Freight Data Cost Elements

DETAILS

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NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

NCFRP REPORT 22

Freight Data Cost Elements

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NATIONAL COOPERATIVE FREIGHT RESEARCH PROGRAM

America's freight transportation system makes critical contributions to the nation's economy, security, and quality of life. The freight transportation system in the United States is a complex, decentralized, and dynamic network of private and public entities, involving all modes of transportation—trucking, rail, waterways, air, and pipelines. In recent years, the demand for freight transportation service has been increasing fueled by growth in international trade; however, bottlenecks or congestion points in the system are exposing the inadequacies of current infrastructure and operations to meet the growing demand for freight. Strategic operational and investment decisions by governments at all levels will be necessary to maintain freight system performance, and will in turn require sound technical guidance based on research.

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Program guidance is provided by an Oversight Committee comprised of a representative cross section of freight stakeholders appointed by the National Research Council of The National Academies. The NCFRP Oversight Committee meets annually to formulate the research program by identifying the highest priority projects and defining funding levels and expected products. Research problem statements recommending research needs for consideration by the Oversight Committee are solicited annually, but may be submitted to TRB at any time. Each selected project is assigned to a panel, appointed by TRB, which provides technical guidance and counsel throughout the life of the project. Heavy emphasis is placed on including members representing the intended users of the research products.

The NCFRP will produce a series of research reports and other products such as guidebooks for practitioners. Primary emphasis will be placed on disseminating NCFRP results to the intended end-users of the research: freight shippers and carriers, service providers, suppliers, and public officials.

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FOREWORD

By William C. Rogers
Staff Officer
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NCFRP Report 22: Freight Data Cost Elements identifies the specific types of direct freight transportation cost data elements required for public investment, policy, and regulatory decisionmaking and describes and assesses different strategies for identifying and obtaining the needed cost data elements.

Accurate freight transportation cost data are required for cost-benefit comparisons, impact and systems analyses, and modal optimization. Measures previously used have included freight bill costs and cargo value, or shipper costs which may include indirect broker costs and other supply chain profit margins. These measures may have little connection to the direct and discrete marginal costs of users of a given facility. Transportation decisionmakers have two methods for obtaining freight cost data: either from primary sources or indirectly through ad hoc estimation. However, many primary sources of freight transportation cost data disappeared with deregulation or because of budget constraints. Estimated freight transportation cost data used today typically derive from secondary data, aggregated piecemeal data, facility-specific surveys, or broad cost indices. While freight transportation cost data can fluctuate dramatically, the relevant cost data elements are relatively stable across modes and time. Consequently, research and guidance are needed on the freight cost data elements required for different transportation planning objectives and the sources of those data elements.

Under NCFRP Project 26, Rensselaer Polytechnic Institute was asked to (1) identify and describe the state of the practice for current multimodal freight transportation cost data uses, sources, methods, collection strategies, and data elements for public-sector planning and decisionmaking; (2) identify current and evolving public-sector freight transportation planning and decision-making functions and the cost data currently used, or that might be used, to support those functions; (3) describe the key freight transportation cost data elements required for public-sector planning and decisionmaking and identify primary and secondary cost data sources and assess their applicability to the key requirements; (4) discuss data issues and limitations, including data accuracy, privacy, anti-trust issues, and other constraints, as well as conceptual collection strategies; and (5) identify available cost estimation tools, methods, and procedures, and their applicability to the key requirements, discuss their strengths and weaknesses, and identify methods for closing any gaps.

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SUMMARY

Freight Data Cost Elements

The objectives of NCFRP Project 26, "Freight Data Cost Elements," were to: (1) identify the specific types of direct freight transportation cost data elements required for public investment, policy, and regulatory decisionmaking; and (2) describe and assess the different strategies needed to identify and obtain these cost data elements. The findings of the research for NCFRP Project 26 are presented in *NCFRP Report 22: Freight Data Cost Elements.*

The research team found that for most freight transportation modes there are no uniform data standards or set data collection frequencies. The exception is rail freight, as the annual reports that railroads submit to the Surface Transportation Board (STB) contain useful freight cost data. The situation prevailing in the other freight transportation modes leads to numerous problems. From the standpoint of a data user, it is difficult to conduct analyses with data that may or may not be the best and most accurate. Also, given that most data are collected to satisfy the needs of specific studies (while some are collected at the national level), for local or regional analyses data are particularly lacking. Other important findings include that (1) the amount of data available among the various freight modes are uneven; (2) most modes lack systematic data collection efforts; (3) significant data gaps exist between data needs and availability, and these gaps are expected to increase in the near future; and (4) research is needed to develop appropriate cost estimation procedures and data collection programs for all modes.

Freight cost data are extremely important and useful, but obtaining such data is often difficult (and sometimes impossible) for public-sector agencies. Chapter 2 of *NCFRP Report 22* establishes standards of practice for cost estimation of various freight modes and identifies the publicly available freight cost estimation procedures and data sources. The chapter provides an overview of the current state of affairs of freight cost data for all transportation modes.

