between 1986 and 1994 in urban areas within the U.S. and abroad. According to Lau⁵³ (1995), the combine telephone-mailout/mailback survey was the most common method for conducting truck travel surveys in urban areas, followed by the roadside/intercept survey. The former was also identified as the most cost-effective technique, yielding reasonably high response rates (30% - 79%) from

respondents. The Lau study actually produced higher response rates (96.5%) and more comprehensive information regarding commercial vehicle trips but was more expensive to administer.

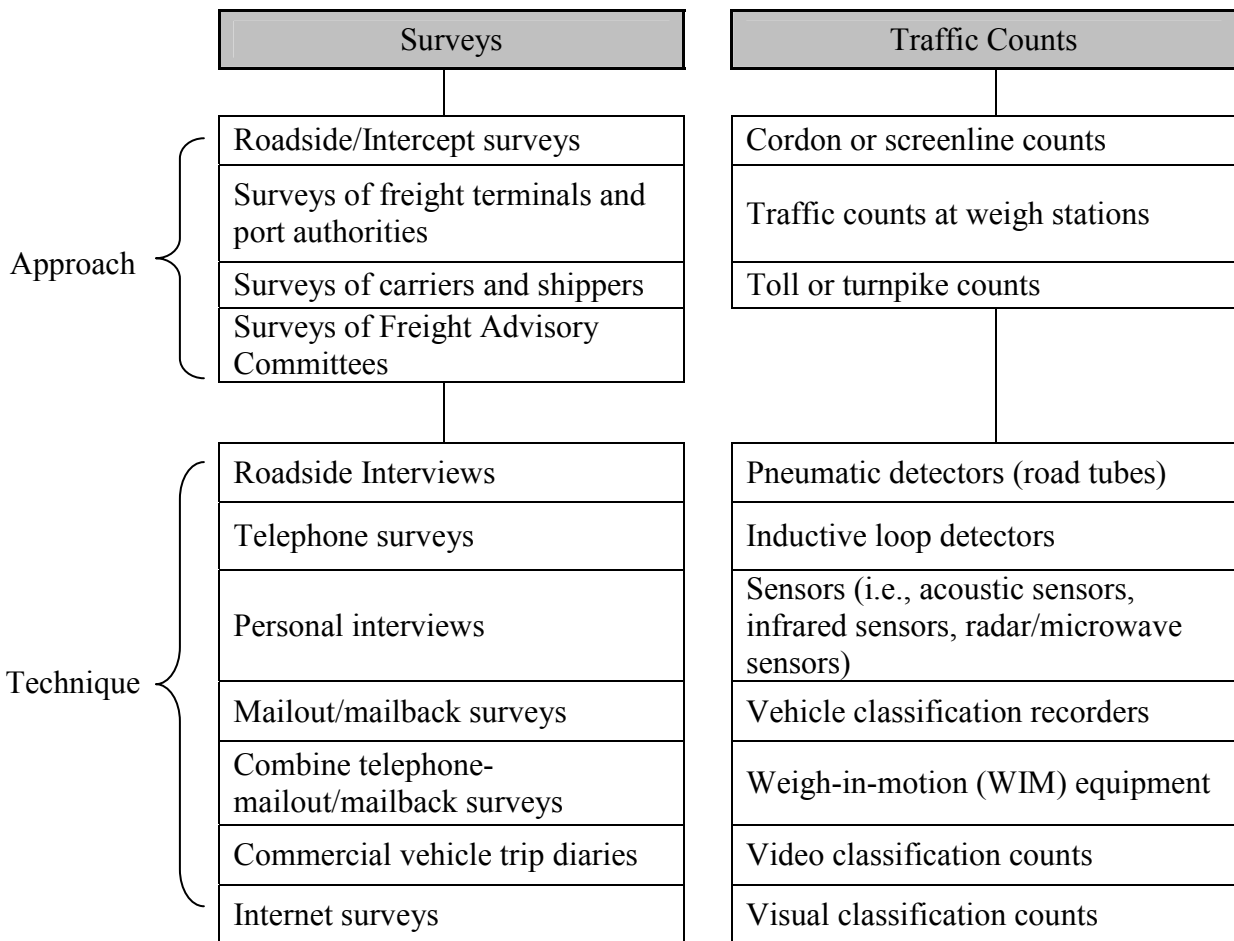


FIGURE 3.2 Surveys and Traffic Counts: Approaches and Techniques

TABLE 3.6 Advantages and Disadvantages of Truck Travel Surveys and Traffic Count Techniques		
Technique	Advantages	Disadvantages
Personal interviews and/or Telephone surveys based on purposeful sampling	1. <u>High response rate</u> resulting from purposeful sampling 2. Easy to make follow-up contacts 3. <u>Complete information</u> on O-D, trip purpose, route, commodity hauled, and trip chaining. 4. May provide more detailed, direct information than written formats 5. Can obtain useful information through interview process beyond structured questions 6. Telephone surveys less geographically restricted than roadside/intercept surveys	1. <u>More costly and time consuming</u> per respondent than other methods 2. Infeasible for a large sample size 3. Potential for lack of uniformity among interview structures/content 4. Purposeful sampling may limit statistical analysis possibilities 5. Calling hours limited to business hours 6. Typically requires callbacks 7. Respondent availability issues (e.g., limited phone time if respondent is busy, limited information available at the time of the initial contact, some respondents may be unwilling to return calls or accept follow-up calls). 8. Requires access to vehicle registration file
Mailout/mailback surveys based on random sampling	1. Least costly method 2. Uniform survey method 3. Facilitate larger and more representative samples than personal interview methods 4. Only follow-up of non-responses is necessary 5. <u>Very good data detail</u> for completed responses 5. Less geographically restricted than roadside/intercept surveys	1. Typically <u>lower response rates</u> than with other methods 2. Difficult to ensure the right individual will complete survey 3. More difficult to control for non-response bias 4. Difficult in interpreting meaning of non-responses 5. No opportunity to correct any misinterpretation of questionnaire instructions 6. Requires access to vehicle registration file
Combine telephone-mailout/mailback surveys based on random sampling	1. The most cost-effective method 2. Can improve response rate over mailout/mailback surveys alone. 3. Uniform survey method 4. Telephone follow-up can provide opportunity to clarify responses and questionnaire instructions when necessary, <u>leading to better data detail</u>. 5. Less geographically restricted than roadside/intercept surveys	1. Same disadvantages as telephone survey technique 2. <u>More costly</u> than mailout/mailback survey alone (i.e., telephone follow-up increase cost and time involved in survey process) 3. Telephone follow-up is not possible for non-respondents if anonymity is promised. 4. Requires access to vehicle registration file

TABLE 3.6 Advantages and Disadvantages of Truck Travel Surveys and Traffic Count Techniques		
Technique	Advantages	Disadvantages
Roadside/Intercept surveys	1. High response rate 2. Complete information on commodity hauled, O-D pair, routing details and shipment details. 3. Provide opportunity to respond to any questions the respondent may have 4. Better sampling control 5. Good representation of vehicles entering or leaving a cordon line 6. Easy comparison with mainstream traffic through vehicle classification counts at the survey site 7. Ability to expand to total truck traffic population	1. Potential disruption to traffic flow 2. High labor requirement 3. Safety hazards for the interviewers 4. Less ability to follow-up with respondents 5. Quality and cover area of survey affected by weather, time of day, and lighting 6. Drivers avoiding the survey station 7. Enforcement problems 8. Only represent truck traffic traveling on the road along the survey station and not the entire region
Automated or electronic traffic counts (pneumatic detectors, loop detectors, vehicle classification recorders, WIM equipment)	1. No traffic disruption 2. Able to collect traffic counts at many sites, efficiently with low labor requirement	1. Wide variances in truck counts or classifications based on pneumatic detectors due to equipment calibration, vehicle speed, and traffic density 2. Potential for equipment failure: 3. Pneumatic detectors present problems in terms of staff safety 4. No information regarding commodity classification, commodity type, O-D pair, shipment details, and routing details.
Video surveillance	1. No traffic disruption 2. Better information on type of commodity hauled compared with automated or electronic counters. Here's another case where the split is confusing b/c it looks like there are no advantages	1. Not a cost-effective option in most situations 2. Potential for equipment failure or recording failure during adverse weather 3. No information regarding commodity classification, O-D pair, shipment details, and routing details.
Visual classification counts (tally sheets, mechanical counting boards, electronic counting boards)	1. No traffic disruption 2. May be more accurate than automated or electronic traffic counts	1. High personal requirement 2. Potential for human error 3. Staff safety and operational problems 4. No information regarding commodity classification, commodity type, O-D pair, shipment details, and routing details.

Sources: Adapted from Lawson, et al (2002), Fisher (2001), and Lau (1995)

Traffic-count techniques gather *traffic volume* and *vehicle classification* by automated, electronic, video or manual means. The most popular techniques include pneumatic detectors (e.g. tube counters or road tubes), inductive loop detectors, sensors, vehicle classification recorders, weigh-in-motion (WIM) equipment, video classification counts, and visual classification counts. The main features of each technology are summarized below:

1. The pneumatic detector is a metal box connected to a tube laid across the travel portion of the roadway. Each time a vehicle crosses the tube, air is displaced, creating a detectable pressure that is registered by the metal box.
2. Inductive loop detectors generally consist of rectangular- or square-shaped loops of wire buried under the pavement surface. Anytime a vehicle passes over the loop detector, a count is registered due to the change in the electrical inductance.
3. Acoustic, infrared, and radar/microwave sensors can be used to count traffic at both permanent and portable installations. Acoustic sensors consist of an array of microphones aimed at the traffic stream that are recording for the sound energy of passing vehicles. Infrared sensors detect the presence of vehicles by emitting a low-energy laser beam(s) at the road surface and measuring the time for the reflected signal to return to the device. The presence of a vehicle is measured by a reduction in time for the signal return. Radar/microwave sensors are based on the natural phenomenon known as the “Doppler Effect.” The radar detection equipment compares the frequency of a transmitted signal (i.e., microwave radiation) with the frequency of the received signal. Wherever a frequency difference exists, a moving vehicle is detected. Radar/microwave sensors have several advantages: they can detect moving vehicles and determine their speed, they can detect the presence of stationary vehicles, and they can sense multiple zones through their range finding ability. Radar devices are not subject to deterioration from traffic wear. However, their initial cost is higher than many other traffic-counting devices.
4. Vehicle classification recorders can be portable or permanent. Portable recorders use two-axle sensors (e.g., road tubes) that are stretched across the road and are spaced apart to record the axle spacing of the vehicles. The permanent design uses two in-pavement inductive loops, two piezo axle sensors, or combinations of inductive loops

- and piezo axle sensors. Data recorded by this technique include date and time, axle spacing, number of axles per vehicle, and speeds.
5. The weigh-in-motion (WIM) equipment can be portable or permanent. The portable WIM consists of two loops and a capacitance weigh pad to collect data. The permanent WIM use a combination of one or two inductive loops and one or more axle weight sensors. WIM equipment collects data on date and time, vehicle lengths, speeds, and axle weights and spacing.
 6. Video classification counts record data by videotaping traffic. Traffic volumes are determined by viewing videotapes recorded with a camera at the survey site and manually counting traffic. Generally, a digital clock in the video image is used to note time intervals.
 7. Visual classification counts can be made using tally sheets, mechanical counting boards, or electronic counting boards. Tally sheets consist of a prepared field form onto which data is recorded with a tick mark. Mechanical counting boards consist of counters mounted on a board so that the counter is pushed by a person every time a vehicle passes the survey site. These two manual techniques require a watch or stopwatch to measure the desired count interval. Electronic counting boards are similar to mechanical counting boards, but the boards are battery-operated and have an internal clock that automatically separates the data by intervals. Furthermore, electronic counting boards have special functions such as automatic data reduction and summary, and memory devices so that data can also be downloaded to a computer.

Until the 1990s, the collection of historical traffic data over metropolitan areas was essentially limited to a number of fixed counting locations using pneumatic detectors, inductive loop detectors, and manual counts. The limitations of these techniques made urban traffic data collection a significant challenge. Currently a number of ITS are being deployed in major urban areas that can gather traffic data without the need to stop commercial vehicles, close lanes to through traffic, or expose staff to unsafe conditions.

3.2.2 ITS Data

Figure 3.3 lists the best known ITS technologies for gathering urban freight data. ITS data collection and surveillance technologies can be classified into **road-based technologies** and

vehicle-based technologies. **Road-based technologies** use detecting devices that are physically located along the highway and can be further classified as (a) pavement-based techniques and (b) non-intrusive techniques. Pavement-based techniques use devices installed in or on the pavement while non-intrusive techniques use devices mounted overhead, on the side, or beneath the pavement in the roadside area. The most popular road-based technologies include inductive loop detectors, sensors, environmental sensor stations, WIM sensor systems, closed circuit TV (CCTV) cameras, and video image detection systems. **Vehicle-based technologies** use devices carried inside vehicles. The most popular vehicle-based technologies include Automated Vehicle Classification (AVC), Automated Vehicle Identification (AVI), Automated Vehicle Location (AVL), cellular phones (probe vehicles), License Plate Matching (LPM), and smart cards. The main features of each technology are listed below:

1. Inductive loop detectors and sensors, as indicated previously in this report, are based on different types of physical wires and sensors that are used for the collection of traffic data, including traffic volumes. These devices are commonly deployed as part of **Advanced Traffic Management Systems (ATMS), Freeway Management Systems (FMS), Traffic Operation Centers (TOCs), and Incident Management Systems (IMS)**⁵⁴. These systems are used (1) to improve the management and operation of traffic on freeways, arterials, and local streets; and (2) to improve incident detection, response, and clearance. Sensors are also deployed as part of **Railroad Grade Crossing Management Systems**⁵⁵ to manage gates and warning systems at at-grade highway-railroad crossings, improve safety, and decrease delays at these network points.
2. Environmental sensor stations monitor pollution, emissions, weather, roadway surface, and air/water quality conditions. It is composed of a remote processor unit connected to one or more sensors that collect environmental or meteorological data. The environmental sensor station collects weather data, such as air temperature, amount and type of precipitation, visibility, and wind speed, to mention a few. It also collects data on surface conditions (dry, wet, or frozen), pavement temperature, and subsurface temperature. These stations are commonly deployed as the roadside component of a **Road/Weather Information System (RWIS)**.

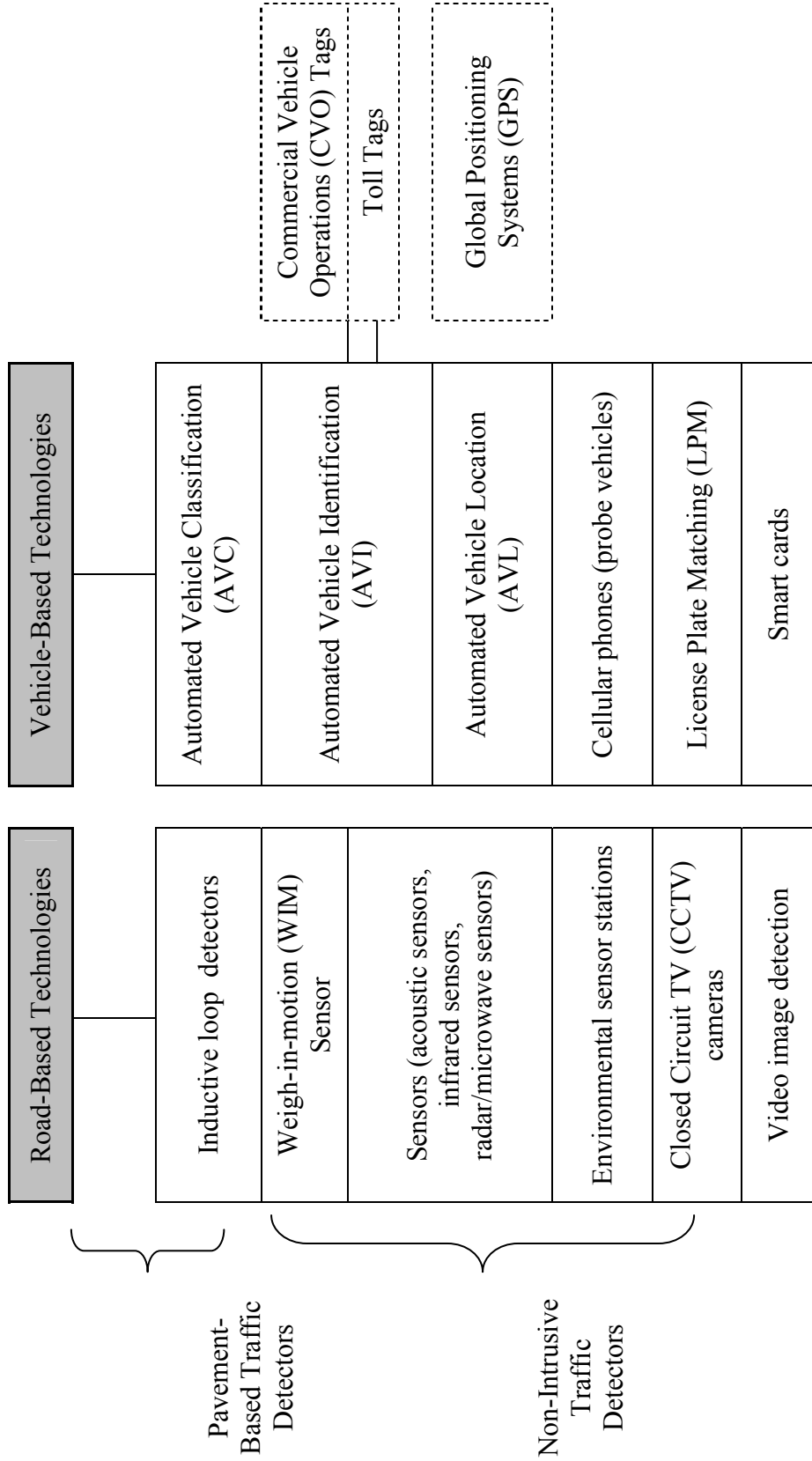


FIGURE 3.3 Primary Freight Data Source: ITS Data

3. Weigh-in-motion (WIM) sensors record truck axle weights and gross vehicle weights while trucks equipped with Dedicated Short Range Communication (i.e., DSRC) transponders drive over the sensor. DSRC provides wireless communication of data between the truck and the roadside. The most utilized WIM devices are piezoelectric sensors, bending plates, single load cells, and fiber optics. These systems, commonly deployed as part of the **Weigh Station Clearance Systems**, enable commercial vehicles to travel at normal speed through weigh stations, avoiding stops, increasing throughput, minimizing queuing and delays, and reducing safety hazards due to trucks queuing at entering and exiting weigh stations⁵⁶. Weigh Station Clearance Systems are ITS elements that support commercial vehicle operations (CVO) as part of the ITS/CVO program. CVO comprises the movement of goods and passengers via commercial vehicles and the regulatory activities related to commercial vehicle credentials and tax administration, roadside operations, safety assurance, freight and fleet management, and vehicle operation⁵⁷.
4. Closed-Circuit TV (CCTV) cameras use video cameras to provide visual surveillance of the highway network. Technical advances in cable transmission systems (i.e., fiber optic, coaxial or twisted pair cables) allow CCTV to provide comprehensive surveillance of traffic, accidents, and weather conditions. CCTV cameras generally are operated from a control center as part of **Advanced Traveler Information Systems (ATIS), ATMS, FMS, TOCs, and IMS**⁵⁸. ATIS, typically linked to traffic management systems, are used to provide real-time information on traffic conditions to the public. CCTV cameras have also been deployed as part of **Security Systems**,⁵⁹ which use sensors, radio frequency identification (RFID) transponders and onboard vehicle communication systems, along with video surveillance systems, to monitor the condition of vehicles, containers, and goods during shipment or in storage at terminals. These systems are typically linked to vehicle location and management systems and terminal inventory management systems.
5. Video image detection systems use image processors to extract information from video cameras (i.e., CCTV cameras) and different techniques (i.e., tripline and tracking) to analyze the video image input. Tripline techniques monitor specific

zones on the video image to detect the presence of a vehicle. Video tracking techniques employ algorithms to identify and track vehicles as they pass through the field of view. These systems can record traffic volumes, speeds, and vehicle classifications. These systems are deployed as part of **ATMS, FMS, TOCs, IMS, and ATIS**⁶⁰.

6. Automatic Vehicle Classification (AVC) provides detailed information on the type and volume of trucks using particular roads. This information is used for designating truck routes. AVC is usually deployed in conjunction with **Electronic Credentials (EC)** technology, which provides a readable, electronic record of the vehicle type. In fact, EC enable motor carriers to electronically file for, obtain, and pay for all required licenses, registrations, and permits⁶¹.
7. Automated Vehicle Identification (AVI) systems represent a major advance in traffic surveillance technology, allowing the identification of vehicles equipped with DSRC transponders or electronic tags when they come within the range of a roadside communication unit. In addition, this technology can be used to provide in-route information, such as travel times. These systems have three basic components as follows: (1) a transponder or electronic tag mounted on the vehicle, (2) a roadside communication unit, and (3) a computer system for storage and data processing. The four main categories of AVI systems include: optical systems, infrared systems, inductive loop AVI systems, and radio frequency and microwave systems. This technology has been applied in the deployment of **Gate Clearance Systems, Electronic Toll Collection (ETC) Systems**, and ITS elements that support **Commercial Vehicle Operations** (i.e., ITS/CVO)⁶². **Gate Clearance Systems**, along with GPS, RFID transponders, and optical character recognition (OCR) allow the verification and inspection of drivers, truck tractors, trailers, containers, and chassis moving into and out of truck, rail, air, and marine terminals. The **ETC systems** allow vehicles equipped with toll tags to pass through toll plazas without stopping to pay tolls, expediting traffic throughput and therefore minimizing delays, improving travel time, reducing fuel consumption, and decreasing congestion at toll plazas. The ETC reading devices can be passive or active. Passive reading devices transmit signals that are reflected by the vehicles. Active reading devices use the on-

board equipment to transmit signals and perform interactive communication. In addition, ETC systems use vehicles equipped with RFID transponders as probes to measure the flow of traffic and identify congestion caused by incidents. **CVO tags** are part of the ITS technologies that support commercial vehicle operations.