Chapter 3 identifies public-sector functions related to freight transportation planning and decisionmaking. The analyses are based on an extensive literature review and several interviews with public-sector planners to identify these functions and their freight cost data needs. The chapter discusses 18 such functions. Route variable cost for trucking was identified as the most commonly used data category among the functions, and the factors most frequently mentioned as determining route variable costs were tour time and tour distance. Among all identified functions, regulation and enforcement and economic development required the widest scope of freight cost data because these functions cover a broad range of activities that can affect route, vehicle, and company costs.

Based on the literature review, Chapter 4 identifies emerging trends that might affect current freight transportation functions or require the creation of new functions. These trends include increased fuel economy and emissions standards, technological innovations, increased renewable energy usage, congestion pricing, increased use of intermodal systems, industry consolidation, enhanced security, and multi-stakeholder decisionmaking. As a

result, the freight transportation cost data needs of nine public-sector functions are anticipated to increase. These trends are likely to have the largest impact on environmental planning, which will require more information on company costs and vehicle costs. In contrast, the cost data needs of some freight transportation functions are unlikely to be influenced by these trends. For example, it is unlikely that emergency preparedness planning and security planning will need more types of freight data in the future.

Chapter 5 identifies the primary and secondary sources of freight cost data, and assesses their suitability in terms of relevant metrics. The chapter is broken into two main components: (1) the identification and assessment of all data sources relevant to the study of freight costs, and (2) the identification of data gaps associated with current and future public decision-making functions. The work completed in Chapter 5 indicates that there is a lack of freight cost data for the various modes of freight transportation, and that no single source can provide the key cost data for any mode. In most cases, some data are available in the reports published by public-sector agencies, trade groups, and research universities. However, because these data were collected in response to the needs of specific projects, they cannot replace data formally collected as part of regularly scheduled data collection efforts.

The frequency and focus of the publications vary. The largest number of publications and data sources focus on trucking, followed by rail transport and waterways. Publicly available cost data for air freight and terminals are practically nonexistent. Unfortunately, no single data source could fill all the gaps in freight cost data.

Chapter 6 outlines techniques to address the gaps in freight cost data that are presented in Chapter 5. The data collection techniques identified include web searches, trade publications, reports, interviews, convenience samples, and random surveys. Since every type of freight cost analysis is different, data users are advised to exercise judgment in determining the best method to obtain freight cost data. If the analysis is relatively simple, an interview with someone familiar with the data might be adequate; however, if the analysis is more in-depth, a more detailed survey might be necessary. Chapter 6 provides suggestions about how and how frequently to collect the freight cost data needed for the various freight transportation modes.

The chief conclusion of the research is that a systematic effort of freight cost data collection and cost estimation research needs to be undertaken to meet the current and future needs of practitioners. To this end, based on its findings, the research team suggests:

- The creation of a freight cost data collection program to gather the data needed to satisfy the needs of the key public-sector functions identified in the report.
- The development of freight cost estimation tools that use the data collected to produce the estimates of freight costs needed by practitioners and researchers.
- The establishment of a clearinghouse that can serve as a repository of data and models, be responsible for updating the available data, describe the data and models, and provide guidance.

The current lack of comprehensive data collection and available tools to support planning efforts is a major obstacle to developing the level of proactive freight transportation planning that the nation needs, now and in the future. Taken together, these recommended actions could play a key role in overcoming the obstacles posed by the lack of access to freight cost data.

CHAPTER 1

Introduction

NCFRP Project 26, "Freight Data Cost Elements," had the following objectives:

- Identify the specific types of direct freight transportation cost data elements required for public investment, policy, and regulatory decisionmaking; and
- Describe and assess different strategies for identifying and obtaining these cost data elements.

Although these objectives could include such aspects as logistics costs, cost of externalities produced by freight activity, and the like, the project panel—considering the state of the practice and knowledge, as well as the project resources available—decided to focus on direct operational costs and the data cost items needed for their estimation.

The movement of goods is largely conducted by private-sector businesses for customers that are also private-sector businesses. Accordingly, cost and rate information often is confidential to these organizations. However, an understanding of costs is essential for public-sector analyses, investments, and policy development.

To achieve the project objectives, the research team focused on four tasks:

- **Task 1:** Identify and describe the state of the practice for current multimodal freight transportation cost data uses, sources, methods, collection strategies, and data elements for public-sector planning and decisionmaking.
- **Task 2:** Identify current and evolving public-sector freight transportation planning and decisionmaking functions and the cost data currently used, or that might be used, to support those functions. Describe the key freight transportation cost data elements required for public-sector planning and decisionmaking.
- **Task 3:** Identify primary and secondary freight transportation cost data sources and assess their applicability to the key requirements identified in Task 2. Discuss data issues and limitations, including data accuracy, privacy, anti-trust issues and other constraints, as well as conceptual collection strategies. Discuss methods for closing any identified gaps.
- **Task 4:** Identify available cost estimation tools, methods, and procedures, and their applicability to the key requirements identified in Task 3. Discuss strengths and weaknesses and identify methods for closing any gaps.

NCFRP Report 22 summarizes the key findings that emerged from each of these tasks, and provides an important compendium of the available cost data (along with sources), alternatives that can be used when cost data do not exist, and areas where additional data collection would be beneficial.