Specifically, CVO tags are used by trucking companies to send and receive data from trucks as they pass a reading device (commonly called readers or antennas) located in the pavement or above or alongside the roadway. Furthermore, AVC and AVI technologies allow uninterrupted movement of vehicles through weigh stations.

8. Automated Vehicle Location (AVL) systems determine the approximate location of a vehicle and track it as it traverses the transportation network. The systems employ Global Positioning Systems (GPS) or other triangulation technologies to provide real-time information regarding vehicle locations at various points in time, travel time, and the overall traffic flows and patterns on the highway network, providing individuals who have access to this type of technology with information about congestion problems. GPS is a space-based radio positioning, navigation, and time-transfer system that utilizes satellites to locate vehicles equipped with a GPS transponder. The private sector has applied AVL technologies to optimize routing and shipment schedules, and for asset management⁶³. Examples of these systems include the following: **Tracking and Navigational Systems, Motor Carrier Routing and Dispatching Systems, Terminal Inventory Management Systems, Gate Clearance Systems, and Asset Location and Management Systems. Vehicle Tracking and Navigational Systems** use GPS technology in vehicles for both tracking and navigation. Tracking systems enable a base station to keep track of the vehicle without the intervention of the driver. Navigation systems help the driver to reach his/her destination. These systems offer an effective tool for improving the operational efficiency and utilization of vehicles. These systems are also called Vehicle Tracking and Information Systems (VTIS) and Mobile Asset Management System (MAMS). **Motor Carrier Routing and Dispatching Systems** use scheduling algorithms, GPS, and optimization software to match equipment, drivers, and loads to pick-up and delivery windows, minimize travel time and cost, and schedule equipment repair and maintenance. **Terminal Inventory Management**

Systems use computer models, optimization or expert systems software, radio frequency identification (RFID), GPS receivers, and mobile inventory vehicles to optimize the use of space in terminals, optimize labor and equipment, and schedule equipment repair and maintenance. **Gate Clearance Systems** use AVI technology, GPS, RFID transponders, and optical character recognition (OCR) systems to verify and inspect drivers, truck tractors, trailers, containers, and chassis moving into and out of truck, rail, air and marine terminals. **Asset Location and Management Systems** use GPS, geostationary satellite or low earth orbit (LEO) satellite, and automated equipment identification (AEI) transponders to locate and track vehicles or containers and estimate arrival time, minimize out-of-route travel, optimize equipment use, and improve safety and security. In addition, the public sector has deployed AVL technologies as part of **Hazardous Materials (HAZMAT) Response Systems**⁶⁴ to provide enforcement and incident management response teams with timely and accurate information on cargo contents, enabling them to react appropriately in emergency situations, thereby reducing the impact of such incidents on traffic flow.

9. Cellular phones (or probe vehicles) use radio frequency receivers and triangulation techniques to determine a vehicle location by measuring signals from cellular phone usage within a vehicle.
10. License Plate Matching Systems are an example of an image-processing technology used to identify vehicles by their license plates. This technology involves the use of at least two video cameras placed at two separate sections along a road segment. The images of the license plates of the downstream vehicles are then matched with those of the upstream images. This technology is used to relay data on travel time and speed of the vehicles passing a road segment. In addition, this technology is used in various security and other traffic-related applications.
11. Smart Cards are often effective and appropriate security mechanisms used to identify drivers and motor carriers at gates, and also provide access to secure areas at ports and terminals. This technology also facilitates the identification and monitoring of crew members aboard cargo ships docked at ports. Smart cards are generally deployed as part of **Security Systems** and **Gate Clearance Systems**⁶⁵. In addition,

the comparison of smart card readings for the same vehicle or driver at two separate locations can help to track vehicles and provide information on travel times and speeds, route selection, and origin-destination patterns. Sometimes these cards are used to pay tolls.

To provide some insight in terms of the quality of the data provided by the ITS technologies, several research efforts were reviewed. Relevant to this study are the work by Jessup, E., et al⁶⁶ (2004) and Riley⁶⁷ (1999). The former study provides the advantages and disadvantages of video surveillance and GPD receivers (see Table 3.7), while the latter presents the advantages of AVI technologies versus loop detectors and GPS technologies for the collection of travel times (see Table 3.8).

TABLE 3.7 Advantages and Disadvantages of Video Surveillance and GPS Receiver

	Video Surveillance	GPS receiver
Implementation	<u>Advantages</u> : no disruption of traffic. <u>Disadvantages</u> : potential for equipment failure or technical difficulties, and weather and time of day/night impact visibility and data collection.	<u>Advantages</u> : no disruption of traffic. <u>Disadvantage</u> : requires private shipper participation.
Investment and Maintenance	<u>Disadvantages</u> : high equipment cost and requirements, and relatively high maintenance and replacement cost for video equipment.	<u>Disadvantages</u> : very high equipment investment cost, and equipment malfunction and technical difficulties are common.
Statistical Reliability/Sampling Frame	<u>Advantage</u> : captures all truck passing a video site during all visible time periods. <u>Disadvantage</u> : provides limited information.	<u>Disadvantages</u> : limited to sample of vehicles participating in study, and very limited sample of all freight movements in urban settings.
Data Attributes	<u>Advantage</u> : provide general descriptive information on traffic flows. <u>Disadvantage</u> : no information regarding O-D pair, trip purpose, commodity hauled, and route.	<u>Advantage</u> : relatively accurate route and trip activity data. <u>Disadvantage</u> : very limited information regarding trip purpose, commodity hauled, and trip chaining.
Geographic Coverage	<u>Disadvantage</u> : limited to locations with video capability within and around urban area.	<u>Disadvantage</u> : limited to sample size.

Source: Adapted from Jessup, E. and Lawson, C.T (2004)

**TABLE 3.8 Comparison of AVI versus Loop Detectors and GPS
for the collection of Travel Time**

Data Collection Technology	Costs			Data Accuracy	Remark
	Capital	Installation	Data Collection		
Loop Detector System	Low	Moderate	Low	Low	High failure rate and inaccurate estimations
GPS Technology	Very High	Very High	Low	Very High	High failure rate in downtown areas
AVI System	High	High	Low	High	Limited to fixed route and checkpoints and probe density

Source: Riley, J.D. (1999)

As can be seen from Table 3.8, GPS technology provides more accurate data relative to loop detectors and AVI. Some limitations of this technology, however, include its high cost and the unreliability of the technology because of signal disruption that can occur when vehicles are shielded by tall buildings, bridges, and tunnels in downtown areas.

In conclusion, ITS technologies, along with other freight data sources, can supply MPOs with the required freight data so that planners can identify freight patterns and the contribution of freight vehicles to urban congestion, pavement deterioration, environmental quality, and the economic vitality of urban regions.

3.2.3 Public and Commercial Data Sources

Secondary data sources include freight data provided in reports, abstracts, and statistics produced or sponsored by private and public agencies. Although most of these data sources do not provide the level of disaggregated data needed by MPOs or quickly become too dated, they are used by metropolitan planning agencies with limited resources to implement the more costly primary data collection techniques.

Secondary data sources for truck freight information can be classified in one of two categories: shipment-based data and transport-based data. The former category contains separate records for individual shipments while the latter category provides transportation flows for modal systems or subsystems⁶⁸. Furthermore, several subcategories can be distinguished from the main two categories as shown in Table 3.9.

TABLE 3.9 Categories and Subcategories of Secondary Data Sources

Category	Subcategories
Shipment-based	General databases: movement between production and consumption locations (“true origin-destination flows”)
	Modal databases: portion of the movement made by a specific mode (“modal origin-destination flows”)
Transport-based	Aggregate data on transportation flows
	Point activity at transportation nodes
	Profiles of carrier operations
	Profiles of modal activities

Source: Adapted from Cambridge Systematics

Table 3.10 lists the best known secondary freight data sources. Based on the works by Cambridge Systematics⁶⁹⁷⁰, Holguín-Veras and et al⁷¹, and information available on the Web, the freight attributes relevant for urban freight planning contained in these databases have been identified and are briefly described in the remainder of this section.

TABLE 3.10 Public and Commercial Data Sources

Data Source Name	Produced/Sponsored Agency
Airport Activity Statistics of Certificated Route Air Carriers	Bureau of Transportation Statistics (BTS)
Border Crossing Data	Bureau of Transportation Statistics (BTS)
Commodity Flow Survey (CFS)	Bureau of Transportation Statistics (BTS) and the U.S. Census Bureau
Freight Analysis Framework (FAF)	U.S. Department of Transportation (DOT)
Freight Commodity Statistics	Association of American Railroads (AAR)
Freight Transportation & Logistics Service	DRI/McGraw-Hill
Fresh Fruit & Vegetable Shipments	U.S. Department of Agriculture (USDA)
Highway Performance Monitoring System (HPMS) Database	Federal Highway Administration (FHWA)
IANA Report	Intermodal Association of North America (IANA)
LTL Commodity and Market Flow Database	American Trucking Association (ATA)
Maritime Administration (MARAD) Website	U.S. Department of Transportation Maritime Administration
North American Trucking Survey (NATS)	Association of American Railroads (AAR)
Port Import/Export Reporting Service (PEIRS)	Journal of Commerce
Rail Waybill Sample	Surface Transportation Board
State Estimates of Truck Traffic	Federal Highway Administration (FHWA)
TRANSEARCH®	Reebie Associates
Transborder Surface Freight Data	Bureau of Transportation Statistics (BTS)
Transportation Annual Survey	U.S. Census Bureau
TranStats: The Intermodal Transportation Database	Bureau of Transportation Statistics (BTS)
U.S. Air Freight Origin Traffic Statistic	The Colography Group, Inc.
U.S. Imports/Exports of Merchandise on CD-ROM	U.S. Census Bureau
Vehicle Inventory and Use Survey (VIUS)	U.S. Census Bureau

The **Airport Activity Statistics of Certified Route Air Carrier** provides summary data of all scheduled and non-scheduled services by large certified U.S. air carriers. The data includes total aircraft departures for each airport, number of passenger enplanements, and tonnage of freight and mail. Table 3.11 summarizes the relevant freight attributes captured by this database.

TABLE 3.11 Freight Data Provided by the Airport Activity Statistics of Certified Route Air Carrier

Cargo Attributes	Description
Origin-destination patterns	Airport of enplanement
Shipment details	Enplaned tons of freight (express and non-express) and mail (priority, non-priority, and foreign)
Transportation Model Attributes	Description
Mode/Service Attributes	Air carrier Departures by service type, equipment type

The **Border Crossing Database** provides data at the port-of-entry/exit level for the U.S.-Mexico and U.S.-Canada borders. The data are collected monthly at border ports by the U.S. Customs Service and summarized by the BTS. The data include incoming monthly border crossing/entry data for vehicles, containers, passengers, and pedestrians at the individual ports⁷².

The **Commodity Flow Survey (CFS)** contains shipment data of establishments selected from the Standard Statistical Establishment List (SSEL) under one of the following categories: manufacturing, mining, wholesale, and selected other industries (i.e., retail and service establishments). The CFS, designed to provide a comprehensive database of freight movements occurring across the entire nation, replaced the Commodity Transportation Surveys (CTS) that were used to track freight movements from 1963 through 1977. CFS presents significant improvements in methodology, sample size, and scope compared to the CTS. Starting in 1997, this survey is given to respondents once every five years. Table 3.12 summarizes the relevant freight attributes provided by the CFS.

TABLE 3.12 Freight Data Provided by the Commodity Flow Survey (CFS)

Cargo Attributes	Description
Commodity classification	5-digit Standard Transportation Commodity Code (STCC) national; 3-digit STCC (regional); Standard Industrial Classification Code (SIC)-based summary planned
Commodity type	Containerized, hazardous material
Origin-destination patterns	50 states 89 National Transportation Analysis Regions (NTARs) based on aggregations of Business Economic Areas (BEAs) Foreign country for exports
Shipment details	Value Weight
Routing details	Port of exit for exports
Transportation Mode Attributes	Description
Mode	All freight modes: air/surface parcel, private and for-hire truck, rail, inland waterway, deep sea, pipeline, air and other Distance estimated using modal networks
Other	On-and off-site facility type; equipment used by type; rail car ownership; responsibility for mode choice

The **Freight Analysis Framework (FAF)** combines data from several sources to estimate commodity flows and associated freight transportation activity among states, regions, and major international gateways. The FAF estimates for 1998 and forecasts for 2010 and 2020 available to DOT's include⁷³:

1. For each county of origin, the tons of freight moved in the U.S. by county of destination, type of commodity, and mode of transportation;
2. For through shipments, the tons of freight moved by county of origin, county of destination, type of commodity, and mode of transportation;
3. For segments on major highways, rail lines, and waterways, the tons of freight moved by county of origin, county of destination, and type of commodity; and
4. For highway segments, the number of trucks.

Recent discussions with FHWA, however, revealed that this level of data is not yet available to state DOT's⁷⁴.

FAF data or estimates for 1998 and forecasts for 2010 and 2020 available to the transportation community outside of the department of transportations include⁷⁵:

1. For each state or major international gateway of origin, tons of freight moved in the U.S. by state or major international gateway of destination, type of commodity, and mode of transportation;
2. For shipments through states, border crossings, and major metropolitan areas, maps showing routes between external origins and destinations by range of tonnage and modes of transportation;
3. For major highway segments, maps showing the ranges of the number of trucks using the segment and the tons of freight; and
4. For rail and waterway segments, maps showing ranges of freight tonnage.

On the other hand, FAF currently is not able to provide⁷⁶:

1. Estimates of commodity flows for geographic units smaller than counties;
2. Commodity flows by (a) local trucking and (b) pipeline;
3. Network flows (a) of commodities for hazardous materials, (b) less than three years old, and (c) by season or time of day;
4. Transportation costs;
5. Capacity constraints and performance indicators for rail and water facilities; and
6. Policy-sensitive mode split models.

Table 3.13 summarizes the freight characteristics provided by the FAF.

TABLE 3.13 Freight Data Provided by the Freight Analysis Framework (FAF)

Cargo Attributes	Description
Commodity classification and commodity type	20 commodity types 4-digit STCC (estimated); 2-digit STCC (reported)
Origin-destination patterns	3,141 counties and county-equivalent jurisdictions
Shipment details	Weight (tonnage)
Route assignment	Assignment of payloads to a limited number of highways
Transportation Mode Attributes	Description
Mode	All major freight modes except pipelines Commodity flows among three types of trucks Commodity flows among railcar types
Network	Most major highways (routes cover 54 percent of the National Highway Planning Network) Most rail and water routes The larger harbors and other major transfer points

The **Freight Commodity Statistics** is an annual publication that summarizes Class I railroad traffic by commodity type for the U.S. and for the Eastern and Western districts. Data includes gross freight revenues, originating carloads and tonnage, terminated carloads and tonnage, and total carloads and tonnage moved. Relevant freight data characteristics included in this publication area summarized in Table 3.14.

TABLE 3.14 Freight Data Provided by the Freight Commodity Statistics

Cargo Attributes	Description
Commodity classification	2-,3-,4-, and 5-digit STCC
Shipment details	Total tons for the following type of shipments: originated and terminated, originated and delivered to another carrier, received and terminated, and received and delivered to another carrier.
Transportation Mode Attributes	Description
Transportation mode	Rail
Other	Freight revenue and carloads by commodity for originating, terminating, and total freight

The **Freight Transportation and Logistics Service** is a proprietary database that contains historical and forecasted commodity traffic, financial and operating, and rate and cost data by mode, region, and carrier. Relevant freight data characteristics captured in this database are summarized in Table 3.15.

TABLE 3.15 Freight Data Provided by the Freight Transportation and Logistic Service

Cargo Attributes	Description
Commodity classification	STCC (detail differs by mode)
Origin-destination patterns	Regional data available for rail only
Shipment details	Cargo tonnage by mode
Transportation Mode Attributes	Description
Transportation mode	Barge, rail, and truck Equipment volumes by mode and type of equipment
Other	Cost and rate profiles Equipment fleet size

The **Fresh Fruit and Vegetable Shipments** database provides detailed information for fresh fruits and vegetables, including mode of transportation, origin, and seasonal patterns. This annual publication captures domestic rail and piggyback shipments, available truck and air

shipments, and exports of fresh fruits and vegetables by commodity, mode of transportation, origin, and month. Relevant freight data characteristics included in this database are summarized in table 3.16.

TABLE 3.16 Freight Data Provided by the Fresh Fruit and Vegetable Shipments

Cargo Attributes	Description
Commodity classification and commodity type	Individual fruits and vegetables with some grouping of minor commodities and mixed load shipments Commodity classification: citrus fruits, non-citrus fruits, melons, and vegetables Domestic and export commodities are listed separately
Origin-destination patterns	U.S. states (with 4 district detail for California) or foreign country of origin Domestic or export destination group
Shipment details	Cargo weight by month and year
Transportation Mode Attributes	Description
Transportation mode	All modes of transportation for domestic shipments: rail refrigerated cars, piggyback, truck, air, and water

The **Highway Performance Monitoring System Database** captures public road mileage information in each state. This database includes information on physical characteristics, condition, use, and performance of sampled roadway sections within each state⁷⁷. Variables in this database that are relevant to urban freight planning include measures of traffic volume and composition, percent trucks, average annual daily traffic (i.e., AADT), highway geometry, and pavement condition⁷⁸.

IANA's Intermodal Market Trends & Statistics, published by the Intermodal Association of North America (IANA), combines two previous reports: the Intermodal Marketing Companies (IMC) Market Activity Report and the Rail Intermodal Traffic Report⁷⁹. The IANA publication reports on intermodal volumes, highway truckload volumes, total loads, intermodal revenue, and highway revenue. The latter publication includes statistics on movements by equipment size, key corridor activity, and traffic flows between regions, including Canada and Mexico. This publication also provides comparisons with prior quarter and prior year activities and current year-to-date activity.

The **LTL Commodity and Market Survey** contains traffic lane statistics for all LTL shipments of carriers subscribing to the American Trucking Association (ATA). This database,

however, does not disclose carrier names. Data are disaggregated by traffic lane, length of haul, commodity classification, weight class, service code, and intermodal and interline activities. Table 3.17 summarizes the relevant freight attributes captured by the LTL Commodity and Market Survey.

TABLE 3.17 Freight Data Provided by the LTL Commodity and Market Survey

Cargo Attributes	Description
Commodity type	Categorized by service type (standard, non-standard delivery time, special equipment/handling)
Origin-Destination patterns	Origin/destination zip codes of foreign area (Canada, Mexico, Asia, Europe or Other)
Shipment details	Weight, number of shipments, and number of pieces
Routing details	Mileage
Transportation Mode Attributes	Description
Transportation mode	Highway/Truck Ton-miles, revenue, service type, intermodal and interline activities
Other	Intermodal shipments

The **Maritime Administration (MARAD)** Web site is a rich source of information pertaining to ports and maritime trade and comprises the following databases: Waterborne Commerce of the U.S., Foreign Traffic Vessel Entrances and Clearances, American Intermodal Equipment Inventory, Cargo Preference Overview System, Port Facilities Inventory, and U.S. Foreign Waterborne Transportation Statistics⁸⁰. Specifically, this Web site provides statistics for shipping fleets, waterborne traffic, and port traffic. Fleet statistics are disaggregated by global fleet and U.S. fleet. The waterborne traffic statistics distinguish U.S. foreign and domestic traffic, exports and imports by region by direction and major vessel, exports and imports by state by direction and major vessel, and U.S. international traffic transshipped via Canadian ports. Port statistics include the top U.S. container ports by direction and the top world port calls by vessel type.

The **Nationwide Truck Activity and Commodity Survey (NTACS)** covered truck activities for the period October 1989 to October 1990 (i.e., a 12 month period). This survey is the only source of micro-level data available that relates truck activity to vehicle characteristics and highway use, and provides a picture of trucking's role in intermodal transportation. Data on vehicle characteristics include vehicle ownership, total miles traveled, places of operation,

vehicle type, and axle configuration. Data on trip characteristics include times, destinations, type of stops, weights, and types of commodities picked up and delivered. Reported statistics showed differences in truck activities by geographic area and temporal changes over the studied period. The NTAC database is, however, considered of poor quality and was discontinued after the implementation of the CFS. Table 3.18 summarizes the relevant freight attributes captured by the NTACS.

TABLE 3.18 Freight Data Provided by the Nationwide Truck Activity and Commodity Survey

Cargo Attributes	Description
Commodity classification	26 Truck Inventory and Use Survey (TIUS) commodity categories
Commodity type	Hazardous material categories, empty cargo
Origin-Destination patterns	Location, type of place (e.g., warehouse, port)
Shipment details	Weight by commodity and load/discharge stop
Routing details	Detailed stop location, type of stop activity (e.g., pick up, delivery), arrival and departure times
Transportation Mode Attributes	Description
Highway/Truck	Ton-miles for top commodities, days of week and time of day use, number of stops, type of use, mileage, type of highways, fuel use and tolls, dimensions, capacity, and load Total mileage by the 26 TIUS commodity categories
Other	Vehicle (model year, ownership, operation)

The **North American Truck Survey (NATS)** was first collected in 1993 and discontinued in August 1994. It replaced the National Motor Transportation Database (NMTDB). The NATS provides information regarding long-haul truckload movements, operator characteristics, and annual vehicle miles traveled (VMT) by the drivers. The NATS, however, does not provide routing details for long haul truckload movements, which is important in estimating the demand of each link on the transportation network. Table 3.19 summarizes the relevant freight attributes contained in this database.

TABLE 3.19 Freight Data Provided by the North American Truck Survey

Cargo Attributes	Description
Commodity classification	STCC (3-digit for major commodities)
Origin-Destination patterns	City and state of origin and destination
Shipment details	Weight in tons
Transportation Mode Attributes	Description
Highway/Truck	Trailer type
Other	Annual VMT by driver Operator characteristics (private, for-hire, owner-operator)

The **Port Import/Export Reporting Service (PIERS)** is considered the most comprehensive database of cargo import and export information moving through ports in the U.S., Mexico, Latin America, and Asia. The relevant freight data characteristics captured by this database are summarized in Table 3.20.

TABLE 3.20 Freight Data Provided by the Port Import/Export Reporting Service

Cargo Attributes	Description
Commodity classification and commodity type	6-digit Harmonized System (HS) 7-digit PIERS Comcode (loosely based on 1979 Tariff Schedule of the United States of America (TSUS)) Actual manifest/bill of lading description
Origin-Destination patterns	U.S. shipper/consignee and foreign shipper (import only): name, U.S. city of origin/destination (as recorded), foreign country of import/export (city for export)
Shipment details	Weight and value: package type and quantity
Routing details	U.S. port of loading/unloading: foreign port of ultimate origin/destination, foreign port of transshipment, no inland mode designation
Transportation Mode Attributes	Description
Mode	Water Carrier and vessel name: container size, estimated cubic volume utilized, package type
Other	U.S. port date, linkage to other company information for importers/exporters

The **Rail Waybill Sample** contains shipment data from a stratified sample of rail waybills by freight railroads collected annually from U.S. Class I freight railroads. The data covers the nation. Some of the most important data elements captured in this sample are origin and destination points, commodity types, number and type of cars, tons, revenue, length of haul,

participating railroads, and interchange locations. Table 3.21 summarizes the relevant freight attributes contained in this sample.

TABLE 3.21 Freight Data Provided by the Rail Waybill Sample

Cargo Attributes	Description
Commodity classification	7-digit STCC on master file 2- to 5-digit STCC on public use file
Commodity type	Hazardous materials (STCC 49) Bulk materials in boxcars (STCC 50)
Origin-Destination patterns	Origin and destination movement identified by BEA Regions Intermodal, import, export and mini-bridge shipments are flagged Master file contains 6-digit Standard Point Location Code (SPLC) and a Freight Station Accounting Code
Shipment details	Billed and actual tons, carloads, trailers, containers, and revenue (sample and expanded universe totals) Date of shipment/waybill
Routing details	Master file contains full railroad and station itinerary. Public use file contains interchange states and number of interchanges
Transportation Mode Attributes	Description
Rail	Rail with some identification of intermodal activity
Other	Equipment type, shipment and expanded revenue by type (freight, transit, miscellaneous), short line miles, number of interchanges, number of intermodal units; carrier and equipment type, design, capacity, dimensions, and ID number

The **State Estimate of Truck Traffic** presents estimates of annual average daily traffic (AADT) for single-unit and combination trucks for selected sections of non-local roads, and VMT for nine classes of trucks for several highway functional classes. The data are included in the HPMS. Table 3.22 summarizes the relevant freight attributes captured by this database.

TABLE 3.22 Freight Data Provided by the State Estimate of Truck Traffic

Transportation Mode Attributes	Description
Highway/Truck	VMT for nine truck configurations (distinguished by numbers of trailers and numbers of axles) Separate VMT estimates for four-tire trucks available for some states AADT for two or three types of trucks (distinguished by length or number of trailers)

The proprietary Reebie **TRANSEARCH®** contains origin-destination freight movements for all major modes of transportation in the U.S. This multi-modal freight flow database provides commodity tonnage by mode and among origins and destinations at the county, Business Economic Area (BEA), metropolitan area, state, and provincial level. The comprehensive geographical, commodity and modal coverage of this database has made it a popular source of freight flow information for state and metropolitan transportation planners. Table 3.23 summarizes the relevant freight attributes provided by this database.

TABLE 3.23 Freight Data Provided by the Reebie TRANSEARCH®

Cargo Attributes	Description
Commodity classification	4-digit STCC 5-digit STCC available for rail and water
Origin-Destination patterns	50 States 183 U.S. BEAs Can be customized at the county or zip code level Some Canadian province data is also available
Shipment details	Total weight
Routing details	Highway routing imputed from O-D patterns
Transportation Mode Attributes	Description
All modes	Fore-hire-truckload, fore-hire LTL, private truck, rail carload, rail/truck intermodal, air and water

The **Transborder Surface Freight Database** contains freight flow data by commodity type and by surface transportation mode (i.e., rail, truck, pipeline, and mail) for U.S. exports to and imports from Canada and Mexico. This database has two data files: the commodity detail file and the geographic detail file. The former is commodity based without much transportation detail, while the latter is geographic based with detailed transportation flows. Table 3.24 summarizes the relevant freight attributes provided by this database.

TABLE 3.24 Freight Data Provided by the Transborder Surface Freight Data

Cargo Attributes	Description
Commodity classification	2-digit TSUSA/HS (for commodity detail files only)
Origin-Destination patterns	U.S. state/Mexican state or Canadian province of origin/destination (all files) U.S. NTAR of origin/destination (all files) U.S. NTAR of origin for U.S. exports (geographic detail file only)
Shipment details	Value Weight (for Canadian imports only) Containerized designation (U.S. imports only)
Routing details	U.S. Customs port of exit/entry for border points and Customs District for non-border points (for commodity detail files only)
Transportation Mode Attributes	Description
All modes	Truck, rail , and pipeline Import freight charges and containerized designations (U.S. imports only)

The **Transportation Annual Survey** provides national estimates of revenue, expenses, and vehicle fleet inventories for commercial motor freight transportation and public warehousing service industries⁸¹. Specifically, this database includes (1) estimates of annual U.S. operating revenues and selected U.S. operating expenses at the 3- and 4-digit SIC level for trucking and warehousing, (2) operating revenue and operating revenue by source, (3) total expenses and expenses by type, (4) percentage of motor carrier freight revenue by commodity type, shipment sizes handled, length of haul, and country of origin and destination, and (5) vehicle fleet inventory. This survey is the only annual source of data of firms that offer for-hire trucking and public warehousing services.

The **TranStats: The Intermodal Transportation Database** is a Web site that aims to provide the transportation community with a searching capability to obtain transportation data needed for analysis⁸². The Web site provides links to more than 100 transportation-related databases covering every mode of transportation. The databases can be searched by transportation mode (i.e., aviation, maritime, highway, transit, rail, pipeline, bike/pedestrian, and other) and subject (i.e., safety, freight transport, passenger travel, infrastructure, economic/financial, social/demographic, energy, and environment). This Web site provides information on each of the databases, summary information about the tables that comprise a database, data definitions, and code information for data variables captured. TranStats provides users with options to create statistical summaries, time-series tables, cross tabulations, online

graphics, and to cut/paste the results into reports. TranStats also allows users to download data directly to their PC for further analysis using various data bases, spreadsheets, or statistical packages.

The **U.S. Air Freight Origin Traffic Statistics** contains annual domestic and export shipment statistics for selected air cargo-producing industries by grouped U.S. geographic locations. This database fuses information in three areas: industrial use of expedited cargo, trends in industrial production for top air cargo industries, and geographic locations of these industries. A significant feature of this database is that it provides relationships between cargo flows and industrial location patterns. However, it does not associate cargo production with transportation patterns (e.g., airport or carrier). Table 3.25 summarizes the freight attributes provided by this database.

TABLE 3.25 Freight Data Provided by the U.S. Air Freight Origin Traffic Statistics

Cargo Attributes	Description
Commodity classification	Industry-based (4-digit SIC industry)
Origin-Destination patterns	State, county, and “market area” of origin. Market area is a group of counties assigned to the transportation and/or economic nexus to which is most intrinsically tied. Destination is characterized as domestic or foreign but not otherwise distinguished.
Shipment details	Annual domestic and export shipment weight, value and number of shipments (with weight and number of shipments shown by shipment size categories).
Transportation Mode Attributes	Description
Air	Shipment size categories corresponding to standard market classifications in air freight industry (express, heavy freight)
Other	Total employment and number of plants (total and by employment size) by area

The **U.S. Imports/Exports of Merchandise on CD-ROM** provides comprehensive information on commodity exports from and imports to the U.S. The import data distinguish general imports (i.e., all shipments entering the U.S. economy, including those designated for foreign trade zones) and imports for consumption (i.e., those shipments actually clearing Customs). The export data include the following variables: quantity, value, and shipping weight by country of destination, customs district of exportation, and transportation mode. Table 3.26 summarizes the freight attributes provided by this database.

**TABLE 3.26 Freight Data Provided by the U.S. Import/Export
of Merchandise on CD-ROM**

Cargo Attributes	Description
Commodity classification and commodity type	10-digit HS with concordance available to the Standard International Trade Classification (SITC) (Revision 3), SIC, BEA end-user category, and USDA agriculture product code.
Origin-Destination patterns	Foreign country of origin/destination No domestic origin/destination (beyond imputations based on district of entry/exit)
Shipment details	Value and quantity (all modes combined) Value and weight (vessel and air separately) monthly and year-to-date Import value statistics cover customs value, CIF (i.e., cost, insurance, and freight) value, and dutiable value Export statistics cover FAS (i.e., free alongside ship) value at the port of export Value for surface and pipeline modes (combined) can be derived by subtraction For commodities for which quantities are given in units of weight (generally bulk commodities), weight for surface and pipeline modes (combined) can also be derived by subtraction
Routing details	U.S. Customs District of exit (i.e., exports); or unlading and entry (i.e., imports)
Transportation Mode Attributes	Description
All modes combined; water; air	CIF value and import freight charges for vessel and air (imports)
Other	Number of shipment documents filed; calculated duty (imports)

The **Vehicle Inventory and Use Survey (VIUS)**, formerly known as the Truck Inventory and Use Survey (TIUS), is a survey of all registered vehicles in the U.S., except buses, automobiles, mobile homes, motorcycles, and vehicles owned by the government. This survey is conducted every five years as part of the economic census. The VIUS constitutes a comprehensive database of the physical and operational characteristics of the truck population in the U.S. This database provides information about vehicle type, ownership, and operating characteristics that can be linked with the type of use by type of business and commodities transported. Table 3.27 shows the freight attributes provided by the VIUS.

TABLE 3.27 Freight Data Provided by the Vehicle Inventory and Use Survey

Cargo Attributes	Description
Commodity classification	26 commodity categories (i.e., 26 TIUS commodity categories)
Commodity type	17 hazardous material categories
Transportation Mode Attributes	Description
Highway/Truck	Percent of annual mileage for the 26 commodity categories including non-freight activities (i.e., personal, idle, and empty haul use) Percent of annual miles outside of designated “base” state and percent by range of operation categories
Other	Vehicle (make, year, dimensions, body/trailer type, capacity, axle and operating configuration, equipment, maintenance) Type of business in which vehicle was used

From the above discussion, it is obvious that several public and commercial data sources exist but they do not capture the levels of detail needed for urban freight planning. Specifically, cargo data and transportation mode data provided in these data sources differ in many aspects, such as:

- Level of detail of commodity classification;
- Level of detail of commodity type;
- Level of detail of origin-destination patterns;
- Level of shipment detail;
- Level of routing detail; and
- Level of detail of freight transportation modes

In conclusion, several freight data sources exist and they have strengths and limitations for supporting planning activities at the metropolitan level. Surveys can provide the level of detail needed for urban freight planning but they require significant resources. Due to the limited resources at the metropolitan level, surveys are not performed on a regular basis by MPOs. Data provided by public and commercial data sources need to be transformed to fit the level of desegregation required at the metropolitan level. Sometimes the usefulness of these databases is limited because the information has not been updated. ITS data is a rich source of freight information but it is limited to areas covered by technologies, the existence of an archive Data User Service (ADUS) in the metropolitan region, and the willingness of carriers to share information with the public planning agencies.

CHAPTER 4 – FREIGHT DATA NEEDS AND SUITABILITY OF INTELLIGENT TRANSPORTATION SYSTEMS IN SUPPLYING MPOs WITH THE NEEDED DATA

This chapter presents the findings from in-persons interviews with Metropolitan Planning Organizations (MPOs) and state transportation planners in Texas, and discusses the results of the *Freight Data Needs Survey* to assess (1) freight data needs at the metropolitan level, (2) methods used by MPOs to collect the available freight data, and (3) the suitability of archived Intelligent Transportation Systems (ITS) in supplying MPOs with the needed freight data. The findings from the survey are presented as follows:

- Freight issues MPOs have to deal with;
- The state-of-the-practice in integrating freight component into the urban travel demand model (TDMs);
- The available and required freight data for planning;
- The perceived quality of the available data;
- The level of importance of the needed data; and
- Methods used by MPOs to collect the available freight data.

To assess the suitability of archived ITS data in supplying MPOs with the needed freight data, this study presents the following:

- The level of ITS deployment in metropolitan regions (based on the MPO respondents);
- The state-of-the-practice of archived ITS data to support urban freight planning (based on the MPO respondents); and
- The relationships between MPOs freight data needs and freight data supply by ITS.

4.1 FINDINGS FROM IN-PERSONS INTERVIEWS

During the months of November and December of 2003, in-person interviews were conducted with urban travel modelers from Houston-Galveston Area Council (H-GAC) and North Central Council of Governments (NCTCOG). The objectives of these interviews were to learn the state-of-the practice regarding freight data collection methods, freight data availability,

and analytical tools to conduct passenger and freight integrated modeling. The most relevant findings from this activity are summarized in the following paragraphs.

4.1.1 Houston-Galveston Area Council (H-GAC)

For the most part, no truck data has been collected. Freight movements are a major concern for the metropolitan region because of the presence of important generators and attractors of truck traffic in the area and its adverse environmental and social impact. For example, the Port of Houston is a major origin and destination of truck traffic which contributes to congestion and emissions in this non-attainment area and safety concerns as well.

H-GAC relies on (1) data collected by the Texas Department of Transportation (TxDOT), including the special generator surveys, and (2) data provided by Port of Houston which is limited due to privacy concerns. Special generator surveys have been conducted at two airports and Barbour's Cut Container Terminal under the direction of the Texas Transportation Institute (TTI). These data collection efforts provided truck counts, truck classification, trip purpose, and origin-destination data.

Two special studies were funded in 1995 and 2003 to determine the impact of freight transportation in the region. The findings of these studies are found in two reports. They are the "Intermodal Facilities Inventory (1995)" and the "Freight Workshop Summary Report (2003)."

H-GAC is not aware of any effort to collect ITS data in its area that can benefit the MPOs in planning or modeling efforts.

H-GAC relies on two models to conduct the traditional four step process. They are TRAC 1 for the trip generation, trip distribution, and mode choice components, and EMME-2 for the route assignment. Truck trip rates are based on the commercial vehicle surveys conducted by TxDOT. These rates are used to estimate the internal trips in the region. The external to internal and through truck estimates are derived from the external station data used in the SAM. The passenger and freight components are not integrated in its travel demand models.

Parsons Brinkerhoff is developing a new model called TRAC 2 which will take into consideration truck size and truck traffic composition in peak and off-peak periods. The consultant is currently evaluating available data from Houston and San Antonio. Regarding data needs, the interviewee expressed they need freight data at a zonal level. Houston-Galveston metropolitan area is divided into 3,000 Traffic Analysis Zones (TAZs)

making freight data to and from these zones needed. County truck data collected for the SAM is too aggregated to conduct freight planning at the metropolitan level. Furthermore, concerns regarding hazardous cargo movements emphasize the need for disaggregate truck data.

4.1.2 North Central Council of Governments (NCTCOG)

NCTCOG relies on data collected by TxDOT, specifically traffic counts and vehicle classification data. Also, TxDOT conducts special generator traffic counts at malls, major retail localities, hospitals, and universities. NCTCOG has access to employment data of major employers. These data are used to determine trip generation rates for personal trips and truck trips. Finally, some limited data is available on airports.

The forecasting technique is based on the traditional four-step sequential process. Trip purposes are defined in four different ways: home-based-work, home-based-nonwork, nonhome-based and 'other'. 'Other' category includes the external-internal, internal-external, and external-external trips as well as truck trips. The urban model is a trip based model. Truck trips are estimated as a factor of employment by establishment type (e.g. retail, service etc.). For the estimation of external truck trips, the MPO relies on the traffic counts conducted by TxDOT.

Until recently, the travel demand model was a mainframe-based model. Currently, the NCTCOG is moving to a TransCAD platform which will include 4,700 TAZs, the GIS network, and new models. Over the past year, NCTOG has been working in the validation and calibration of the new models. The new platform will allow for the modeling of intra-zonal trips, zone-to-zone trips, and external movements. The model also will estimate morning, mid-day, and evening peak automobile and truck traffic volumes. For the truck component, the model has been validated using truck count data of TxDOT. It is foreseen that the new model will eventually allow distinguishing truck trips by vehicle types.

The NCTCOG expressed they need disaggregate truck data such as truck time-of-day data, truck peak hour travel percentages, and truck traffic compositions. These data are required to conduct corridor-based analysis and assess contribution of trucks on urban congestion and air quality problems, among others.

NCTCOG needs information to evaluate the traffic impacts associated with Trade Zones. There are a number of Free Trade Zones in the Dallas/Fort Worth region (i.e. Alliance, Dallas/Fort Worth Airport) for which no data exists in terms of the volumes of goods entering or

leaving these zones. Freeport also has extensive rail service however no data exists on the truck trips generated at this facility.

NCTOG also needs data regarding less-than-truckload (LTL) and FedEx services. The increase in these types of services has resulted in large trucks (e.g., FedEx, UPS and post offices trucks) moving through residential areas.

4.2 *FREIGHT DATA NEEDS SURVEY: CONTENT AND ADMINISTRATION*

A comprehensive questionnaire was administered to MPOs in the U.S. to assess the freight data needs at the urban level. The questionnaire (see Appendix A), consisting of 37 questions, was organized into eight sections as shown in Table 4.1.

Two lists were consulted from the World Wide Web to identify the MPO target population. One list was available on the homepage of the AMPO⁸³ and the second was the MPO Directory provided by the FHWA's Travel Model Improvement Program Website⁸⁴. Combining these two lists resulted in a population size of 343 observation units (e.g., MPOs). To facilitate the distribution of the questionnaire among the MPO population and the compilation of the answers, the survey was administered through the Internet. Electronic mails were sent to all MPOs with an electronic mail account, which accounted for 301 observation units. The electronic mail included a link to the Uniform Resource Locator (URL) where the survey could be filled out.

The survey was conducted between the months of May and June of 2004. A reminder email was sent to those MPOs that had not completed the survey at the specified time. Sixty-five (65) MPOs completed the survey, representing a response rate of approximately 22% based on the original sampled population. The effective response rate computed based on the successfully delivered mails was 25% (see Table 4.2). All emails did not reach the intended recipients for the following reasons:

- Invalid mailbox;
- The recipient name was not recognized or unknown;
- Address had permanent fatal errors,
- Account no longer in service;
- Recipient had exceeded their available disk space for emails; and
- Service unavailable.

TABLE 4.1 Freight Data Needs Survey: Survey Content

Section	Content	Focus of the Questions
I.	Contact Information	MPO name and contact information
II.	General Information	MPO size Air quality in the area
III.	Freight Activity	Freight transportation modes in the area Intermodal transfer facilities in the area
IV.	Freight Planning Issues	Infrastructure issues Safety issues Environmental issues
V.	Analytical Tools to Support Freight Planning	Existing of a travel demand model in the area Integration of the passenger and freight components in the travel demand model Approaches for forecasting freight transportation demand
VI.	ITS: Level of Deployment and Archived Data	Level of deployment of ITS in the area Existing of Archive Data User Service (ADUS) in the area Use of archived ITS data for freight planning
VII.	Freight Data Collection Methods	Surveys Traffic counts ITS technologies Public and commercial data sources
VIII.	Freight Data: Available and Needed	Available and needed freight data Collection methods for the available data Quality of the available data Important of the freight data for planning

TABLE 4.2 Freight Data Needs Survey: Response Rate

	Amount
Sampled population size (n)	301
Not reachable emails (u)	37
Adjusted sampled population size ($n_{adj} = n - u$)	264
Completed surveys (R)	65
Response rate $\left(r = R / n_{adj} \right)$	25%

4.3 GENERAL INFORMATION AND FREIGHT ACTIVITY IN THE STUDIED LOCATIONS

An analysis of the demographic characteristics, environmental conditions, and available freight transportation modes and facilities in the various metropolitan regions provided some insight into the diversity of the metropolitan areas and the potential issues MPOs have to deal with. The results from the *Freight Data Needs Survey* showed the following:

1. The responding MPOs varied in terms of population size (see Table 4.3). The metropolitan regions were classified by the number of inhabitants based on the thresholds used in a previous study prepared for FHWA⁸⁵.

TABLE 4.3 Distribution of the MPO Size in the Studied Locations

Size		Number of inhabitants	Percent of total respondents
Smaller MPOs	Small	<250,000	42 (27)
	Mid-Sized	250,000-500,000	14 (9)
Larger MPOs	Mid-Large	500,000-1,000,000	9 (6)
	Large	>1,000,000	35 (23)

Note: Figures in parenthesis indicate the number of respondents

2. Pollution levels in 58% of the responding metropolitan regions persistently exceeded the national ambient air quality standards (see Table 4.4). A test of independence between MPO size and whether the MPO was in non-attainment condition at a 0.05 significance level revealed a dependence between MPO size and air quality concerns (chi-squared (1) = 16.60, p-value < 0.001). As is expected, a higher number of major metropolitan regions (i.e., regions with more than 0.5 inhabitants) are facing air quality concerns relative to minor metropolitan regions (i.e., regions with less than 0.5 inhabitants). This suggests the need for increasing attention on projects that promote the protection and preservation of the environment by major MPOs.

TABLE 4.4 Air Quality in the Studied Metropolitan Regions

Size	Attainment Area Percent of total respondents	Non-attainment Area Percent of total respondents
Small	28 (18)	14 (9)
Mid-Sized	8 (5)	6 (4)
Mid-Large	1 (1)	7 (5)
Large	5 (3)	31 (20)
TOTAL	42 (27)	58 (38)

Note: Figures in parenthesis indicate the number of respondents.

- Truck and rail are the predominant freight transportation modes in the responding locations, which results in an equal emphasis on the intermodal transfer facilities between these two modes (see Table 4.5). A number of MPOs also have airports and seaports in their metropolitan areas, which emphasize the need to integrate the different freight transportation modes in ensuring the easy movement of freight through urban areas. A test of independence at a 0.05 significance level revealed no difference between available freight modes in major metropolitan regions and available freight modes in minor metropolitan regions ($\chi^2(4) = 6.17$, $p\text{-value} > 0.05$). It should be noted that 15% of the responding MPOs reported no intermodal transfer facilities in their regions.