The report consists of five chapters that describe the fundamentals of freight cost estimation and its use, analyze current and future public-sector functions and cost data needs, estimate future cost data needs for the public sector, identify and assess the various freight cost data sources, address freight cost data gaps, and provide conclusions and recommendations. Three appendices are included with the report. Appendix A presents the basic cost concepts and definitions. Appendix B shows the cost data elements for the various modes of freight transportation. Appendix C shows the different data collection techniques and frequencies suggested to close data gaps.

CHAPTER 2

Fundamentals of Freight Cost Estimation and Its Use

Freight cost analyses and the factors that influence them are discussed in this chapter, which seeks to identify the specific types of direct freight transportation cost data elements required for public investment, policy, and regulatory decision-making, and describe and assess different strategies for identifying and obtaining the needed cost data elements. The goal of this analysis is to ensure that the recommended approaches are conceptually valid and in accordance with current best practices and the latest research.

The complexities involved in defining "cost" are explored further in Appendix A. Depending on the type of decision being made, definitions of cost may vary. In this context, discussing the various cost definitions ensures a common basis for discussion.

2.1 Freight Costs and External Factors that Impact Them

Freight costs are influenced by a number of external factors that impact the resources used in the activity. These external factors include:

- **Business Models:** The freight industry is very heterogeneous and complex, and encompasses a wide range of modes, users, and business relationships. As such, a multitude of business models have been developed that reflect the needs of the various industry segments. Just within the trucking industry, examples include:
  - Specialized (e.g., auto carriers, hazardous materials, liquid cargo, bulk)
  - Full truckload (FTL) vs. less than truckload (LTL)
  - Express couriers

  Some models are found in all freight modes, while others are specific to a given mode. Different models emphasize different aspects of the business and employ various strategies to succeed in the marketplace. For example, express carriers emphasize fast deliveries, while small FTL carriers compete on the basis of price.
- **Private vs. For-Hire Operations:** The market orientation of a company could play a role in its freight costs. In the case of private carriers—whose primary mission is to provide ancillary transportation services to a parent or related company—some of the cost components could be shared with other units of the company. This leads to internal cross-subsidization that, in addition to being extremely difficult to ascertain, could change the cost structure. In contrast, for-hire carriers, which provide services to an open market, need to cost out all the key expenses. As a result of these differences, private and for-hire carriers are likely to have dramatically different cost structures that in turn, may lead to different behavioral responses to public-sector policies.
- **Units:** When evaluating across modes, the analysis generally must make the costs consistent. The models usually convert costs per vehicle-mile to costs per ton-mile, which requires data on the amount of a commodity that can fit on a given vehicle type. Given that the volume-to-weight ratio varies across commodities, the tonnage per vehicle type usually varies across commodities.
- **Line Haul vs. Trip:** In comparing the cost of freight trips across modes, the analysis is complicated by the inclusion of these important costs: loading, drayage, transloading, and unloading costs. For all freight modes except truck, a trip often involves multiple modes, so cost estimates must reflect this multi-dimensionality.
- **Vehicle Type:** Costs vary for each configuration of a specific mode. Numerous truck sizes and configurations exist, each with different costs and cargo capacities. Barge sizes and drafts also vary, and trains may carry containers in single or double stacks.
- **Vehicle Configurations:** Multiple configurations of vehicles are used in freight movements. Truck movements may be truckload (TL) or less than truckload (LTL); rail freight may be in carloads or unit trains; and barges move in various tow sizes, carrying commodities in containers, bulk, or break-bulk.

- **Service Area:** Vehicle cost will often vary according to service area. For example, truck costs will be different for short haul versus long haul, or urban versus rural, due to labor costs, speed and fuel usage, and vehicle age. Barge costs will vary depending on up-bound versus down-bound travel, the speed of the current, and the presence of locks. Rail costs vary as well, often dropping with the length of haul.
- **Overhead:** Overhead items include administrative fees, management, advertising, and marketing.

Numerous other factors associated with public-sector interventions and market-related factors can impact freight costs. Some examples include:

- **Fuel Price Volatility:** Sudden changes in fuel costs can negatively impact freight costs and profits, as most contracts only allow for price revisions once the fuel cost increase reaches a minimum threshold. Increases below that threshold are absorbed by the carrier.
- **Labor Shortages:** Since labor is one of the industry's largest cost components, across all modes, labor shortages have a significant impact on costs. In some cases, regulations that limit labor supplies have the unintended consequence of increasing labor costs.
- **Congestion Costs and Parking Availability in Urban Areas:** It is widely known that urban congestion costs are significant. Cost estimates produced by the research team and corroborated with industry input indicate that, in equal conditions, delivering at night in New York City is 30% cheaper than delivering in the congested daytime hours (Holguín-Veras 2006). The same research reveals that parking fines—an obvious byproduct of lack of suitable parking—average between $500 and $1,000 per truck per month.
- **Urban Sprawl:** As urban areas grow, land prices in the surrounding areas increase, which forces freight transportation companies to locate farther away. An analysis of the business relocation patterns in New Jersey from1990–1999 indicates that the location decisions of freight companies is negatively correlated with the distance to both New York City and Philadelphia (Holguín-Veras et al. 2005). In other words, freight companies tend to locate farther away from these cities. The net effect of this is to increase even further transportation costs to the urban areas. However, while freight companies located far from city centers have increased variable costs, their fixed costs are lower because of lower land prices.
- **Other Restrictions:** The research confirms that restrictions such as delivery time curfews, truck routes, large truck bans, etc., tend to increase freight costs. While the use of such restrictions may be justified for other reasons, well-documented cases suggest that some of these restrictions are clearly counterproductive.