TABLE 4.5 Freight Transportation Modes and Transfer Facilities in the Studied Locations

Modes	Percent
Highways/Trucks	100%
Rail	98%
Air	85%
Water	49%
Pipeline	11%
Intermodal Transfer Facilities	Percent
Truck/rail	93%
Truck/airport	70%
Truck/seaport	34%
Rail/seaport	34%
Rail/airport	11%
Other intermodal transfer facilities (e.g., truck/pipeline, truck/barge, rail/barge, rail/riverport, and international borders)	11%

4.4 FREIGHT PLANNING AND CHALLENGES IN THE RESPONDING METROPOLITAN REGIONS

The significant and continued growth in freight movements in metropolitan areas is currently challenging MPOs to integrate the movement of people and freight in their planning activities so that they can analyze the impact of domestic and through passengers and freight traffic in their areas. The results from the *Freight Data Needs Survey* showed that 69% of the metropolitan regions do freight planning (see Figure 4.1). To determine whether the percentage of MPOs conducting freight planning depends on the MPO size, a test of independence was carried out using an alpha-level of 0.05. The analysis showed that a higher percentage of major metropolitan regions are conducting urban freight planning compared to minor metropolitan regions (chi-square (1) = 14.00, p-value < 0.001).

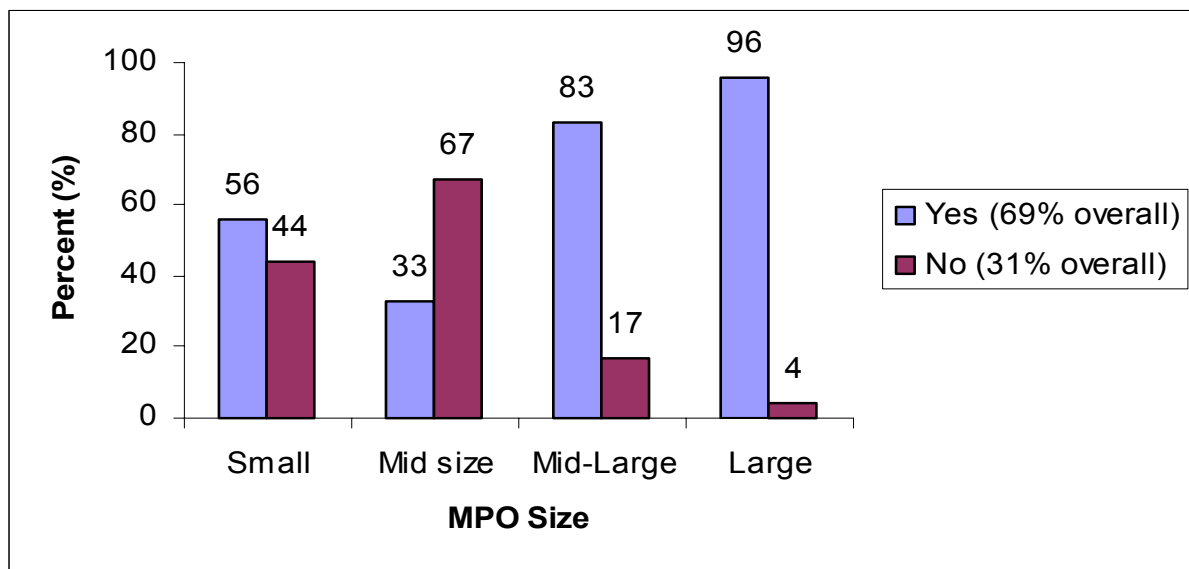


FIGURE 4.1 Freight Planning in the Studied Metropolitan Regions

For the most part, freight traffic growth is being handled by the existing transportation system. As a result, responding MPOs indicated that capacity constraints, safety, system preservation, and environmental concerns are currently the most relevant transportation issues that they have to contend with (see Figure 4.2).

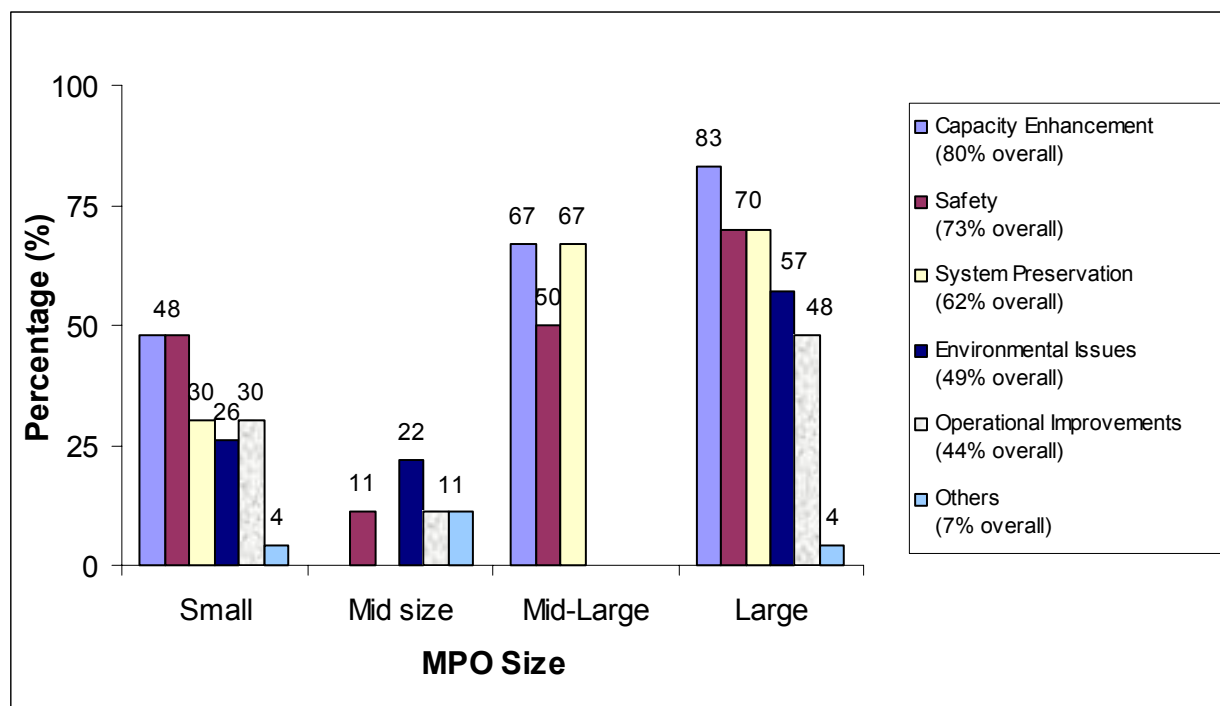


FIGURE 4.2 Freight Transportation Issues in the Studied Metropolitan Regions

To determine if freight transportation issues are related to the MPO size, a test of independence was carried out using an alpha-level of 0.05. The analysis showed that freight issues (i.e., capacity enhancement, safety, system preservation, environmental issues, and operational improvements) prevail in both major metropolitan regions and minor metropolitan regions (chi-square (4) = 1.88, p-value > 0.05). It should, however, be noted that the scale of these issues depends on the magnitude of freight activities taking place in the metropolitan regions. Other transportation issues cited by the respondents included new transportation facilities to re-direct truck traffic around the urban area, passenger rail/freight rail track capacity, and cargo-handling technology. This category was not considered in the present analysis.

An interesting finding is that only 45% of the MPOs with non-attainment areas are dealing with environmental issues (see Figure 4.3). As expected, the results from a test of independence at alpha-level of 0.05 showed that MPOs with non-attainment areas are more likely to deal with environmental issues (chi-square (1) = 4.85, p-value < 0.05).

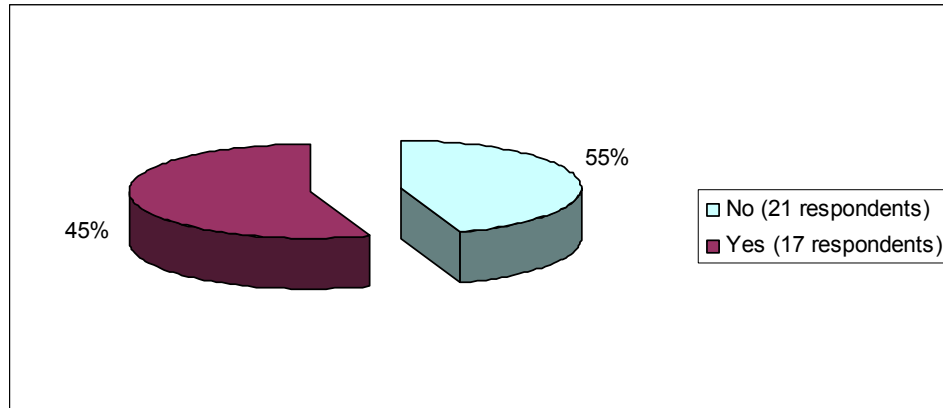


FIGURE 4.3 Environmental Issues Consideration in Metropolitan Regions with Non-attainment Areas

4.5 FREIGHT URBAN DEMAND MODELING IN THE RESPONDING METROPOLITAN REGIONS

Freight demand modeling helps MPO planners to understand urban freight patterns and to formulate and evaluate strategies or policies to improve the efficiency of goods movement. In particular, urban freight modeling can shed light on infrastructure, safety, and environmental issues (such as those discussed in the previous section) pertaining to the transportation system. This will enable the identification and evaluation of alternative actions based on performance measures obtained through the modeling process. The proposed freight modeling approaches in the literature (as presented in Chapter 2) aim to integrate the freight component into the urban travel demand modeling process, thus taking into consideration the underlying factors that affect the demand for freight.

In spite of the advances in freight modeling, the *Freight Data Needs Survey* revealed that less than one-third of the responding metropolitan regions have integrated passenger and freight components into their urban TDMs (see Figure 4.4). An interesting finding is that no mid-size MPO reported that its TDM has a freight component. To determine if the percentage of MPOs that have an integrated freight component in their TDMs depends on the MPO size, a test of independence was carried out at an alpha-level of 0.05. The analysis showed that the percentage of MPOs with a TDM that have a freight component depends on whether the MPO is a major or a minor region (chi-square (1) = 6.28, p-value < 0.05). The survey results revealed that five

small MOPs, two mid-large MPOs, and ten large MPOs have a TDM with an integrated freight component.

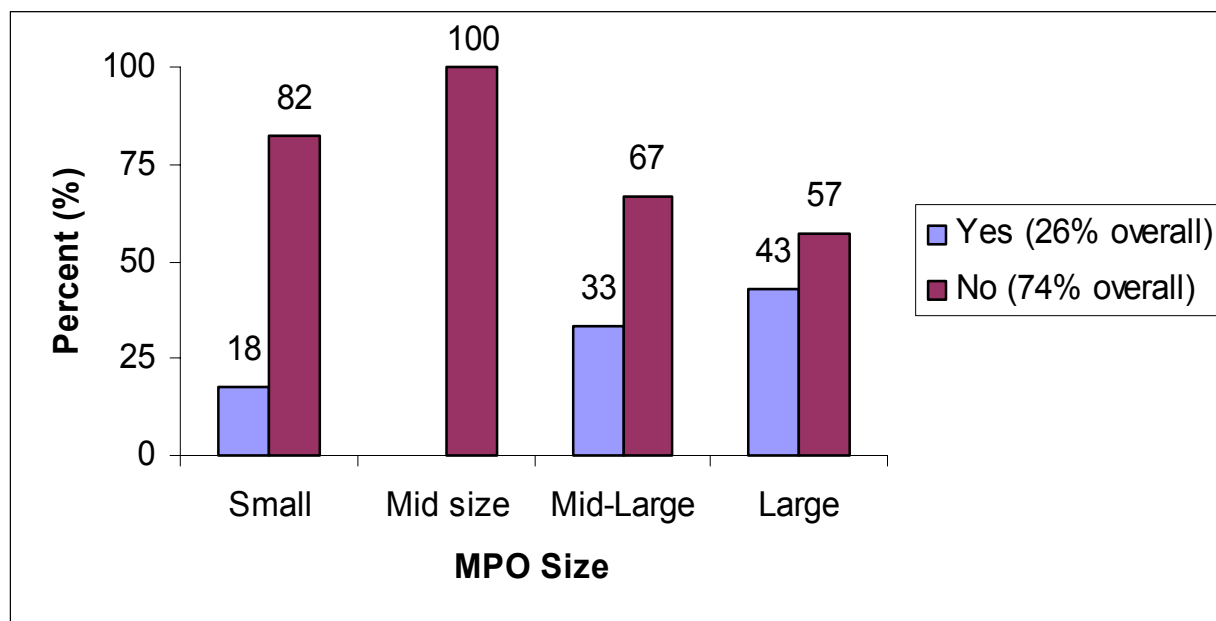


FIGURE 4.4 Freight Component in the Travel Demand Model in the Studied Metropolitan Regions

The need to achieve greater integration among freight transportation modes has added considerable complexity and additional requirements to the MPOs when conducting freight planning. Two of the most cited resources in the literature that are considered essential to facilitate freight planning are data and analytical tools. A lack of data, to some extent, also explains the limited level of deployment of freight modeling in many urban areas in the U.S.

4.6 ASSESMENT OF FREIGHT DATA AVAILABILITY AND NEEDS IN THE RESPONDING METROPOLITAN REGIONS

Chapter 3 identified the relevant attributes and level of detail for each freight data category. To obtain a better understanding of the data used and needed by metropolitan regions, MPOs were asked regarding the following:

1. Availability or need for freight data attributes (based on 65 responses);
2. The level of detailed data available and needed (based on valid responses, i.e., number of respondents who appropriately answered questions regarding data used and needed);
3. The level of detailed data needed as a function of MPO size (based on number of valid responses);
4. The level of detailed data available as a function of MPO size (based on number of valid responses);
5. The quality of the available freight data (based on number of valid responses); and
6. The importance of the needed freight data (based on number of valid responses).

Only the questions answered for no less than 30 respondents were included in this analysis.

4.6.1 Assessment of Cargo Data

4.6.1.1 Availability and Need for Cargo Attribute Data. Table 4.6 summarizes the MPOs responses as to what cargo attribute data are used or needed in their metropolitan regions. The results suggest the following:

1. Overall, origin-destination and routing data are the most used or needed cargo attribute in the studied locations. This information is extremely relevant for freight urban planning because it helps planners to identify urban freight patterns and the contribution of freight vehicles to urban congestion, pavement deterioration, environmental quality, and the economic vitality of urban areas.
2. Shipment details were ranked third in terms of available or needed cargo attribute data. This is partly due to the fact that some popular modeling approaches require shipment volumes or tonnage to be converted to truck trips. It is done using simple methods, such as the average vehicle payload factors (also known as truck conversion factors).
3. Finally, 60% of the respondents indicated that commodity classification and commodity type data were used or needed by the MPO.

**TABLE 4.6 Cargo Attributes Available or Needed in the Studied Metropolitan Regions
(based on the 65 surveyed MPOs)**

Attributes	Use/Need	
	Yes	No
Origin/Destination Patterns	77% (50)	23% (15)
Routing Details	75% (49)	25% (16)
Shipment Details	65% (42)	35% (23)
Commodity Classification Commodity Type	60% (39)	40% (26)

Note: Figures in parenthesis indicate the number of respondents.

Figure 4.5 illustrates the availability or need for cargo attribute data as a function of MPO size. The following conclusions can be made:

1. In general, a higher percentage of larger metropolitan regions indicated that they use or need cargo attribute data. For origin-destination patterns, specifically, all the mid-large metropolitan regions reported that they need or use these data.
2. To determine if the expressed availability and need for cargo attribute data depend on the MPO size, tests of independence were carried out. The outcomes indicated the following:
 - (a) The expressed need and availability of origin-destination patterns, shipment details and routing details depend on whether the metropolitan region has less than 0.5 million inhabitants or more than 0.5 million inhabitants at a 0.05 significance level. The observed chi-squares at 1 degree of freedom were 7.72 for the origin-destination patterns, 10.67 for the shipment details, and 5.75 for the routing details. In all three cases, p-values were less than 0.05.
 - (b) The expressed need and availability of commodity type data does not depend on the demographic characteristics (i.e., number of inhabitants) of the metropolitan region at a 0.05 significance level (chi-square (1) = 1.75, p-value > 0.05), and
 - (c) The expressed need and availability of commodity classification data are the same for the major and minor metropolitan regions at a 0.05 significance level (chi-square (1) = 3.36, p-value > 0.05). However, this null hypothesis of independence should be rejected for a higher alpha value of 0.10.

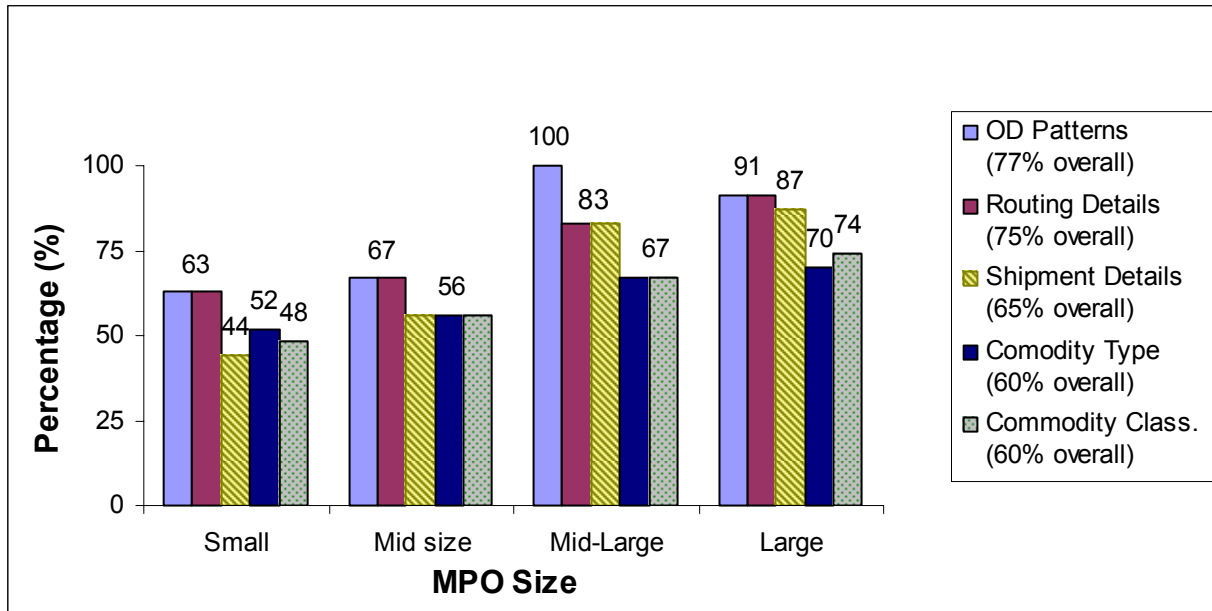


FIGURE 4.5 Cargo Attribute Data Used or Needed by MPO Size

4.6.1.2 Level of Detailed Cargo Data Available and Needed. Table 4.7 summarizes the MPO responses in terms of the level of detailed cargo data that is available or needed. The results suggest the following:

1. The percentage of respondents that indicated a need for detailed cargo data varied between 49% and 94%, depending on the attribute. In contrast, the percentage of respondents that indicated that detailed cargo data were available and used by the MPO ranged between 6% and 46%. It should be noted that a similar percentage of respondents indicated the use and need formal commodity classification data.
2. The most needed level of detail for each cargo attribute were (a) hazardous material for commodity type, (b) zip codes for origin-destination patterns, (c) empty shipments for shipment details, and (d) hazardous material vehicle routing for routing details.
3. The most available level of detail for each cargo attribute were (a) formal classification system for commodity classification, (b) state data for origin-destination patterns, (c) weight following by value and mode of transportation for shipment details, and (d) major routes used by freight vehicles for routing details.

TABLE 4.7 Cargo Detail Available or Needed in the Studied Metropolitan Regions

Commodity Classification and Commodity Type	Valid Responds	Need	Use	Use/Need
Hazardous material (HAZMAT)	30	83%	17%	0%
Aggregate categories (e.g., bulk, break-bulk, etc.)	34	76%	24%	0%
Formal Classification System (e.g., SIC, STCC, SITC, NAICS)	37	49%	46%	5%
Origin-Destination Patterns	Valid Responds	Need	Use	Use/Need
Zip codes	29	86%	10%	3%
Metropolitan Statistical Areas (MSA)	30	80%	17%	3%
Traffic Analysis Zones (TAZ)	39	74%	26%	0%
Counties	38	74%	21%	5%
States	30	67%	33%	0%
Shipment Details	Valid Responds	Need	Use	Use/Need
Empty shipments	30	87%	13%	0%
Average length of haul	36	86%	14%	0%
Volume	32	84%	16%	0%
FTL or LTL shipments	34	82%	18%	0%
Value	30	73%	27%	0%
Weight	32	72%	28%	0%
Mode of transportation	37	70%	27%	3%
Routing Details	Valid Responds	Need	Use	Use/Need
HAZMAT vehicle routing	35	94%	6%	0%
Vehicle routing	34	88%	9%	3%
Interim trip origins and destination	35	83%	11%	6%
Number of stops	30	83%	13%	3%
Major routes used	42	79%	17%	5%

4.6.1.3 Level of Detailed Cargo Needed as a Function of MPO Size. Table 4.8 summarizes the expressed level of detailed cargo needed as a function of MPO size. The results suggest the following:

1. Zip code details are the most needed origin-destination patterns by large metropolitan regions. MSA, county and state details are the most needed origin-destination patterns by mid-large metropolitan regions. TAZ details are the most needed origin-

- destination patterns by mid-sized metropolitan regions. Finally, zip codes and MSA details are the most needed origin-destination patterns by small metropolitan regions.
2. HAZMAT vehicle routing details are the most needed routing data by large metropolitan regions. Vehicle routing and HAZMAT vehicle routing details are the most needed routing data by mid-large and mid sized metropolitan regions. Small metropolitan regions ranked major routes used by freight vehicles as the most needed routing detail.
 3. In terms of shipment details, average length of haul is the most important information needed by large metropolitan regions. For the mid-large and mid sized metropolitan regions, volume details are the most needed. The former, however, ranked FTL and LTL shipment as important as volume details. Small metropolitan regions ranked FTL and LTL shipment details as the most needed shipment detail.
 4. In terms of commodity data, most respondents expressed a need for aggregate categories and hazardous materials independent of the size of the metropolitan region.

**TABLE 4.8 Cargo Detail Needed in the Studied Metropolitan Regions
(based on valid responses)**

Attributes	Detail	MPO Size				Valid Responds
		Small	Mid sized	Mid-large	Large	
OD Patterns	Zip codes	38%	10%	10%	28%	29
	MSA	37%	13%	13%	17%	30
	TAZ	28%	15%	8%	23%	39
	Counties	34%	11%	13%	16%	38
	States	34%	10%	13%	10%	30
Routing Details	HAZMAT Vehicle Routing	32%	14%	11%	37%	35
	Vehicle Routing	32%	15%	12%	29%	34
	Interim trip OD	34%	11%	9%	29%	35
	Number of stops	27%	13%	10%	33%	30
	Major routes used	36%	10%	12%	21%	42
Shipment Details	Empty shipments	34%	13%	10%	30%	30
	Average length of haul	31%	11%	11%	33%	36
	Volume	34%	16%	15%	19%	32
	FTL or LTL shipments	38%	12%	15%	17%	34
	Value	24%	13%	13%	23%	30
	Weight	31%	12%	13%	16%	32
	Mode of transportation	30%	13%	13%	14%	37
Commodity Classification and Commodity Type	Aggregate Categories	35%	12%	12%	17%	34
	Formal Classification System	25%	8%	8%	8%	37
	Hazardous material	36%	17%	13%	17%	30

4.6.1.4 Level of Detailed Cargo Available as a Function of MPO Size. Table 4.9 summarizes the MPO responses to the level of cargo detail available and used by MPO size. The results suggest the following:

1. In terms of origin-destination details, the survey results seem to indicate that a higher level of disaggregated data is available and used by small and large MPOs. The only origin-destination detail used by the mid-large metropolitan regions is at the state level, while the mid-size metropolitan regions reported no use of detailed origin-destination data. Approximately 30% of the large MPOs respondents use state data for freight planning.

2. The large metropolitan regions indicated that they have access to and use various levels of routing detail. However, only 14% of the large MPO respondents have access to the major routes used by the freight vehicles. Mid-large and mid-sized metropolitan regions reported that no routing details are available for use. Finally, only approximately 3% of small metropolitan regions reported using some routing details.
3. Only large metropolitan regions have access to and use shipment details for freight planning. The three highest ranked shipment details used are weight (28%), value (27%), and mode of transportation (27%).
4. In terms of commodity classification and commodity type details, most of the respondents indicated that they use the formal commodity classification system. The mid-large and mid-sized MPOs respondents indicated that this is the only level of commodity detail available to them. Small metropolitan regions have, in addition, access to hazardous material detail. Finally, large MPOs use aggregate commodity category detail (24%) and hazardous material detail (29%) in addition to the formal classification (14%).

**TABLE 4.9 Cargo Detail *Available* in the Studied Metropolitan Regions
(based on valid responses)**

Attributes	Details	MPO Size				Valid Responds
		Small	Mid sized	Mid-large	Large	
OD Patterns	Zip codes	3%	0%	0%	7%	29
	MSA	3%	0%	0%	14%	30
	TAZ	13%	0%	0%	13%	39
	Counties	3%	0%	0%	18%	38
	States	0%	0%	3%	30%	30
Routing Details	HAZMAT Vehicle Routing	0%	0%	0%	6%	35
	Vehicle Routing	0%	0%	0%	9%	34
	Interim trip OD	0%	0%	0%	11%	35
	Number of stops	3%	0%	0%	10%	
	Major routes used	3%	0%	0%	14%	42
Shipment Details	Empty shipments	0%	0%	0%	13%	30
	Average length of haul	0%	0%	0%	14%	36
	Volume -small	0%	0%	0%	16%	32
	FTL or LTL shipments	0%	0%	0%	18%	34
	Value	0%	0%	0%	27%	30
	Weight	0%	0%	0%	28%	32
	Mode of transportation	0%	0%	0%	27%	37
Commodity Classification and Commodity Type	Aggregate Categories	0%	0%	0%	24%	34
	Formal Classification System	11%	3%	3%	29%	37
	Hazardous material	3%	0%	0%	14%	30

4.6.2 Assessment of Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Data

4.6.2.1 Availability and Need for Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Attribute Data. Table 4.10 summarizes the MPOs responses as to what transportation modes and terminal/intermodal transfer facilities attributes are used or needed in their metropolitan regions. The results suggest the following:

1. As expected, highway/truck and rail data are the most used or needed mode attributes. This finding reflects the needs and availability for data from the two predominant freight transportation modes in the studied locations (i.e., highway/truck and rail).
2. Terminal and intermodal transfer facilities are also used or needed by 66% of the studied locations. This reveals the emphasis MPOs are putting on intermodal freight data to support their intermodal planning activities.
3. Air data are also used or needed by 60% of the studied locations, while water data are used or needed by 40% of the respondents. This reflects the needs and availability for these data in the MPO respondents who indicated having freight movements by air and water as well.

TABLE 4.10 Transportation Mode Attributes Available or Needed in the Studied Metropolitan Regions (based on the 65 surveyed MPOs)

Attributes	Use/Need	
	Yes	No
Highway/Truck Mode	82% (53)	18% (12)
Rail Mode	74% (48)	26% (17)
Air Mode	60% (39)	40%(26)
Water Mode	40% (26)	60% (39)
Terminal and Intermodal Transfer Facilities	66% (43)	34% (22)

Note: Figures in parenthesis indicate the number of respondents.

Figure 4.6 illustrates the availability or need for transportation modes and terminal/intermodal transfer facilities attributes as a function of the MPO size. The following conclusions can be made:

1. In general, a higher percentage of larger metropolitan regions indicated they use or need highway/truck mode, rail mode, air mode, and terminal/intermodal transfer facilities attributes.
2. In general, a higher percentage of mid-size metropolitan regions indicated they use or need water mode attribute.
3. To determine if the expressed availability and need for transportation modes and terminal/intermodal transfer facilities attributes depend on the MPO size, tests of independence were carried out at a 0.05 significance level. The outcomes indicated that the expressed need and availability of highway/truck data, rail data, air data, water data, and terminal and intermodal transfer facilities data depend on whether the metropolitan region has less than 0.5 million inhabitants or more than 0.5 million inhabitants. The observed chi-square at 1 degree of freedom were 4.65 for the highway/truck data, 4.14 for the rail data, 5.49 for the air data, 5.02 for the water data, and 9.40 for the intermodal and transfer facilities data. In all cases, p-values were less than 0.05.

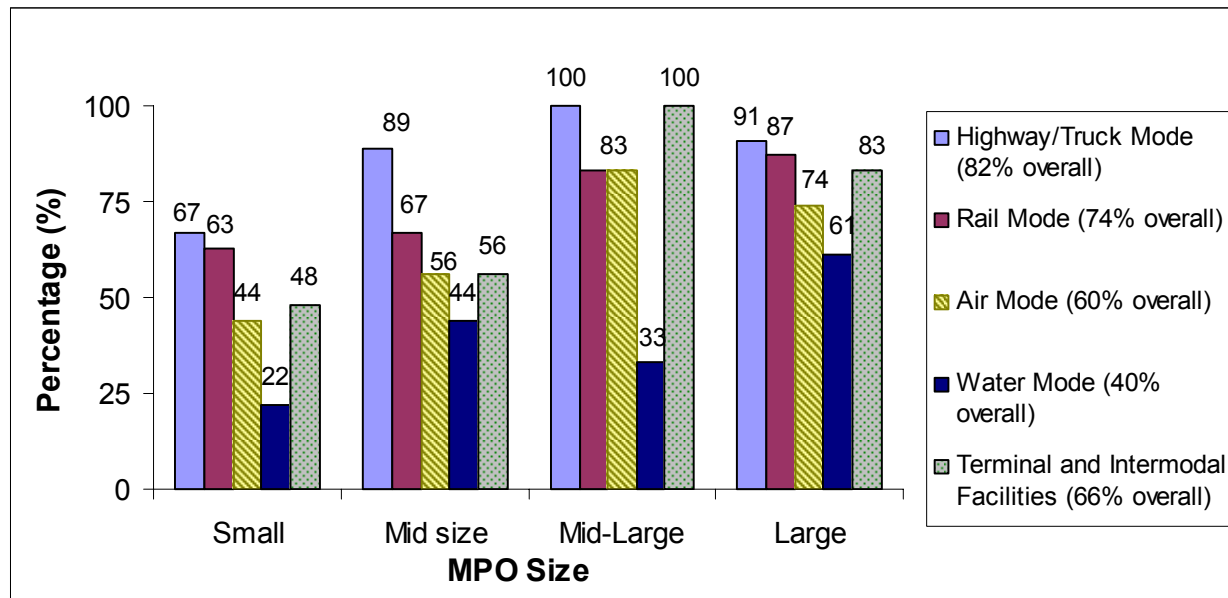


FIGURE 4.6 Transportation Mode and Terminal/Intermodal Transfer Facility Data Used or Needed by MPO Size

4.6.2.2 Level of Detailed Transportation Mode Data Available and Needed. Table 4.11 summarizes the MPO responses in terms of the level of detailed transportation mode and terminal/intermodal transfer facilities data that is available or needed. It should be noted that there were less than 30 valid responds for detailed water mode data, so this attribute was excluded from this analysis. The applicable results suggest the following:

1. The percentage of respondents who indicated a need for transportation mode detail data varied between 51% and 100%, depending on the attribute. The percentage of respondents who indicated detailed transportation mode data were available and used by the MPO ranged between 0% and 40%. Although highway/truck data seem to be the more accessible data for the MPOs, these figures reveal that MPOs persistently have a significant need for detailed freight transportation mode data.
2. The percentage of respondents that indicated a need for terminal/intermodal transfer facilities detail data varied between 82% and 97%, depending on the attribute. These figures reflect the significant need for this data at the metropolitan level.
3. The most needed level of detail for each transportation mode attribute were (a) travel time for highway/truck mode, (b) hazardous materials for rail mode, and (c) origin-destination patterns for air mode.
4. The most available level of detail for each transportation mode attribute were (a) traffic volume data for highway/truck mode, (b) commodity type for rail mode, and (c) shipment characteristics for air mode.
5. The most needed level of detail for terminal/intermodal transfer facilities was length of queue on access roads, while the most available level of detail for this attribute was the capacity of facility.

**TABLE 4.11 Transportation Mode and Terminal/Intermodal Transfer Facilities Detail
Available or Needed in the Studied Metropolitan Regions (based on valid responses)**

Highway/Truck Mode	Valid Responds	Need	Use	Use/Need
Travel time	36	92%	6%	3%
Average vehicle speed	32	88%	13%	0%
Vehicle emission data	30	83%	13%	3%
Incident data	30	83%	17%	0%
Truck O/D patterns	41	83%	12%	5%
Trip O/D patterns	42	76%	19%	5%
Vehicle size (e.g., heavy, medium, light, small commercial)	41	73%	22%	5%
Vehicle type (formal FHWA classification/State classification)	42	64%	31%	5%
Traffic volume data	45	51%	40%	9%
Rail Mode	Valid Responds	Need	Use	Use/Need
Hazardous materials	30	100%	0%	0%
O/D patterns	40	95%	5%	0%
Routing data	40	90%	10%	0%
Shipment characteristics (e.g., weight, volume, value)	37	89%	11%	0%
Commodity type	37	78%	19%	3%
Air Mode	Valid Responds	Need	Use	Use/Need
O/D patterns	32	94%	6%	0%
Commodity type	34	85%	15%	0%
Shipment characteristics (e.g., weight, volume, value)	33	79%	18%	3%
Terminal and Intermodal Transfer Facilities	Valid Responds	Need	Use	Use/Need
Length of queue on access roads	31	97%	3%	0%
Incident rates on access roads to the facility	31	90%	10%	0%
Congestion-related delays on access roads to the facility (time)	36	89%	11%	0%
Truck volumes entering or exiting facilities	43	86%	14%	0%
Capacity of facility (e.g., tons, number of containers)	33	82%	18%	0%

4.6.2.3 Level of Detailed Transportation Mode and Terminal/Intermodal Transfer Facilities Needed as a Function of MPO Size. Table 4.12 summarizes the expressed level of *detailed* transportation mode and terminal/intermodal transfer facilities *needed* as a function of MPO size. The results suggest the following:

1. Travel time is the most needed highway/truck mode data by large metropolitan regions. Average vehicle speed and truck origin-destination patterns are the most needed highway/truck mode data by mid-large metropolitan regions. Vehicle size and average vehicle speed are the most needed highway/truck mode data by mid-sized metropolitan regions. Finally, travel time and incident data are the most needed highway/truck mode data by small metropolitan regions
2. Hazardous material is the most needed rail data by large metropolitan regions. Commodity type is the most needed rail data by mid-large metropolitan regions. Shipment characteristics and commodity type are the most needed rail data by mid-sized metropolitan regions. Finally, origin-destination patterns are the most need rail data by small metropolitan regions.
3. In terms of air mode data, origin-destination patterns are the most needed by larger metropolitan regions. Mid-large metropolitan regions also reported a high need for commodity type details. Mid-sized and small metropolitan regions reported almost the same needs for air mode details.
4. In terms of terminal and intermodal transfer facilities, length of queue on access roads is the most needed by large metropolitan regions. The mid-large metropolitan regions indicated that length of queue on access roads and incident rates on access roads to the facility are the most needed data. Finally, capacity of facility is the most needed data by the mid-sized and small metropolitan regions.

**TABLE 4.12 Transportation Modes and Terminal/Intermodal Transfer Facilities Detail
Needed in the Studied Metropolitan Regions (based on valid responses)**

Attributes	Details	MPO Size				Valid Responds
		Small	Mid-sized	Mid-large	Large	
Highway/Truck Mode	Travel time	31%	14%	11%	36%	36
	Average Vehicle speed	25%	16%	13%	34%	32
	Vehicle emission data	27%	13%	10%	33%	30
	Incident Data	30%	10%	10%	33%	30
	Truck O/D Patterns	27%	15%	12%	29%	41
	Trip O/D Patterns	26%	14%	10%	26%	42
	Vehicle size	19%	17%	10%	27%	41
	Vehicle type	26%	14%	10%	14%	42
	Traffic volume data	22%	13%	5%	11%	45
Rail Mode	Hazardous material	34%	13%	13%	40%	30
	O/D Patterns	40%	13%	12%	30%	40
	Routing Data	38%	12%	7%	33%	40
	Shipment characteristics	30%	16%	11%	32%	37
	Commodity type	30%	16%	13%	19%	37
Air Mode	O/D Patterns	34%	16%	16%	28%	32
	Commodity type	35%	15%	15%	20%	34
	Shipment characteristics	34%	15%	12%	18%	33
Terminal and Intermodal Transfer Facilities	Length of queue on access roads	26%	10%	16%	45%	31
	Incident rates on access roads to the facility	26%	13%	16%	35%	31
	Congestion-related delays on access roads to the facility (time)	28%	11%	14%	36%	36
	Truck volumes entering or exiting facilities	30%	12%	14%	30%	43
	Capacity of facility (e.g., tons, number of containers)	34%	18%	9%	21%	33

4.6.2.4 Level of Detailed Transportation Mode and Terminal/Intermodal Transfer Facilities Available as a Function of MPO Size. Table 4.13 summarizes the MPO responses to the level of transportation modes and terminal/intermodal transfer facilities details available by MPO size. The results suggest the following:

1. In terms of highway/truck mode data, the survey results seem to indicate that a higher level of disaggregated data is available and used by small and large MPOs. The most available detail data at the large and small metropolitan regions are vehicle type and traffic volume respectively. Traffic volume is the only highway/truck mode detail used by the mid sized metropolitan regions. Finally, the highway/truck mode details available at the mid-large metropolitan regions are vehicle size (3%), vehicle type (2%), and traffic volume (2%).
2. The large metropolitan regions indicated that they have access to and use various levels of rail mode detail. About 16% of the large MPO respondents have access to the commodity type transported by rail. Mid-large and mid sized metropolitan regions reported that no rail mode details are available for use. Finally, the small metropolitan regions reported using commodity type (3%) and routing data (2%) rail details. None of the MPO respondents has access to hazardous material data transported by rail.
3. Only large metropolitan regions have access to and use air mode details for freight planning. These detailed data are shipment characteristics (18%), commodity type (15%), and origin-destination patterns (6%).
4. The large and small metropolitan regions indicated that they have access to and use various levels of terminal and intermodal transfer facilities details. Capacity of the facility (18%) is the most available data at the large metropolitan regions, while length of queue, incident rates and congestion-related delays on access roads to the facilities are the most available data at the small metropolitan regions. Congestion-related delays are the only terminal and intermodal transfer facilities detail available at the mid-large metropolitan regions. The mid sized MPO respondents indicated that no terminal and intermodal transfer facilities details are available for use.

**TABLE 4.13 Transportation Modes and Terminal/Intermodal Transfer Facilities Detail
Available in the Studied Metropolitan Regions (based on valid respondents)**

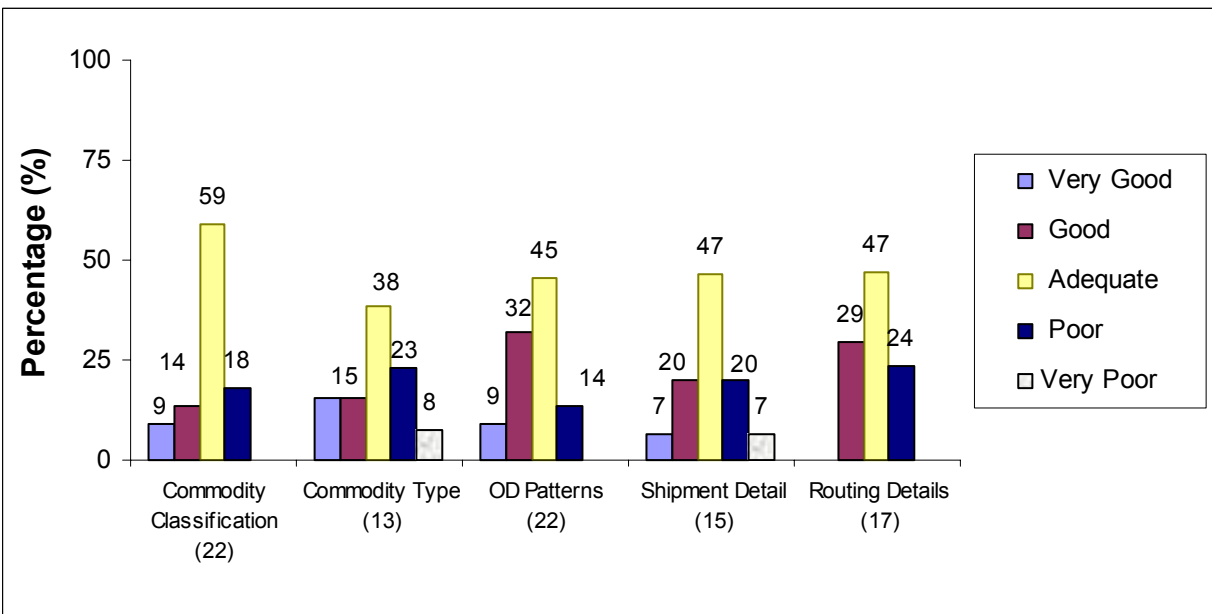
Attributes	Details	MPO Size				Valid Responds
		Small	Mid sized	Mid-large	Large	
Highway/Truck Mode	Travel time	3%	0%	0%	3%	36
	Average Vehicle speed	3%	0%	0%	9%	32
	Vehicle emission data	0%	0%	0%	13%	30
	Incident Data	7%	0%	0%	10%	30
	Truck O/D Patterns	2%	0%	0%	10%	41
	Trip O/D Patterns	5%	0%	0%	14%	42
	Vehicle size	7%	0%	3%	12%	41
	Vehicle type	5%	0%	2%	24%	42
	Traffic volume data	14%	2%	2%	22%	45
Rail Mode	Hazardous material	0%	0%	0%	0%	30
	O/D Patterns	0%	0%	0%	5%	40
	Routing Data	2%	0%	0%	8%	40
	Shipment characteristics	0%	0%	0%	11%	37
	Commodity type	3%	0%	0%	16%	37
Air Mode	O/D Patterns	0%	0%	0%	6%	32
	Commodity type	0%	0%	0%	15%	34
	Shipment characteristics	0%	0%	0%	18%	33
Terminal and Intermodal Transfer Facilities	Length of queue on access roads	3%	0%	0%	0%	31
	Incident rates on access roads to the facility	3%	0%	0%	7%	31
	Congestion-related delays on access roads to the facility (time)	3%	0%	3%	5%	36
	Truck volumes entering or exiting facilities	2%	0%	0%	12%	43
	Capacity of facility (e.g., tons, number of containers)	0%	0%	0%	18%	33

4.6.3 Quality of the Available Freight Data

Figure 4.7 summarizes the MPO responses in terms of the quality of the available cargo data based on the valid responses. The results suggest the following:

1. The quality of the available cargo attributes varied among MPO respondents.

2. A higher number of the MPOs (i.e., 43 MPOs) assessed the quality of the available cargo data as adequate.
3. While 20 MPOs expressed their cargo data are good, 17 MPOs expressed their data are poor and 2 MPOs indicated their cargo data are very poor.
4. Only 7 MPOs assessed the quality of the commodity classification, commodity type, origin-destination patterns, and shipment details attributes as very good. No MPOs assessed their routing data as very good.