2.1.1 Classification of Cost Components

The main emphasis of this project is on operational costs. Other costs, such as value of time and logistic costs, are not discussed. Operational costs include all cost components that are the direct result of the provision of the service, such as fuel, tires, crew wages, indirect costs, and fringe benefits.

2.1.1.1 Operational Costs

"Operational costs" (also called "operating expenses") are those expenses incurred in the daily running of a business. Operational costs are internal to the carriers and include both fixed and variable costs. From an accounting perspective, "variable costs" are incremental costs that can go up or down based on the amount of business activity or consumption. (By contrast, "fixed" costs do not change depending on the level of activity or consumption.) "Marginal" costs are variable costs, indicating the amount of cost that goes up or down if production or consumption increases (or decreases) by one unit.

Variable and fixed costs may be either "direct" or "indirect." A direct cost is one that can be directly associated with a specific cost item (e.g., a task, service, or material). Indirect costs cannot be directly tied to a specific cost item.

In this context, "indirect" costs refer to the portion of the fixed costs that are adjudicated to the direct cost (typically in the form of a multiplier) so that the resulting pricing structure recovers both variable and fixed costs. Unlike direct costs, indirect costs are not affected by consumption. Typical freight operational cost components include the following:

- **Variable Costs**
  - Fuel, fuel taxes, oil, tires, and depreciation
  - Maintenance and repair
  - Crew wages
  - Travel time
  - Paid parking and tolls
- **Fixed Costs**
  - Capital investment (buildings, equipment, land, etc.)
  - Obsolescence
  - Insurance
  - Registration fees

2.2 Freight Cost Estimation Techniques

Because the movement of goods is largely handled by private-sector businesses for private-sector customers, cost and rate information can be difficult to obtain. However, estimating the cost of producing a good or service is one of the most important subjects in microeconomics, and crucial to freight cost analysis. For that reason, current research

emphasizes the importance of developing increasingly sophisticated estimation techniques.

Four factors make freight cost estimation particularly complex:

1. Freight costs depend on the amount of cargo being transported.
2. In transportation, operators frequently provide service to different markets—each being a different output—as part of a multi-output process in which the concept of average cost ceases to have meaning.
3. Especially in regulatory analyses, there may be a need to assess the degree of scope and scale economies, which requires the use of functional forms that do not impose any constraints on these parameters.
4. All of these data may be hard to obtain.

This section briefly summarizes the wide range of techniques specifically designed to overcome these challenges. Freight cost estimation can be approached from two different perspectives: accounting and statistical (Pels and Rietveld 2000). Readers interested in more information should consult Pels and Rietveld (2000), Jara-Díaz (2012), and Small (1992).

2.2.1 Activity-Based Costing (ABC) and Other Accounting Techniques

Activity-based costing (ABC) methods identify the data cost elements that influence costs, estimate the amounts in which the cost elements enter into the provision of a unit of output, and compute their contribution to the cost. These methods implicitly assume a linear relation between costs and output. In the case of freight, for example, one can identify the variable cost components that are related to distance traveled and time traveled, as well as additional fixed costs. Then, by estimating the amounts in which they enter into the transportation of a unit of cargo, one can aggregate their contributions and obtain the parameters that quantify the cost per unit distance, per unit time, and at a fixed cost. The limitations of such approaches include that no consideration is given to substitution effects. This prevents the consideration, for instance, that a carrier who faces increasing fuel costs may purchase a more efficient vehicle. These techniques also assume constant returns to scale, given that they cannot consider how costs could decrease or increase depending on the amount of cargo transported. As a result, the use of accounting techniques is only appropriate for short-term analyses.

2.2.2 Statistical Techniques

The second approach to cost estimation involves the use of statistical techniques, of which there are two subgroups: econometric models, in which statistical estimation is combined with economic theory to estimate the parameters of cost models, and statistical models that do not use economic theory in the estimation process.

In econometric models, the functional form used in the analyses may restrict the analyses and the results that can be obtained (Pels and Rietveld 2000). Recognizing this, econometricians make a distinction between "basic" and "flexible" functional forms. The basic functional forms (e.g., Cobb-Douglas, Leontief, and Constant Elasticity of Substitution) impose one or more restrictions on the cost functions. Flexible forms impose no restrictions and allow the data to determine the nature of the cost function. This family of models includes quadratic, trans-log, and generalized Leontief models, among others.

A drawback of statistical techniques is that they require significantly more data than do accounting techniques. This is particularly true with flexible forms, which have a large number of parameters. This challenge is an important consideration in freight cost estimation, as such data may be hard to obtain.