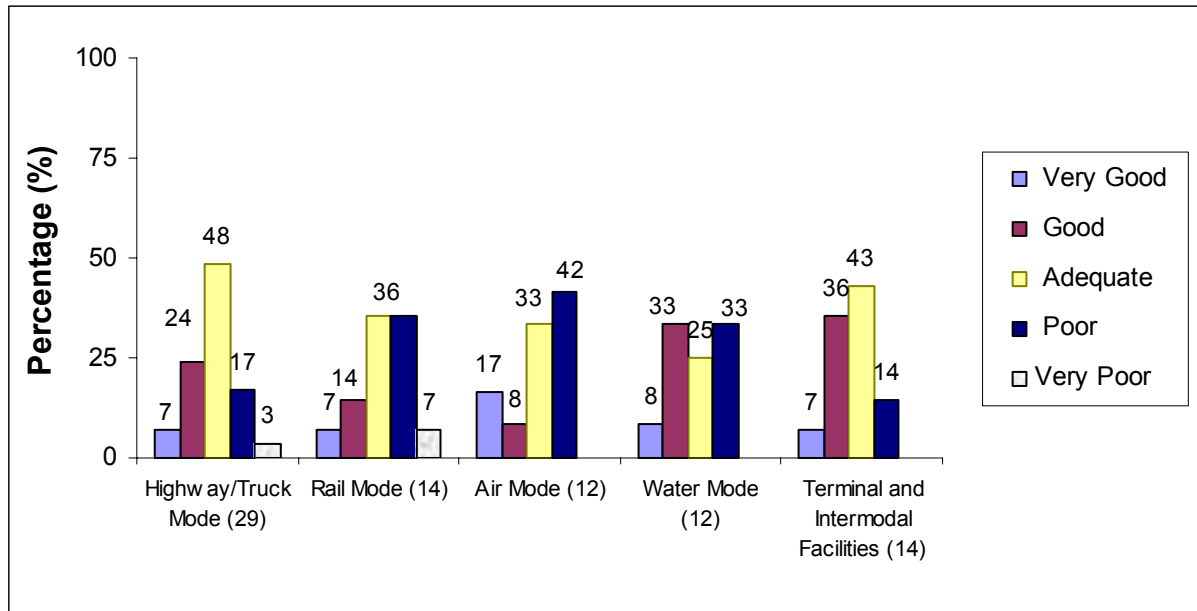
Note: Figures in parenthesis indicate the number of respondents

FIGURE 4.7 Quality of the Available Cargo Attributes

Figure 4.8 summarizes the MPO responses in terms of the quality of the available freight transportation modes and terminal/intermodal transfer facilities data based on the valid responses. The results suggest the following:

1. A higher number of the MPOs (i.e., 32) assessed the quality of the available freight transportation modes and terminal/intermodal transfer facilities data as adequate since highway/truck mode the better ranked quality data overall.
2. While 19 MPOs expressed their freight transportation modes and terminal/intermodal transfer facilities data were good, only 7 MPOs assessed the quality of this data as very good.

- While 21 MPOs expressed their freight transportation modes and terminal/intermodal transfer facilities data were poor, 2 MPOs indicated that this data was very poor.



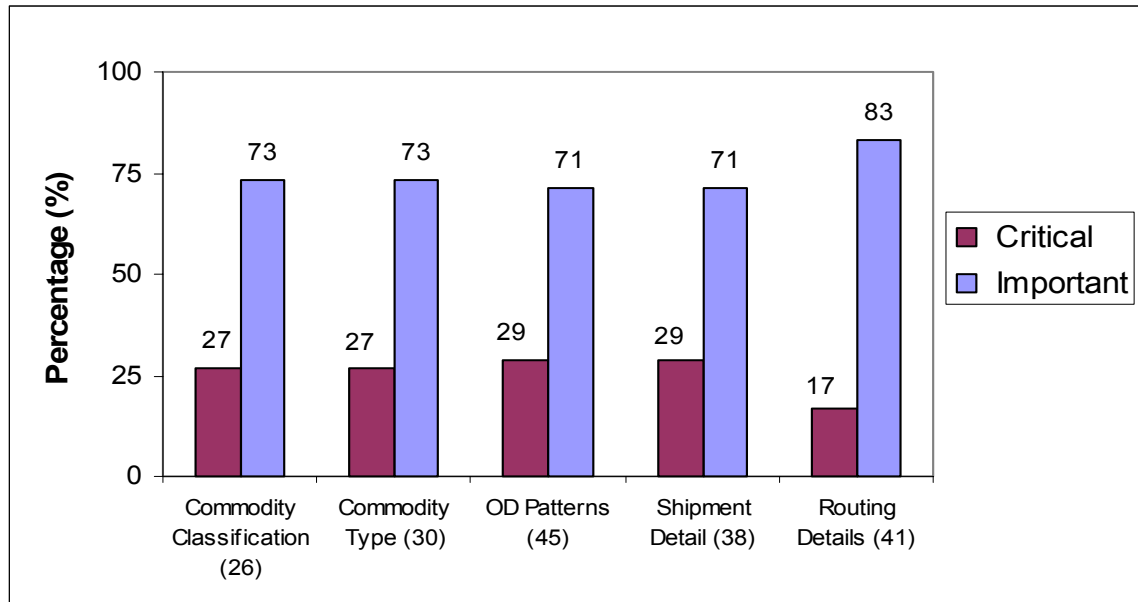
Note: Figures in parenthesis indicate the number of respondents

FIGURE 4.8 Quality of the Available Freight Transportation Modes and Terminal/Intermodal Transfer Facilities Attributes

4.6.4 Significant of the Needed Freight Data

Figure 4.9 summarizes the MPO responses in terms of how important is the cargo data for urban planning based on the valid responses. The results suggest the following:

- Overall, all cargo attributes are more important than critical for freight planning. In all cases, more than 70% of the MPO respondents expressed that these cargo attributes are important.
- Routing details were ranked first as the most important cargo attribute.

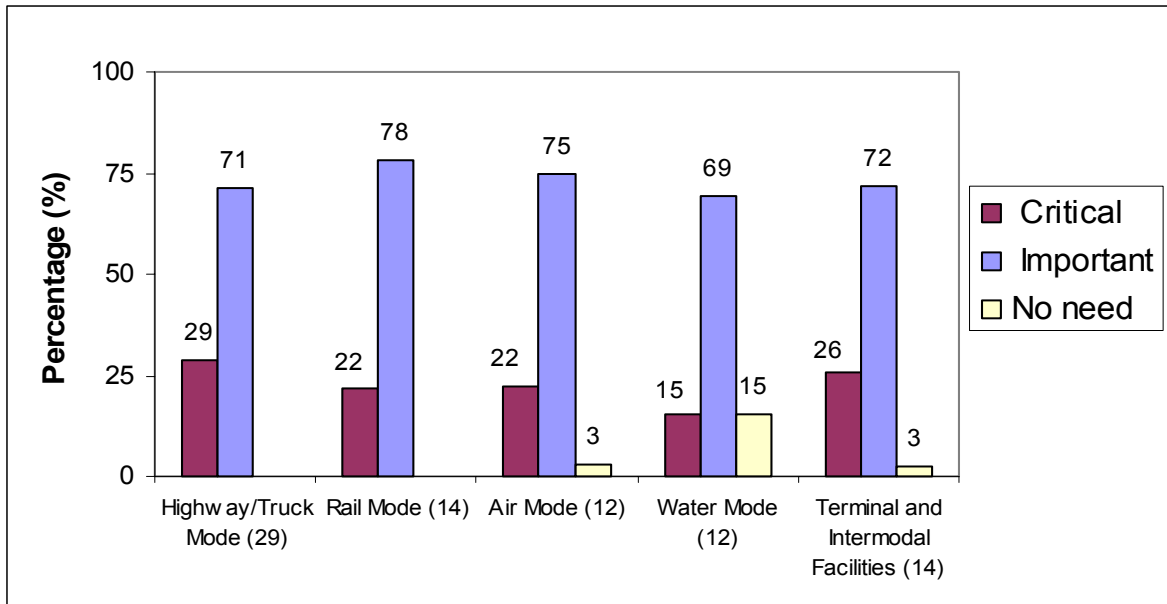


Note: Figures in parenthesis indicate the number of respondents

FIGURE 4.9 Significant of the Needed Cargo Attributes

Figure 4.10 summarizes the MPO responses in terms of how important are the freight transportation modes and terminal/intermodal transfer facilities data for urban planning based on the valid responses. The results suggest the following:

1. Overall, all freight transportation modes and terminal/intermodal transfer facilities attributes are more important than critical for freight planning. In all cases, more than two-thirds of the MPO respondents expressed that these attributes are important.
2. Rail water mode data were ranked as the most important freight transportation mode attribute.
3. Some MPOs respondents expressed they did not need air mode, water mode, and terminal and intermodal facilities data.



Note: Figures in parenthesis indicate the number of respondents
FIGURE 4.10 Significant of the Needed Transportation Modes and Terminal/Intermodal Transfer Facilities Attributes

4.7 FREIGHT DATA COLLECTION METHODS

To assess the available freight data collection methods at the metropolitan level, MPOs were asked what freight data collection methods are used to gather and populate freight databases. The results summarized in Table 4.14 suggest the following:

1. Overall, ITS technologies are the most used collection method to gather freight data in the studied MPOs. This finding points out the ITS opportunities for providing the needed freight data at the metropolitan level.
2. Public and commercial data sources also play an important role in providing MPOs with the needed freight data.
3. Surveys are the least used collection method in the studied locations. Because these traditional data collection efforts are prohibitively expensive, it seems that only 42% of the MPO respondents have the resources to afford these collection techniques.

**TABLE 4.14 Freight Data Collection Methods in the Studied Metropolitan Regions
(based on the 65 surveyed MPOs)**

Collection Method	Use	
	Yes	No
ITS Technologies	62% (40)	38% (25)
Public or Commercial Data Sources	58% (38)	42% (27)
Traffic Counts	51% (33)	49% (32)
Administer or Fund Surveys	42% (27)	58% (38)

Note: Figures in parenthesis indicate the number of respondents.

Figure 4.11 illustrates the freight collection methods used in the studied locations as a function of the MPO size. The following conclusions can be made:

1. ITS technologies and public and commercial data sources are the two most popular collection methods to gather freight data in large and small metropolitan regions.
2. Surveys and traffic counts are the two most popular collection methods to gather freight data in the mid-size and mid-large metropolitan regions. ITS technologies are also popular in the mid-large regions.
3. Public and commercial data sources are the least popular collection method in the mid-large and mid-size metropolitan regions.
4. To determine if the collection methods used by the MPOs depend on the demographic characteristics of the region, tests of independence were carried out at a 5% significance level. The outcomes indicated the following:
 - (a) The expressed accessibility to surveys and public and commercial data sources to collect freight data depends on whether the metropolitan region has less than 0.5 million inhabitants or more than 0.5 million inhabitants. The observed chi-square at 1 degree of freedom and p-values were, respectively, 4.00 and less than 0.05 for surveys, and 12.73 and less than 0.001 for public and commercial data sources.
 - (b) The expressed accessibility to traffic counts and ITS technologies to collect freight data does not depend on whether the metropolitan region is larger or smaller. The observed chi-squares at 1 degree of freedom were 1.29 for traffic counts and 2.62 for ITS technologies. The p-values were greater than 0.05.

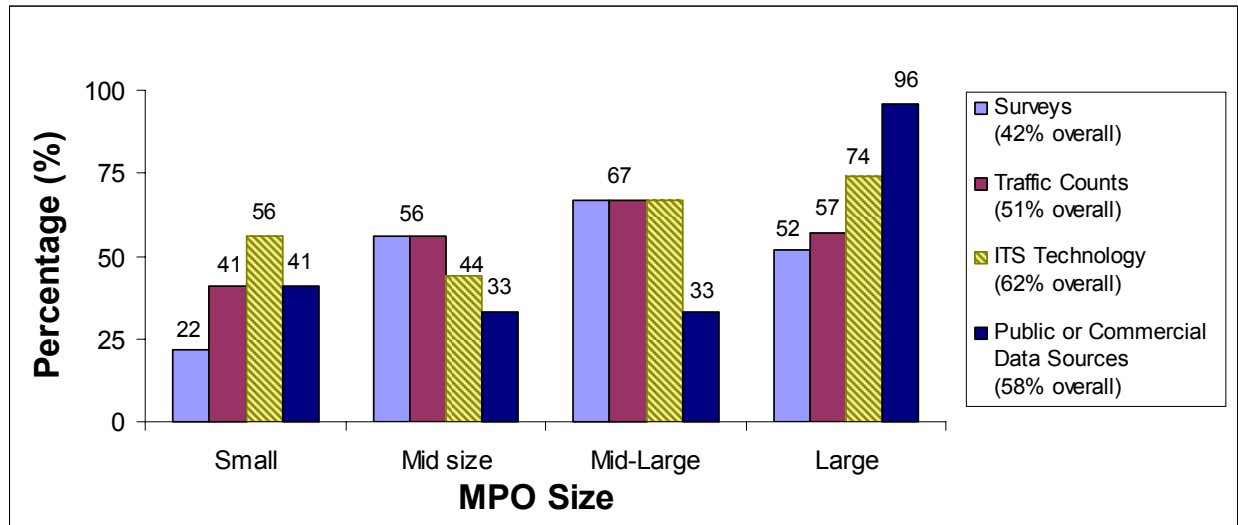


FIGURE 4.11 Freight Collection Methods Used in the Studied Locations as a Function of the MPO Size

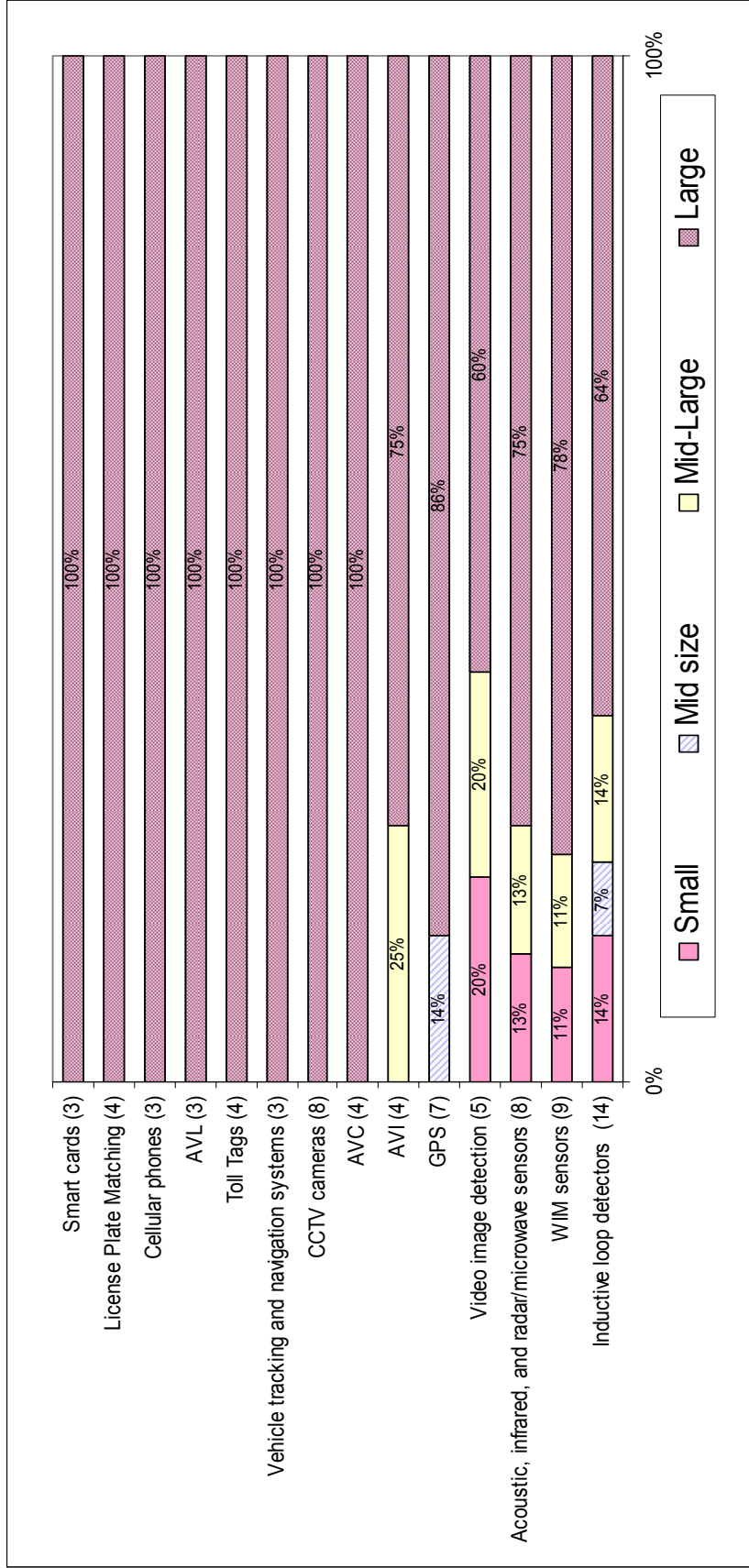
From the MPOs that responded they use ITS freight data, only 18 indicated the ITS technologies that provide such freight data. The results summarized in Figure 4.12 suggest the following:

1. All the ITS technologies identified in this study as a rich source of freight information prevail in large metropolitan regions. In fact, only these regions use freight data collected by AVC, CCTV cameras, vehicle tracking and navigation systems, toll tags, AVL, cellular phones, license plate matching, and smart cards.
2. Inductive loop detector is the only ITS technology that is common to all studied locations.
3. Surprisingly, neither WIM technology nor sensors are used to collect freight data in the mid-size metropolitan regions that responded to this survey.

From the MPOs that responded they use public and commercial data sources, 34 explicitly indicated what source(s) they use. The results summarized in Figure 4.13 suggest the following:

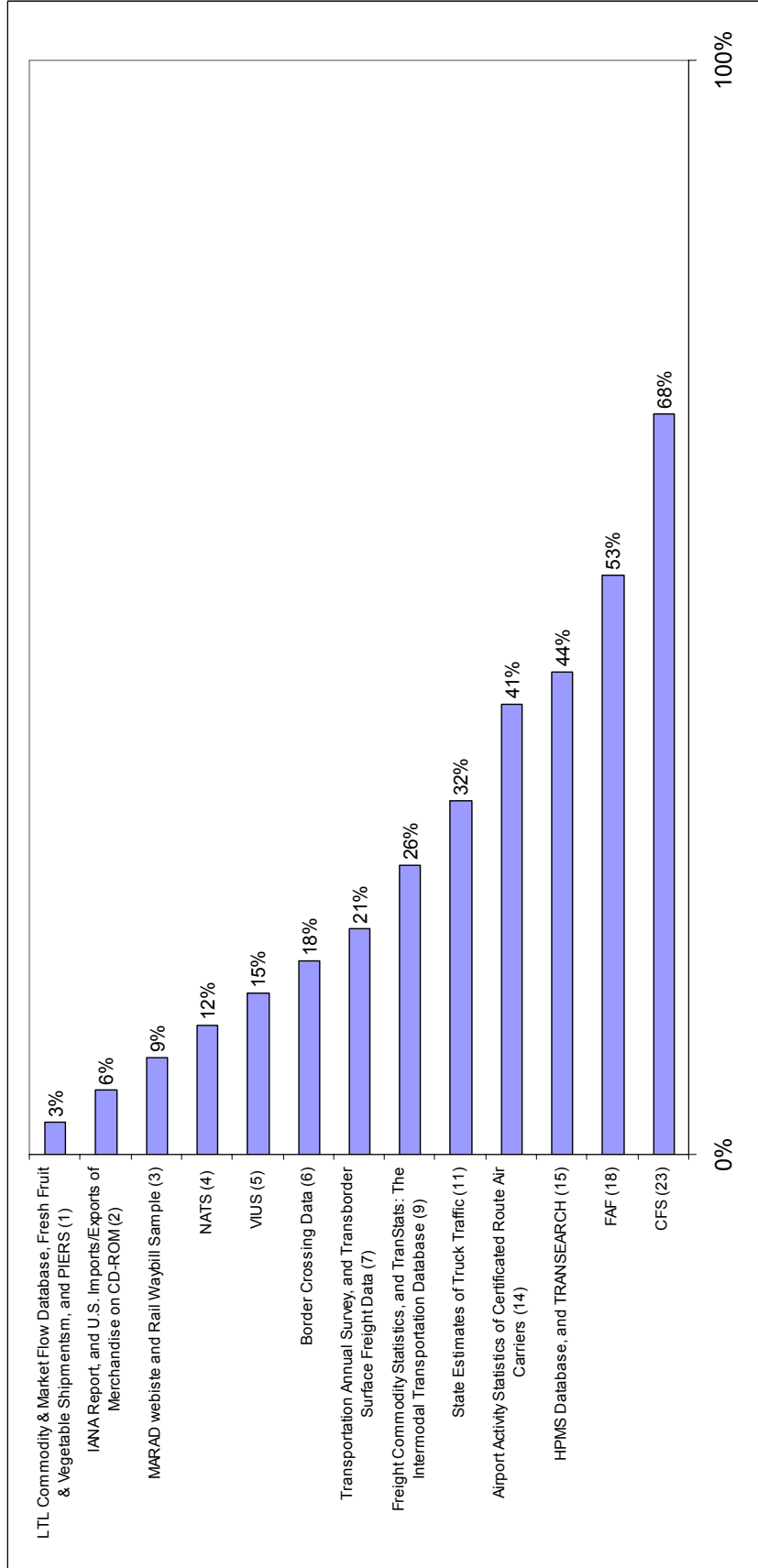
- a. As expected, a higher percentage of MPOs use the Commodity Flow Survey (CFS).
- b. Surprisingly, 53% of the MPO respondents indicated they use the Freight Analysis Framework.
- c. Forty four percent (44%) of the MPO respondents use the TRANSEARCH® database.

- d. It was expected that a higher number of MPO respondents indicated they use the HPMS database.



Note: Figures in parenthesis indicate the number of respondents.

FIGURE 4.12 ITS Technologies in the Studied Regions to Collect Freight Data as a Function of the MPO size



Note: Figures in parenthesis indicate the number of respondents.

FIGURE 4.13 Public and Commercial Data Sources Used by the Studied Regions to Populate Freight Databases

4.8 SUITABILITY OF INTELLIGENT TRANSPORTATION SYSTEMS IN SUPPLYING MPOs WITH THE NEEDED DATA

MPOs were asked to gauge the level of deployment of ITS technologies and assess the state-of-the-practice in the use of archived ITS data. Figure 4.14 shows the level of deployment of ITS technologies in the responding metropolitan regions based on five inquired level of deployment. The results suggest the following:

1. In general, a higher percentage of MPOs indicated ITS technologies have been deployed in their areas.
2. Two levels of deployment of ITS technologies prevail in metropolitan regions with more than 250,000 inhabitants. These levels of deployment are ‘ready for use’ and ‘under development’.
3. The level of deployment of ITS technologies in the small metropolitan regions is spread out among the inquired levels.
4. As expected, a higher number of large metropolitan regions are already using ITS technologies relative to the other metropolitan regions. Furthermore, a smaller number of these regions are developing ITS technologies relative to the other metropolitan regions.
5. Mid-large metropolitan regions seem to be at a break-even point of ITS deployment between ‘ready for use’ and ‘under development’.
6. The ITS technologies are under development in a higher number of smaller metropolitan regions relative to the larger metropolitan regions. Furthermore, seven small MPOs, which account for 26% of the small MPOs, have not yet started the deployment of ITS technologies in their regions.

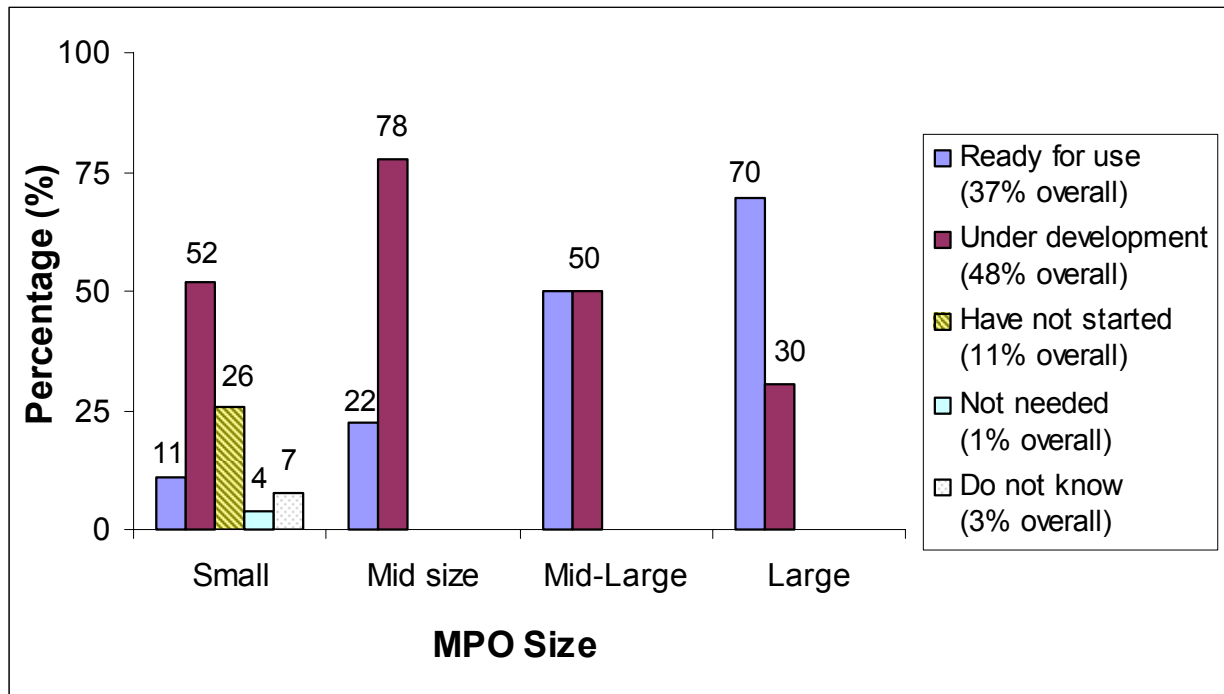


FIGURE 4.14 Level of Deployment of ITS Technologies in the Studied Locations as a Function of the MPO Size

Figure 4.15 shows whether an Archive Data User Service (ADUS) exists in the responding metropolitan regions. In general, most of the MPO respondents did not know whether there was an ADUS in their regions (i.e., 43%). Only 15% of the respondents (i.e., 10 MPOs) indicated that an ADUS is present in their regions, while 42% (i.e., 27 MPOs) indicated there is not. Furthermore, ADUS mostly prevails in the large metropolitan regions (i.e., 9 large MPOs). Only one small metropolitan region (i.e., 1 small MPOs) indicated that an ADUS was present in its region. Available information for the ADUS from the National ITS Architecture reveals that the most common archived data comes from Arterial Management Systems, Freeway Management Systems, Incident Management Systems, Traffic Management Systems, and Traveler Information Systems. Vehicle Commercial Operations (CVO) has the potential to provide ADUS with freight data, which is currently needed at the metropolitan level. Such an application, however, was not identified in any of the literature.

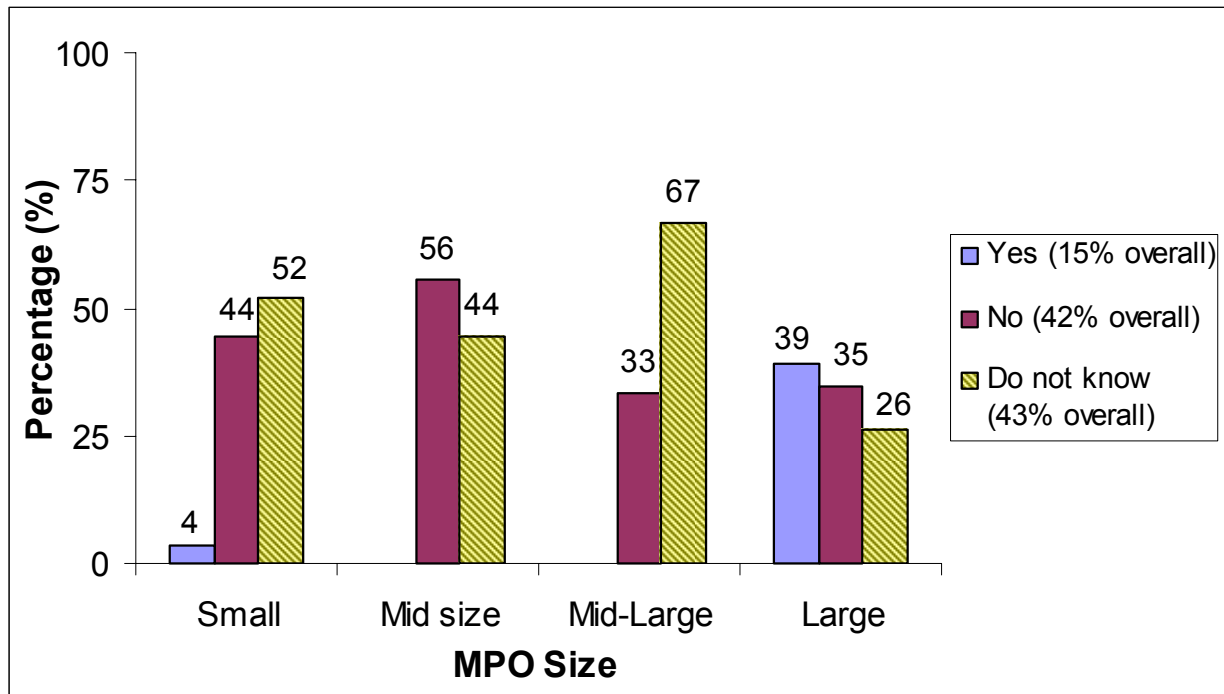


FIGURE 4.15 Existence of Archive Data User Service (ADUS) in the Studied Locations as a Function of the MPO Size

Table 4.15 shows the percentage of MPO respondents who indicated they used archived ITS freight data to support their freight planning activities. From the 62% of the respondents who expressed they use ITS technologies to collect freight data (i.e., 40 MPOs), only one small MPO and four large MPOs indicated they use archived ITS data.

TABLE 4.15 Number of Metropolitan Regions that use Archive ITS Data to Support Freight Planning Activities

MPO Size	ADUS exists in the metropolitan region	ADUS is used to support MPO freight planning activities
Small (27)	1	1
Large (23)	9	4

Note: Figures in parenthesis indicate the number of respondents by MPO size.

In conclusion, the figures regarding the level of ITS deployment in the metropolitan regions and the MPOs already using ITS freight data show that over 50% of the MPO respondents are getting data from ITS technologies (see Table 4.16). However, few of these MPOs indicated they use ADUS to get the needed data. This finding could be explained in part to

the fact that 43% of the MPO respondents are unaware if there was an ADUS in their respective regions.

**TABLE 4.16 Relationships among ITS level of Deployment
in the Studied Locations and MPOs Users**

Size	ITS Deployment		Users of ITS Technologies to collect freight data	Users of Archived ITS data
	Ready for use	Under development		
Small	5% (3)	21% (14)	23% (15)	1% (1)
Mid-Sized	3% (2)	11% (7)	6% (4)	0% (0)
Mid-Large	5% (3)	5% (3)	6% (4)	0% (0)
Large	24% (16)	11% (7)	27% (17)	6% (4)
TOTAL	37% (24)	48% (31)	62% (40)	7% (5)

Note: Figures in parenthesis indicate the number of respondents.

Based on the MPO freight data needs identified in the *Freight Data Needs Survey* and the freight data provided by ITS technologies (as described in Chapter 3), the suitability of ITS in supplying MPOs with the needed data can be recognized. Table 4.17 points out the level of detailed cargo data provided for the ITS technologies, while Table 4.18 presents the level of detailed highway/truck data provided for the ITS technologies.

Cargo Detail Data		ITS Technologies										
		Inductive loop detectors	WIM sensor systems	Sensors	Environmental sensor stations	CCTV cameras	Video image detection	AVC	AVI CVO Toll Tags	AVL GPS	Cellular phones (probe vehicles)	License Plate Matching (LPM)
Commodity Type:												
Aggregate categories									√	√*		
Hazardous material									√	√*		
OD Patterns:												
Commodity O-D patterns									√	√	√	√
Shipment Details:												
Empty shipments									√			
Average length of haul									√	√	√	√
Payload weight (cargo weight)			√						√			
Volume									√			
Mode of transportation									√			
Routing Details:												
HAZMAT Vehicle routing						√			√	√	√	√
Vehicle routing						√			√	√	√	√
Interim trip origins and destinations												
Number of stops												
Major routes used						√			√	√	√	√

*Limited information regarding commodity hauled.

TABLE 4.18 ITS Technologies which Provide Highway/Truck Detail Data												
Highway/Truck Detail Data	ITS Technologies											
	Inductive loop detectors	WIM sensor systems	Sensors	Environmental sensor stations	CCTV cameras	Video image detection	AVC	AVI CVO Toll Tags	AVL GPS	Cellular phones (probe vehicles)	License Plate Matching (LPM)	Smart Cards
Travel time	✓		✓		✓			✓	✓	✓	✓	✓
Average vehicle speed	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓
Vehicle emission data				✓								
Incident data	✓		✓		✓	✓						
Truck O-D patterns								✓	✓	✓	✓	✓
Trip O-D patterns								✓	✓	✓	✓	✓
Vehicle type	✓	✓	✓		✓	✓	✓	✓				
Traffic volume data	✓	✓	✓		✓	✓	✓	✓				

According to Tables 4.17 and 4.18, ITS technologies are a rich source of urban freight data that can significantly enhance the amount and quality of information needed by MPOs. Since road freight is the predominant mode of urban freight transportation, it is clear that ITS technologies can supply MPOs with the needed highway/truck data. Furthermore, some cargo detailed data can be drawn for ITS applications at the metropolitan level. This freight data can significantly help planners to identify urban freight patterns and the contribution of urban freight vehicles to urban congestion, pavement deterioration, environmental quality, and the economic vitality of their urban areas. On the other hand, few MPOs seem to know basic information regarding ADUS in their regions and the potential of this archived ITS data in supplying them with the needed information.

CHAPTER 5 – CONCLUSIONS

This study conducted an in-depth literature review regarding the following:

- The most relevant freight issues faced by Metropolitan Planning Organizations (MPOs);
- The state-of-the-art in urban travel demand forecasting to integrate the passenger and freight components;
- Data requirements for freight modeling;
- The primary and secondary freight data sources and their strengths and limitations for supporting urban planning activities; and
- The full spectrum of ITS technologies that are rich sources of freight data.

Second, a comprehensive questionnaire was administered to the MPOs to ascertain the following:

- Freight transportation issues faced by MPOs;
- The state-of-the-practice in integrating the freight component into the urban travel demand models (TDMs);
- Freight data available to metropolitan areas, including an assessment of their quality;
- Freight data needed to conduct meaningful freight planning in metropolitan areas, including an assessment of their importance;
- Freight collection activities at the metropolitan level;
- The level of deployment of ITS technologies and the use of archived ITS data to support urban planning activities; and
- Suitability of archived ITS data in supplying MPOs with the needed freight data.

This chapter summarizes, first, the most relevant findings from the literature review and from the Freight Data Needs Survey, and second, extensions of the present work.

5.1 FINDINGS FROM THE LITERATURE REVIEW

The most relevant findings from the literature review are summarized in the following paragraphs.

Freight traffic, and in particular road hauling, are an important source of congestion and pavement deterioration in urban areas. No single solution exists to this serious problem. It

requires a combination of various strategic projects pertaining to capacity enhancements, system preservation, operational improvements, and demand management. Recognizing how all of these issues interact is important in understanding and modeling freight patterns and assessing their implications in urban areas.

Freight demand modeling can help MPO planners to understand urban freight patterns and to formulate and evaluate strategies or policies to improve the efficiency of goods movement. In particular, urban freight modeling can shed light on infrastructure, safety, and environmental issues pertaining to the transportation system. This will enable the identification and evaluation of alternative actions based on performance measures obtained through the modeling process. The proposed methodologies in the literature aim to integrate the freight component into the urban travel demand modeling process, taking into consideration the underlying factors that affect the demand for freight.

Several approaches have been suggested to model urban freight demand. A proposed classification categorized these approaches into the structural approach and the direct approach. The structural approach to freight modeling integrates the freight component of the urban transportation system into the standard four-step travel forecasting process and estimates the entire demand for the two components of the system, that is, passengers and freight. The direct approach to freight modeling is a simplification of the structural approach in that it forecasts the freight demand for specific components of the system (i.e., corridor, freight transfer facility, etc.). The structured process can be conducted using two sub-approaches: the vehicle-based approach, which focuses on commercial vehicle trips, and the commodity-based approach, which focuses on commodity flows. The special features of models and techniques embedded in these approaches in terms of its capabilities and freight data requirements make some of them more appealing for application at the metropolitan level.

The vehicle-based approach presents several advantages to the MPOs, such as: (1) highway/truck data is more available than commodity data, (2) truck trips are estimated in the beginning of the modeling process so conversion to truck trips from commodity shipment volumes is not required, and (3) truck trips are easily combined with passenger car trips for route assignment. However, this approach also has several disadvantages, such as: (1) it provides little or no information about commodities transported between analysis zones, (2) it does not provide any basis for estimating trip end control totals, (3) internal trips made by external truck

trips are ignored, (4) few existing models seem to address trip chain patterns, and (5) it has limited capability to analyze policy options such as changes in modal attributes, new freight modes or facilities, new links or pricing measures. On the other hand, a significant advantage of the commodity-based approach is that it is concerned with the movement of commodities (not trucks) that produce the demand for freight movements in that it links the producers and consumers of goods. Therefore, for MPOs to undertake comprehensive urban freight planning, accurate and reliable cargo and highway/truck data are needed.

This study classifies the data required for urban freight planning into five categories as follows: cargo, road transportation, major freight generators and corridors, non-road transportation modes, and economic, land-use, and socio-economic data. This study also identified the relevant attributes for each category. Although the largest share of the urban freight is moving by road, attributes related to other freight transportation modes were integrated into a separate category to account for the multimodal freight activities taking place in metropolitan regions and their impact on the urban freight traffic patterns.

Primary and secondary freight data sources have strengths and limitations for supporting planning activities at the metropolitan level. Surveys can provide the level of detail needed for urban freight planning but they require significant resources. Due to the limited resources at the metropolitan level, surveys are not performed on a regular basis by MPOs. Several public and commercial data sources exist but they do not capture the levels of detail needed for urban freight planning. For example, cargo data and transportation mode data provided in these data sources differ in many aspects, such as (1) level of detail of commodity classification, (2) level of detail of commodity type, (3) level of detail of origin-destination patterns, (4) level of shipment detail, (5) level of routing detail, and (6) level of detail of freight transportation modes. In addition, the usefulness of these databases is limited because the information has not been updated. ITS data is a rich source of freight information but it is limited to the areas covered by the technologies, the existence of an archive Data User Service (ADUS) in the metropolitan region that supply MPOs with the needed data, and the willingness of carriers to share information with the public planning agencies.

This study lists the best-known ITS technologies for gathering urban freight data. The most popular road-based technologies to gather cargo and road/highway data are inductive loop detectors, sensors, environmental sensor stations, WIM sensor systems, closed circuit TV

(CCTV) cameras, and video image detection systems. The most popular vehicle-based technologies to gather cargo and road/highway data are Automated Vehicle Classification (AVC), Automated Vehicle Identification (AVI), Automated Vehicle Location (AVL), cellular phones (probe vehicles), License Plate Matching (LPM), and smart cards.

5.2 FINDINGS FROM THE *FREIGHT DATA NEEDS*

The *Freight Data Needs Survey* provided detailed information which enabled several analyses. The findings of these analyses are summarized in the following paragraphs.

Significant and continued growth of freight movements in metropolitan areas is putting pressure on key components of the existing transportation system. This represents a major challenge to MPOs that are responsible for providing urban mobility for passengers and freight. This study showed that more than two-thirds of the responding MPOs are conducting freight planning (i.e., 69%), of which 41% were major regions (i.e., regions with more than 0.5 inhabitants) and 28% were minor regions (i.e., regions with less than 0.5 inhabitants). Although the number is lower than the figure reported in the 2003 AMPO Freight Survey (80% from a sampled population of 340 MPOs), it indicates the active role MPOs are taking in dealing with freight transportation issues. In this regard, this study showed that capacity constraints, safety and environmental concerns, system preservation, and operational improvement needs prevail in all metropolitan regions. Although the extent of these issues were not considered, this finding suggests some common freight data is needed to support freight planning activities by all MPOs, regardless of their size.

MPOs are increasingly challenged to consider strategic projects that support local land use, protect the environment and neighborhoods, promote the energy conservation, and advance economic productivity and growth of their regions. With respect to these issues, the analysis showed that pollution levels in 58% of the responding metropolitan regions (i.e., 38 MPOs) persistently exceeded the national ambient air quality standards but only 45% of the MPOs with non-attainment areas are dealing with environmental issues (i.e., 17 MPOs). This finding suggests the need for increasing attention on projects that promote the protection of the environment by MPOs.

MPOs require both reliable freight data and robust analytical tools with which to analyze and evaluate potential freight project impacts. The analysis, however, showed that less than one-

third of responding MPOs have integrated freight components in their TDMs (i.e., 26%), of which 18% were major regions and 8% were minor regions. A lack of freight data can partially explain the limited application of freight modeling in urban areas.

Regarding cargo data available or need in the studied metropolitan regions, of the 65 MPOs that completed the *Freight Data Needs Survey*, 77% indicated they used/needed origin-destination patterns, 75% used/needed routing details, 65% used/needed shipment details, and 60% used/needed commodity classification and commodity type data. In addition, between 49% and 94% of the responding MPOs indicated they need additional detailed data to the various cargo attributes listed. These figures reflect the enormous need for cargo data to facilitate meaningful freight planning at the metropolitan level.

Concerning freight transportation mode data, of the 65 MPOs that completed the *Freight Data Needs Survey*, 82% indicated they used/needed highway/truck data, 74% used/needed rail data, 60% used/needed air data, and 40% used/needed water data. In addition, between 51% and 100% of the responding MPOs indicated they need additional detailed data to the various transportation mode attributes listed. These figures suggest the significant need for transportation mode data that is desirable for urban freight planning.

Concerning terminal/intermodal transfer facilities data, of the 65 MPOs that completed the *Freight Data Needs Survey*, 66% indicated they used/needed these data. Between 82% and 97% of the responding MPOs indicated they need additional detailed terminal and intermodal transfer facilities data. These figures points out the lack of relevant data to assess the impact of terminal/intermodal transfer facilities in the urban travel patterns.

In terms of the quality of the available freight data, most of the MPO respondents assessed the quality of the available cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data as adequate. Among the cargo attributes, commodity classification data was ranked as the most adequate. Among the freight transportation mode attributes, highway/truck mode data was ranked as the most adequate.

In terms of the significant of the needed freight data, most of the MPO respondents expressed that the needed cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data was important. Among the cargo attributes, routing details was ranked as the most important. Among the freight transportation mode attributes, rail mode data was ranked as the most important.

The identified MPOs needs in terms of cargo data, freight transportation mode data, and terminal/intermodal transfer facilities data reveal the limited data MPOs have for freight planning. This study also highlighted the lack of detailed data available to small, mid-size, and mid-large MPOs. It is thus obvious that effective freight planning and informed decisions are still largely limited by a lack of reliable data. Given a lack of funding sources, primary data collection is also not an option for many small- to mid-large MPOs.

Overall, ITS technologies are the most used collection method to gather freight data in the studied MPOs (i.e., 62% of the MPO respondents). This finding points out the ITS opportunities for providing the needed freight data at the metropolitan level. Public and commercial data sources also play an important role in providing MPOs with the needed freight data (i.e., 58% of the MPO respondents are using these data sources). Surveys are the least used collection method in the studied locations. Because these traditional data collection efforts are prohibitively expensive, it seems that only 42% of the MPO respondents have the resources to afford these collection techniques.

From the 40 MPOs that responded they use ITS freight data, only 18 indicated the ITS technologies that provide such freight data. The results show that the large metropolitan regions are using ITS technologies as a rich source of freight information. In fact, only these regions use freight data collected by AVC, CCTV cameras, vehicle tracking and navigation systems, toll tags, AVL, cellular phones, license plate matching, and smart cards. Inductive loop detector is the only ITS technology that is common to all studied locations. Finally, neither WIM technology nor sensors are used to collect freight data in the mid-size metropolitan regions that responded to this survey.

This study assessed the level of deployment of ITS technologies in the studied metropolitan regions. The results reveal that, in general, a higher percentage of MPOs indicated ITS technologies have been deployed in their areas. The ITS technologies are under development in a higher number of smaller metropolitan regions relative to the larger metropolitan regions. As expected, a higher number of large metropolitan regions are already using ITS technologies relative to the other metropolitan regions. Mid-large metropolitan regions seem to be in a break point of ITS deployment between 'ready for use' and 'under development'. Finally, the level of deployment of ITS technologies in the small metropolitan regions is spread out among the inquired levels.