Statistical approaches are also needed when cost components are not measurable, either because doing so is too difficult (e.g., because of proprietary data), or because direct observation is impossible. In the latter context, statistical approaches are usually applied to (1) transport and economic modeling, to assess preferences of decisionmakers in the sector to perform freight transportation demand analysis; and (2) non-market valuation in cost-benefit analysis, where not all values are expressed in market prices. Costs measured using statistical techniques include environmental costs (to assess the environmental impacts of industry decisions) and the value of transport time (to assess the value of services to shippers).

2.3 State of the Practice

This section summarizes the state of the practice for freight cost estimation for the various modes of transportation, indicating those approaches currently in use. Professional freight cost estimation techniques range from extremely simple to fairly advanced techniques. Because the state of the practice evolves over time—in most cases toward increased sophistication—the research team included methodologies that represent the highest standard of practice, even when used by a relatively small number of practitioners.

Not surprisingly, the literature reflects the varying levels of practice. Table 2.1 and Table 2.2 summarize the key publications on freight cost estimation in the United States and Europe. The tables classify the literature in terms of intended use, mode, type of costs considered, geography of interest, needs area, freight cost estimation technique used, data, and main focus.

The publications studied also are broken down by mode. If a publication covers two or more modes, it has been counted

Table 2.1. Summary of key literature on freight cost estimation—United States.

	Use		Mode					Costs considered				Geography				Needs area			FCE		Data used				Focus area	
Study	Public	Private	Road	Rail	Air	Water	Operational	Logistical	Externalities	Value of time	Zonal/Urban	Regional	National	Global	Regulation	Policy	Planning	ABC	Statistical	Cost elements	Aggregate	Behavioral	Collected?	Costs	Market rates
ATRI (2008)	✓		✓				✓						✓			✓		✓		✓			Y	✓	
Holguín-Veras and Brom (2008)	✓		✓				✓			✓	✓					✓	✓	✓	✓	✓			Y	✓	
Vanegas et al. (2005)	✓	✓	✓				✓						✓				✓	✓	✓	✓			Y	✓	
Litman (2002)	✓		✓				✓		✓				✓			✓	✓	✓		✓			N	✓	
Musso (2001)	✓		✓				✓	✓	✓				✓			✓		✓	✓	✓				✓	
Colombian Government (2000)	✓		✓				✓					✓	✓		✓			✓		✓			Y	✓	
Litman (1996)	✓		✓				✓		✓				✓			✓	✓	✓		✓			N	✓	
Waters et al. (1995)	✓		✓				✓	✓		✓			✓			✓		✓		✓		✓	Y	✓	
Archondo-Callao et al. (1994)	✓	✓	✓				✓					✓	✓				✓	✓		✓			Y	✓	
Harrison (1990)	✓		✓				✓							✓			✓	✓		✓			N	✓	
Chesher and Harrison (1987)		✓	✓				✓					✓	✓				✓	✓		✓			Y	✓	
Resor and Blaze (2004)	✓			✓			✓					✓				✓		✓		✓			Y	✓	
Resor and Smith (1993)	✓			✓			✓						✓			✓	✓	✓	✓	✓			N		
Meyer and Kraft (1961)	✓			✓			✓					✓	✓		✓				✓		✓		N		✓
Márquez-Ramos et al. (2010)	✓					✓		✓						✓		✓	✓		✓		✓		Y		✓
Micco and Pérez (2002)	✓					✓		✓						✓	✓	✓			✓		✓		Y		✓
Johnsson and Gaier (1998)	✓				✓		✓						✓	✓			✓	✓		✓			N	✓	
Lall et al. (2009)	✓		✓					✓					✓		✓	✓			✓	✓			Y		✓

Note: FCE refers to freight cost estimation technique; ABC is activity-based costing.

Table 2.2. Summary of key literature on freight cost estimation—Europe.

	Use		Mode						Costs considered				Geography				Needs area			FCE		Data used				Focus area	
Study	Public	Private	Road	Rail	Air	Intermodal	Water	Operational	Logistical	Externalities	Value of time	Zonal/Urban	Regional	National	Global	Regulation	Policy	Planning	ABC	Statistical	Cost elements	Aggregate	Behavioral	Collected?	Costs	Market rates
Ballis and Golias (2002)	✓	✓			✓	✓		✓						✓				✓		✓			N	✓	
Cantos et al. (1999)	✓			✓				✓	✓						✓		✓			✓			N	✓	
Combers and Lafourcade (2005)	✓		✓					✓					✓	✓			✓			✓			N	✓	
NEA (2009)	✓	✓					✓	✓	✓					✓			✓		✓		✓			Y	✓	
NEA (2010)	✓	✓		✓				✓	✓					✓	✓		✓		✓		✓			Y	✓	
European Commission (2002)	✓					✓		✓		✓				✓	✓		✓		✓		✓	✓		N	✓	
Rothengatter et al. (2002)	✓		✓					✓		✓				✓			✓			✓		✓		N	✓	
Boerkamps and van Binsbergen (1999)	✓		✓					✓	✓	✓		✓						✓	✓		✓			Y		✓
Combes (2010)	✓		✓	✓				✓	✓					✓										N		✓
Fischer et al. (2005)	✓		✓					✓	✓				✓	✓		✓	✓	✓	✓	✓	✓	✓		N		✓
Friedrich (2010)	✓		✓	✓				✓	✓				✓	✓			✓	✓	✓	✓	✓	✓		Y	✓	
Jin (2005)	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N		✓
Klaus et al. (2009)		✓	✓	✓					✓					✓	✓		✓		✓			✓		Y	✓	
Mauer (2008)	✓		✓	✓				✓	✓	✓	✓		✓	✓			✓		✓		✓	✓	✓	N		✓
Tavasszy et al. (1998)	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Y		✓