This study assessed the state-of-the-practice in the use of archived ITS data to support freight planning activities at the metropolitan region. In general, most of the MPO respondents do not know whether there is an ADUS in their regions (i.e., 43%). Only 15% of the respondents (i.e., 10 MPOs) pointed out that an ADUS is present in their regions, while 42% (i.e., 27 MPOs) indicated there is not. Furthermore, ADUS mostly prevails in the large metropolitan regions (i.e., 9 large MPOs), and trails off considerably for small metropolitan regions (i.e., 1 small MPO). Available information for the Archive Data User Service (ADUS) from the National ITS Architecture reveals that the most common archived data comes from Arterial Management Systems, Freeway Management Systems, Incident Management Systems, Traffic Management Systems, and Traveler Information Systems. Vehicle Commercial Operations (CVO) has the potential to provide ADUS with freight data, which is currently needed at the metropolitan level. Such an application, however, was not identified in the literature.

Regarding the level of ITS deployment in the metropolitan regions and the MPOs already using ITS freight data, this study shows that over 50% of the MPO respondents are getting data from ITS technologies. Few of these MPOs, however, indicated they use the ADUS to get the needed data. This finding could be explained in part to the fact that 43% of the MPO respondents are unaware if there was an ADUS operating in their regions.

Based on the MPO freight data needs identified in this study and the freight data provided by ITS technologies, this study identified the suitability of ITS in supplying MPOs with the needed data. Specifically, this study points out the level of detailed cargo data and highway/truck data provided by ITS technologies. Since road freight is the predominant mode of urban freight transportation, it is clear that ITS technologies can supply MPOs with the needed highway/truck data. Furthermore, some cargo detailed data can be drawn for ITS applications at the metropolitan level. These freight data can significantly help transportation planners to identify urban freight patterns and the contribution of urban freight vehicles to urban congestion, pavement deterioration, environmental quality, and the economic vitality of their urban areas. On the other hand, few MPOs seem to know about ADUS and the potential of this archived ITS data in supplying them with the needed information.

In the future, these MPOs will have to explore innovative and cost-effective means to gather an understanding of freight sector movements, the impacts on their infrastructure, and what it means to freight planning given limited data. Using Commercial Vehicle Operation

(CVO) systems as part of Intelligent Transportation Systems (ITS) can provide a rich source of cargo data such as weight, cargo type, and origin-destination patterns, to mention a few. Because transportation planners have limited resources to collect pertinent primary data, considerable reliance should be placed on the use of advanced information and communication technologies that can be invaluable to urban freight planning.

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APPENDIX A

Freight Data Needs Survey

The Center for Transportation Research (CTR) at the University of Texas at Austin is conducting this survey on the freight data needs by metropolitan planning organizations. This questionnaire consists of eight sections as follows:

Section	Content
I.	Contact Information
II.	General Information
III.	Freight Activity
IV.	Freight Transportation Issues
V.	Analytical Tools to Support Freight Planning
VI.	ITS: Level of Deployment and Archived Data
VII.	Freight Data Collection Methods
VIII.	Freight Data: Available and Needed

Your participation in completing this survey is very important for assessing current and emerging freight data needs and determining how Intelligent Transportation System (ITS) data can be used to conduct meaningful freight planning at the metropolitan level. Be assured that your responses will be treated confidentially and will be used solely for this study. Your answers will not be given to anyone outside of the study team and will never be reported in a manner that could identify you.

Thank you in advance for your help in this important project. We estimate that it will take you no more than 30 minutes to complete the survey. If you have any questions regarding the survey, please feel free to contact Isabel Victoria at victoriahiguera@mail.utexas.edu

Sincerely yours,

C. Michael Walton
Ernest H. Cockrell Centennial Chair in Engineering
University of Texas at Austin

I. Contact Information

MPO:(required)			
Address:			
City:		State:	Zip Code:
Name of contact person: (required)			
Title:			
Telephone number: (required)	Second Telephone number:	Fax number:	
FROM e-mail address: (required)			

II. General Information

1. What is the size of the metropolitan planning area (based on number of inhabitants)?

- ☐ Small (< 250,000)
- ☐ Mid-Sized (250,000 - 500,000)
- ☐ Mid-Large (500,000 - 1,000,000)
- ☐ Large (> 1,000,000)

2. Are there non-attainment areas in your planning area?

- ☐ Yes ☐ No

III. Freight Activity

3. What transportation modes are available for freight in your area?

- ☐ Highways/trucks
- ☐ Rail
- ☐ Air
- ☐ Water (seaport, barge, short sea shipping)

☐ Others (Please specify)

4. What freight intermodal transfer facilities are in your area?

- ☐ Truck/rail
- ☐ Truck/airport
- ☐ Truck/seaport
- ☐ Rail/seaport
- ☐ Rail/airport
- ☐ Others (Please specify)

5.. Does your agency do freight planning?

- ☐ Yes ☐ No ([If no, click here](#))

6. What freight planning issues do you consider?

- ☐ Capacity enhancement (e.g., dedicated truck lanes, access roads to rail intermodal yards, etc.)
- ☐ System preservation (e.g., road maintenance and rehabilitation, dredging port channels, etc.)
- ☐ Operations (e.g., routing restrictions for heavy loads, restrictions on terminal hours, etc.)
- ☐ Safety (e.g., highway-rail crossings, dedicated routes for hazardous material shipments, etc.)
- ☐ Environmental (e.g., restrictions on trucks traveling through neighborhoods, etc.)
- ☐ Others (Please specify)

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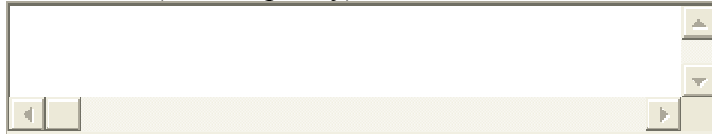
V. Analytical Tools to Support Freight Planning

7. Do you have a travel demand model for your MPO?

- ☐ Yes ☐ No ([If no, click here](#))

8. What travel demand modeling software do you use?

- ☐ TRANPLAN
- ☐ EMME-2
- ☐ TransCAD
- ☐ Others (Please specify)

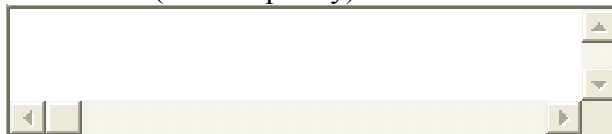
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9. Is freight demand integrated in your travel demand model?

- ☐ Yes ☐ No

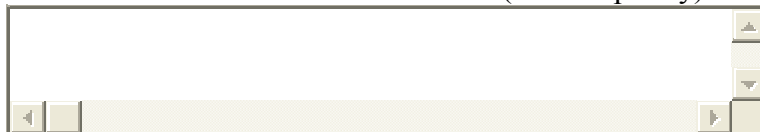
10. How do you forecast freight transportation demand?(Check all that apply)

- ☐ Similar to the four steps from the urban transportation passenger travel forecasting model: freight generation and distribution, mode choice, and traffic/route assignment
- ☐ Forecast specific aspects or components of the system rather than estimating the entire freight demand on the transportation system (e.g, corridor analysis, site analysis)
- ☐ Forecast freight for one industry or economic sector at a time (e.g., forecast demand for grain production)
- ☐ Others (Please specify)

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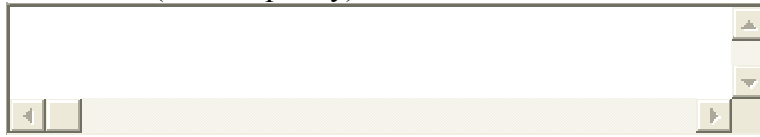
11. If you follow the traditional four step urban planning approach, how do you estimate freight generation and distribution?

- ☐ Commodity-based approach (commodity shipment volume estimates)
- ☐ Vehicle-based approach (truck trip estimates)
- ☐ Input-Output models (economic activity estimates)
- ☐ Combination of the above models (Please specify)

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- ☐ Do not know

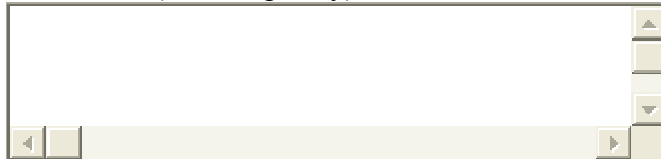
☐ Others (Please specify)



12. If you follow the traditional four step urban planning approach, what modes are included in your freight mode choice model?

☐ Truck ☐ Rail ☐ Barge ☐ Seaports ☐ Airports

☐ Others (Please specify)



13. If you follow the traditional four step urban planning approach, how do you estimate freight mode choice or modal diversion?

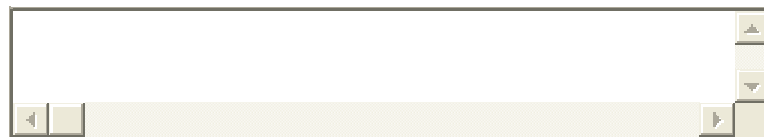
☐ Disaggregate models (focus on the factors that affect individual shippers' choices)

☐ Aggregate models (focus on aggregate data sets such as commodity flow data or macroeconomic data)

☐ Freight network models (modal attributes are presented for each network link, e.g., freeway links that prohibit truck movements)

☐ Do not know

☐ Others (Please specify)



14. If you follow the traditional four step urban planning approach, how do you assign freight traffic?

☐ Assigning all truck classes and passenger vehicles along the shortest route between each origin and each destination not considering congestion

☐ Incremental assignment approach (allocates a limited number of trips at a time along the cheapest available route, updating after each allocation the new travel costs on each link as a result of these allocations)

☐ Multipath assignment approach (extension of the incremental approach but at any stage in the allocation process all trips from an origin are not assigned along the least-cost route to each destination; instead, different routes between each origin and destination are examined)

☐ Do not know

☐ Others (Please specify)

VI. ITS: Level of Deployment and Archived Data

15. What is the level of deployment of Intelligent Transportation Systems (ITS) in your region?

- ☐ Ready for use
☐ Under development
☐ Have not started
☐ Not needed
☐ Do not know

16. Is there an Archive Data User Service (ADUS) in your region?

- ☐ Yes ☐ No ☐ Do not know

17. Have you used archived ITS data in your freight planning activities?

- ☐ Yes ☐ No ☐ Do not know

VII. Freight Data Collection Methods

18. Do you administer or fund **surveys** to collect freight data?

- ☐ Yes ☐ No ([If no, click here](#))

19. What type of **surveys** do you use? (Check all that apply)

☐ Roadside/intercept surveys	☐ Combined telephone-mailout/mailback surveys
☐ Telephone surveys	☐ Commercial vehicle trip diaries (e.g. trip logs)
☐ Personal interviews	☐ Internet surveys
☐ Mailout/mailback surveys	
☐ Others (Please specify)	

20. Do you conduct **traffic counts** to collect freight data?

☐ Yes ☐ No ([If no, click here](#))

21. What type of **traffic counts** do you use?(Check all that apply)

☐	Cordon or screenline counts	☐	Toll or turnpike counts
☐	Tube counts	☐	Visual classification counts
☐	Electronic sensors	☐	Video classification counts
☐	Traffic counts at weigh stations	☐	Vehicle classification recorders
☐	Others (Please specify) 		

22. Do you use **ITS technologies** to collect freight data?

☐ Yes ☐ No ([If no, click here](#))

23. What type of **ITS technologies** do you use? (Check all that apply)

☐	Loop detectors	☐	Weigh-in-motion (WIM) technologies
☐	Sensors (i.e., acoustic sensors, infrared sensors, and radar/microwave sensors)	☐	Automated vehicle identification (AVI) technologies
☐	Environmental sensor stations	☐	Vehicle tracking and navigation systems (VT&NS)
☐	Closed circuit cameras (CCTV)	☐	Geographic position system (GPS) equipment
☐	Aerial videos	☐	License plate matching systems
☐	Advanced video image processing	☐	Cellular phones (probe vehicles)
☐	Automated vehicle classification (AVC)	☐	Electronic toll collection equipment
☐	Automatic vehicle location (AVL) system	☐	Smart cards
☐	Others (Please specify) 		

24. Do you use any **public or commercial data sources** to populate freight databases?

☐ Yes ☐ No ([If no, click here](#))

25. Which **public or commercial data sources** do you use to populate freight databases?
(Check all that apply)

☐	Airport Activity Statistics of Certificated Route Air Carriers - Bureau of Transportation Statistics
☐	Border Crossing Data - Bureau of Transportation Statistics
☐	Commodity Flow Survey (CFS) - Bureau of Transportation Statistics and the Census Bureau
☐	Freight Analysis Framework (FAF) - U.S. Department of Transportation
☐	Freight Commodity Statistics - Association of American Railroads
☐	Freight Transportation & Logistics Service - DRI/McGraw-Hill
☐	Fresh Fruit & Vegetable Shipments - U.S. Department of Agriculture
☐	Highway Performance Monitoring System (HPMS) Database - Federal Highway Administration
☐	IANA Report - Intermodal Association of North America
☐	LTL Commodity and Market Flow Database - American Trucking Association
☐	MARAD - U.S. Department of Transportation Maritime Administration
☐	North American Trucking Survey (NATS) - Association of American Railroads
☐	Port Import/Export Reporting Service (PIERS) - Journal of Commerce
☐	Rail Waybill Sample - Surface Transportation Board
☐	State Estimates of Truck Traffic - Federal Highway Administration
☐	TRANSEARCH - Reebie Associates
☐	Transborder Surface Freight Data - Bureau of Transportation Statistics
☐	Transportation Annual Survey - U.S. Census Bureau
☐	TranStats: The Intermodal Transportation Database - Bureau of Transportation Statistics
☐	U.S. Air Freight Origin Traffic Statistic - The Colography Group, Inc.
☐	U.S. Imports/Exports of Merchandise on CD-ROM - U.S. Census Bureau
☐	U.S. Exports by State of Origin of Movements - Massachusetts Institute for Social and Economic Research
☐	Vehicle Inventory and Use Survey (VIUS) - U.S. Census Bureau
☐	Others (Please specify)
	↑ ↓ ◀ ▶

VIII. Freight Data: Available and Needed

Questions 26 to 36 have the following structure:

▲ Do you currently use or need the listed detailed freight data?

★ If used, how are the available data collected?

■ If used, how would you rate the quality of the available data?

● If needed, how important is the data to planning?

26. Commodity Detail

▲ Do you currently use or need the following freight commodity detail?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
1. Formal classification system (e.g., SIC, STCC, HS, SITC, NAICS)	☐	☐
2. Other (Please specify) 	☐	☐

★ If used, how are the available data collected?

☐ Administer surveys	☐ ITS data
☐ Obtain data directly from carriers/shippers	☐ Available freight data sources (public and commercial)
☐ Other (Please specify) 	

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

27. Cargo Detail

▲ Do you currently use or need the following freight cargo detail?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
Aggregate categories(e.g., bulk, break-bulk,etc.)	☐	☐
Hazardous and non-hazardous cargo	☐	☐

Empty vs. non-empty	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐ Administer surveys	☐ ITS data
☐ Obtain data directly from carriers/shippers	☐ Available freight data sources (public & commercial)
☐ Other (Please specify)	

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

28. Origin/Destination Detail

▲ Do you currently use or need the following freight origin/destination detail?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
States	☐	☐
National Transportation Analysis Regions (NTARs)	☐	☐
Counties	☐	☐
Metropolitan Statistical Areas (MSA)	☐	☐
Business Economic Areas (BEAs)	☐	☐
Zip codes	☐	☐
Shipper detail (names and locations)	☐	☐
Traffic Analysis Zone (TAZ)	☐	☐
Customs District	☐	☐
U.S. Customs port of exit/entry	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐	Administer surveys	☐	ITS data
☐	Obtain data directly from carriers/shippers	☐	Available freight data sources (public & commercial)
☐	Other (Please specify)		

 If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

 If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

29. Shipment Detail

 Do you currently use or need the following freight shipment detail?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
Weight	☐	☐
Volume	☐	☐
Value	☐	☐
Mode of transport	☐	☐
Average length of haul	☐	☐
Number of stops per trip	☐	☐
Time-sensitive shipment	☐	☐
Truckload or less-than-truck load shipments	☐	☐
Empty shipments	☐	☐
Other (Please specify)	☐	☐

 If used, how are the available data collected?

☐	Administer surveys	☐	ITS data
☐	Obtain data directly from carriers/shippers	☐	Available freight data sources (public & commercial)
☐	Other (Please specify)		

31. Highway/Truck Mode

▲ Do you currently use or need the following freight data for the highway/truck mode?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
Vehicle type (formal FHWA classification/State classification)	☐	☐
Vehicle size (e.g., heavy, medium, light, small commercial)	☐	☐
Average vehicle speed	☐	☐
Vehicle emission data	☐	☐
Traffic counts & classification data	☐	☐
Cargo type	☐	☐
Payload weight (i.e., cargo weight)	☐	☐
Truck O/D patterns	☐	☐
Trip O/D patterns	☐	☐
Travel time	☐	☐
Travel time reliability	☐	☐
Number of truck stops for LTL shipments	☐	☐
Incident data	☐	☐
Line-haul costs	☐	☐
Drayage costs	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐	Administer surveys	☐	ITS data
☐	Traffic counts	☐	Available freight data sources (public & commercial)
☐	Obtain data directly from carriers/shippers		
☐	Other (Please specify)		

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

32. Cross Border Data

▲ Do you currently use or need the following cross border freight data?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
O/D patterns	☐	☐
Commodity	☐	☐
Vehicle type	☐	☐
Shipment characteristics (weight, volume, value)	☐	☐
Mode	☐	☐
Stop/delay data	☐	☐
Rail-grade crossing safety data	☐	☐
Department of Public Safety (DPS) inspection data	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐ Administer surveys	☐ ITS data
☐ Traffic counts	☐ Available freight data sources (public & commercial)
☐ Obtain data directly from carriers/shippers	
☐ Other (Please specify)	

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

33. Rail Mode

▲ Do you currently use or need the following rail freight data?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
O/D patterns	☐	☐
Commodity	☐	☐
Equipment details (e.g. car type)	☐	☐
Shipment (weight, volume, value)	☐	☐
Routing data	☐	☐
Travel time	☐	☐
Reliability	☐	☐
Stop/delay data	☐	☐
Ramp-to-ramp costs	☐	☐
Drayage costs	☐	☐
Hazardous materials	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐	Administer surveys to shippers
☐	Obtain data directly from rail carriers
☐	Available freight data sources (public & commercial)
☐	ITS data
☐	Other (Please specify)

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

34. Air Mode

▲ Do you currently use or need the following air freight data?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
O/D patterns	☐	☐
Commodity	☐	☐
Shipment (weight, volume, value)	☐	☐
Routing data	☐	☐
Travel time	☐	☐
Reliability	☐	☐
Air Freightage	☐	☐
Drayage costs	☐	☐
Hazardous materials	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐	Administer surveys to shippers
☐	Obtain data directly from air carriers
☐	Available freight data sources (public & commercial)
☐	ITS data
☐	Other (Please specify)

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

35. Water Mode

▲ Do you currently use or need the following waterborne freight data?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
O/D patterns	☐	☐
Commodity	☐	☐
Equipment details (e.g. vessel type)	☐	☐
Shipment (weight, volume, value)	☐	☐
Routing data	☐	☐
Travel time	☐	☐
Reliability	☐	☐
Port-to-port costs	☐	☐
Drayage costs	☐	☐
Hazardous materials	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐	Obtain data directly from carriers/shippers
☐	Available freight data sources (public & commercial)
☐	ITS data
☐	Other (Please specify)

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

☐ Critical ☐ Important ☐ No need

36. Terminal and Intermodal Transfer Facilities

▲ Do you currently use or need the following freight data for terminal and intermodal transfer facilities?

☐ Yes (If yes, please continue) ☐ No ([If no, click here](#))

Data	Use	Need
Truck volumes entering or exiting facilities	☐	☐
Congestion-related delays on access roads to the facility (time)	☐	☐
Length of queue on access roads	☐	☐
Incident rates on access roads to the facility	☐	☐
Travel time contours around the facility	☐	☐
Capacity of facility (e.g., tons, number of containers)	☐	☐
Other (Please specify)	☐	☐

★ If used, how are the available data collected?

☐ Administer surveys	☐ ITS data
☐ Traffic counts	☐ Available freight data sources (public & commercial)
☐ Obtain data directly from carriers/shippers	
☐ Other (Please specify)	

■ If used, how would you rate the quality of the available data?

☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

● If needed, how important is the data to planning?

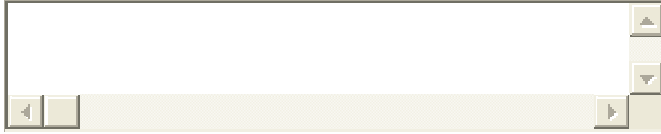
☐ Critical ☐ Important ☐ No need

37. What other data do you use for freight planning?

A. Economic Data ☐ Yes ☐ No

Quality of the data: ☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

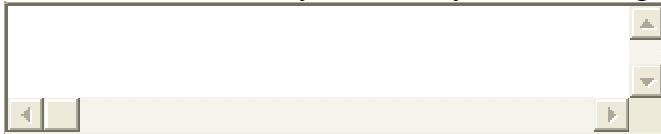
What economic data do you critically need for freight planning?



B. Land-Use Data ☐ Yes ☐ No

Quality of the data: ☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

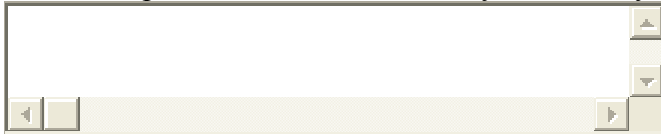
What land-use data do you critically need for freight planning?



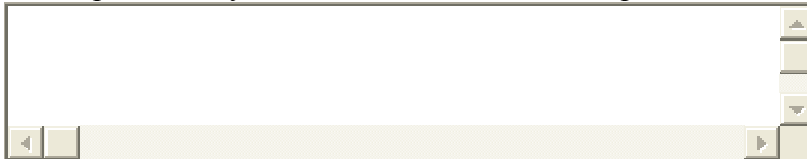
C. Transportation Network Data ☐ Yes ☐ No

Quality of the data: ☐ Very poor ☐ Poor ☐ Adequate ☐ Good ☐ Very good

What transportation network data do you critically need for freight planning?



Please provide any additional comments in the space below.



Thank you for participating in our survey!

Send Form

Clear Form

Last modified: 5/6/2004

For more information, contact Isabel Victoria at victoriahiguera@mail.utexas.edu

Form created by Isabel Victoria

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