Note: FCE refers to freight cost estimation technique; ABC is activity-based costing.

once per mode, and the total counts for the research reflect this adjustment. The publications studied are: NEA(2010), Cantos et al. (1999), NEA (2009), NEA (2004), European Commission (2002), Ballis and Golias (2002), Holguín-Veras and Cetin (2008), Ruta (2002), Litman (2002), Litman (1997), Litman (1996), Archondo-Callao et al. (1994), Harrison (1990), Chesher and Harrison (1987), Meyer and Kraft (1961), Short et al. (2010), ATRI (2008), Lall et al. (2009), Holguín-Veras and Brom (2008), Vanegas et al. (2005), Rizet (2003), Holguín-Veras (2003), Musso (2001), Ministry of Transportation of Colombia (2000), Combers and Lafourcade (2005), Márquez-Ramos et al. (2010), Micco and Pérez (2002), Resor et al. (2012), Resor and Smith (1993), Waters et al. (1995), and Klaus et al. (2009).

Most publications are primarily intended for public-sector use. The predominance of research on highway-related modes is apparent. Out of the 33 unique publications, 22 focus on highway users, 11 on freight rail, 5 on waterways, 4 on air and intermodal transport, and 9 on logistic costs. To complement the information gathered from the published literature, and to gain insight into industry cost estimation practices, the research team conducted a number of in-depth interviews with industry representatives who are familiar with freight costs.

Given that most research occurs at the national level, there is a lack of research publications with a local focus that could support local decisionmaking. The majority of these publications seem to have been motivated by planning and policy needs. In terms of freight cost estimation techniques, activity-based costing (ABC) is the preferred choice. Statistical modeling was most often used to explain the relationship between freight rates and a set of independent variables.

CHAPTER 3

Public-Sector Functions and Current Cost Data Needs

Freight transportation cost data could be a critical input of numerous public-sector activities. This chapter identifies current public-sector freight transportation planning and decision-making functions, and the cost data used to support those functions.

While this chapter focuses on the public-sector agencies that are primarily involved in transportation functions, such as federal and state departments of transportation (DOTs), metropolitan planning organizations (MPOs), and port/airport/railroad authorities, the information conveyed may be useful to other public agencies as well, such as economic development and environmental agencies.

This chapter has two main sections. Section 3.1 identifies current public-sector freight transportation functions based on a review of research publications and government documents. The research team examined five levels of public-sector organizations, including MPOs; state DOTs; the federal government; local governments; and other stakeholders, such as port authorities and the business community. The relevant government functions are summarized in a matrix that includes a description of the function, the modes affected, and the levels of government organizations involved. Functions were identified from Unified Planning Work Programs (UPWPs), state transportation plans, and other sources.

Section 3.2 examines the freight cost data elements currently used to support those public-sector freight transportation functions. The cost data elements were identified through interviews with public transportation planners and a literature review. The section has three parts: (1) a comprehensive literature review of publications that are relevant to freight transportation planning and operations, as well as research publications and case studies at federal, state, and local levels; (2) a function-by-function data needs assessment, which examines needs for company costs, vehicle costs, and route costs; and (3) the findings in a function-by-cost matrix based on the previous assessment.

3.1 Public-Sector Functions

Data collection and analysis are crucial components of a wide variety of public-sector planning activities. The project provides research and guidance on the freight cost data elements required for transportation planning objectives, and the sources of those data elements. Section 3.1 identifies the public-sector organizations that are responsible for freight transportation planning, as well as current government functions informed by freight data and cost considerations.

3.1.1 Organizations Involved in Freight Transportation Planning

The research team first examined various types of organizations involved in freight transportation planning and operations to identify the characteristics and roles of these stakeholders and those planning and decision-making functions that require freight cost data.

3.1.1.1 Metropolitan Planning Organizations

MPOs are federally mandated transportation policy-making organizations composed of representatives from local governments and governmental transportation authorities. The purpose of an MPO is to implement 23 U.S.C. 134 and Section 5303 of the Federal Transit Act, as amended, which require that an MPO be designated for each urbanized area (defined as a metropolitan statistical area with a population of 50,000 or more). In addition, the metropolitan area must have a continuing, cooperative, and comprehensive transportation planning process that results in plans and programs that consider all transportation modes and support metropolitan community development and societal goals. These plans and programs lead to the development and operation of an integrated, multimodal transportation system that facilitates the efficient, economic movement of

people and goods. In rural areas, the counterparts of MPOs are rural development councils (RDCs).

3.1.1.2 State Agencies

State DOTs are responsible for coordinating and developing comprehensive transportation policies for the state, and for assisting in the development and operation of transportation facilities and services for highways, railroads, mass transit systems, ports, waterways, and aviation facilities. State DOTs also regulate public safety for railroads and motor carriers, and provide oversight in matters relative to the safe operation of bus lines, commuter railroads, and publicly subsidized subway systems. Governors and legislatures provide political support and investment for transportation policy frameworks and investment. State transit authorities are government-owned organizations that are responsible for the operation of transit services such as buses and ferries.

3.1.1.3 The Federal Government

The U.S.DOT administers programs to promote connectivity and development, reduce congestion, protect the environment, ensure safety, and ensure effective emergency response. The U.S.DOT enables programs involving highways, airports, mass transit, the maritime industry, railroads, and motor vehicle safety. It regulates the construction and operation of bridges over navigable waters, the prevention of oil pollution, and the security of commercial aviation and passenger vessels. Other responsibilities include developing policies concerning acquisitions and grants, access for the disabled, environmental protection, energy conservation, information technology, property asset management, seismic safety, security, and the use of aircraft and vehicles.

Several agencies within the U.S.DOT contribute to freight policy and planning. For example, FHWA is charged with maintaining the National Highway System. To this end, FHWA distributes funding, mostly to state DOTs, for roadway construction and maintenance. FHWA also conducts highway design and construction on federal lands under the Federal Lands Highway Program. The Federal Motor Carrier Safety Administration is responsible for safety oversight of motor carriers operating in interstate and foreign commerce. Among its activities are regulatory enforcement, data collection and analysis, and safety outreach programs. Many of the Federal Motor Carrier Safety Administration's programs are conducted by state partners who receive substantial funding through safety grant programs. The Federal Aviation Administration manages aircraft, airports, and air traffic, developing Airport Improvement Programs and conducting research based on aviation data and statistics. The Federal Railroad Administration (FRA) manages freight and passenger rail, improves railroad safety, and develops strategic plans. For example, the FRA developed the Intermodal Transportation and Inventory Cost Model (ITIC) (Federal Railroad Administration 2005), which computes total logistic costs for the freight modes available in a given corridor or region. The Maritime Administration promotes the use and integration of waterborne transportation with other segments of the transportation system, as well as the viability of the U.S. Merchant Marine fleet.

Other federal departments provide transportation infrastructure support. For example, the U.S. Army Corps of Engineers provides funding and dredging services to maintain many of the deep-water ports that make international trade feasible. The U.S. Congress charges the Surface Transportation Board with resolving railroad rate and service disputes, and reviewing proposed railroad mergers (Surface Transportation Board 2010). Within DHS, TSA develops a variety of transportation security programs including grants, law enforcement, and security screening (Holguín-Veras et al. 2011). DHS coordinates with states and regional organizations to incorporate emergency preparedness and other considerations into transportation planning. The U.S. Coast Guard is responsible for port/waterway/coastal/marine safety, marine resources, environmental protection, and defense readiness, as well as other law enforcement duties.

3.1.1.4 Local Governments

Local governments are responsible for many transportation planning and decision-making functions, often in collaboration with state DOTs, MPOs, modal partners, and other stakeholders. Public agencies are involved in a variety of transportation programs, including federal economic recovery projects, interregional connectivity, emergency relief, highway safety improvement, local bridge improvement, freight rail infrastructure improvement, and surface transportation improvement (Yunjun et al. 2007).

3.1.1.5 Other Stakeholders

A variety of other organizations are involved in freight transportation planning, including local units of government, port/airport/roadway authorities, regional planning offices, and the business community. In particular, port authorities are often primarily responsible for the day-to-day management and maintenance of regional transportation hubs, such as airports, train and bus stations, and water ports. Turnpike authorities are responsible for the construction, operation, and maintenance of turnpike systems. Regional planning offices often attempt to create procedures and processes that complement those of the metropolitan areas served and that foster seamless transportation flow from one area to another. In a general sense, the business community is a stakeholder in

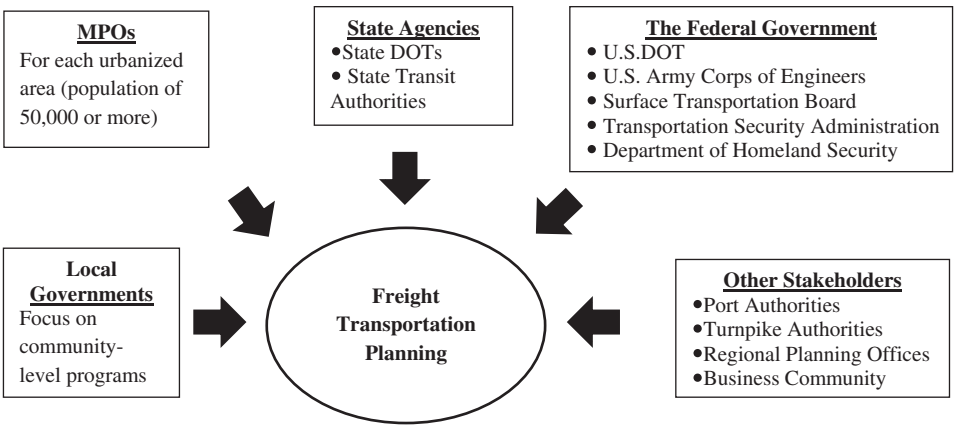

Figure 3.1. Levels of public-sector organizations.

transportation policy because business costs and profits are directly related to transportation times. The various public-sector organizations involved in freight transportation planning and operations are illustrated in Figure 3.1.

3.1.2 Methodology

The research team employed a three-step methodology to select public-sector planning and decision-making functions. In Step 1, "functions" were defined. For this study, "function" is defined as an area of transportation planning work that comprises more specific activities. "Activity" is defined as an organizational unit for performing a specific transportation planning function. In this study, the list of functions is limited to those that make use of freight data and costs.

Step 2 was an extensive literature review. Previous TRB and NCHRP reports provided insight on the role of freight data in numerous public-sector functions. Additional data sources considered included a UPWP and a United Nations database, Classification of the Functions of Government, which list the varying functions and modes present in the transportation sector (Yushimito et al. 2012). Several states' transportation plans, such as Florida's 2025 Transportation Plan, provided insight on the transportation roles and functions of state entities. These sources are discussed in the literature review.

Step 3 was to select the relevant functions. The functions were combined when appropriate, and some functions were excluded as not being specific enough to support the analysis of cost data requirements. The result was a list of 18 functions associated with freight cost data.

3.1.3 Literature Review

This subsection presents a review of the documents and source materials used by the research team. Each paragraph includes a short description of the relevancy of each source. Bibliographic information for these documents and sources is included in the references section.

Information from a survey of 14 state transportation agencies included in the TRB Electronic Circular E-C080: Freight Data for State Transportation Agencies identifies a variety of uses of freight data across transportation modes and functions (TRB 2005). Among other survey questions, respondents were prompted to "list the types of policy questions, planning studies, project plans and designs, or other activities for which your DOT needs to analyze data on the movement of commodities, truck travel, rail freight and shipping, safety, or other aspect of rail transportation." Data uses and needs were summarized by modes (such as highway, rail, air, water, and multimodal) as well as by government functions (such as safety, hazardous materials, large truck management, etc.). TRB Electronic Circular E-C080 also identifies current freight data sources, relevant organizations, and opportunities for potential improvements.

NCHRP Synthesis 358: Statewide Travel Forecasting Models provides an inventory of major sources of information on statewide travel forecasting models, and identifies trends in recent statewide model development based on five case studies: Kentucky, Indiana, Ohio, Virginia, and Wisconsin (Horowitz 2006). The report also summarizes those planning needs that have not been fully realized due to deficiencies in either data or algorithms, and the innovations needed for better planning.

NCHRP Synthesis 384: Forecasting Metropolitan Commercial and Freight Travel provides insight on freight transportation planning from the metropolitan perspective (Kuzmyak 2008). This report is focused on trucks, because they account for 80% of freight movement in most metropolitan areas. It addresses a range of issues related to metropolitan freight travel, such as the impacts of trucks on traffic and infrastructure, and the challenges associated with modeling the freight movement of heavy trucks and other commercial vehicles.

Based on a survey of 23 state DOTs, *NCHRP Report 606: Forecasting Statewide Freight Toolkit* identifies several policy and planning needs for freight analysis and forecasting (Cohen, Horowitz, and Pendyala 2008). The report addresses the difficulties imposed by the deregulation of the freight transportation industry and summarizes techniques for long- and short-distance freight movement forecasting.

NCHRP Report 570: Guidebook for Freight Policy, Planning, and Programming in Small-and Medium-sized Metropolitan Areas provides small- and medium-sized MPOs with the necessary resources to begin or enhance their freight transportation planning programs (Williamson et al. 2007). It also provides definitions for terms used repeatedly in this area of research, including the following:

- **Freight policy development** relates to the development of specific policy guidance concerning freight movements. Freight policy development is designed to help MPOs assess their roles in addressing freight issues, and can help focus metropolitan freight planning efforts.
- **Freight planning** relates to the process by which freight issues and concerns are addressed in statewide or metropolitan transportation planning activities and documents, such as long-range transportation plans (LRTPs), Transportation Improvement Programs (TIPs), and UPWPs.
- **Freight programming** involves the ways in which MPOs commit funds to freight-specific projects identified in the regional TIP.
- **Metropolitan freight planning programs** integrate these various components into a comprehensive, continuous process of improvement.

The Baltimore Region FY 2011 UPWP presents a multitude of public-sector functions, including those dependent on freight data and costs (Baltimore Metropolitan Council 2010), and describes the contributions of federal, state, and local authorities to the transportation planning process. The transportation section of the United Nations database, Classification of the Functions of Government, describes several functions that the public sector is expected to perform for road, rail, air, port, and pipelines modes (Yushimito et al. 2012).

Many states publish general transportation and freight-specific action plans which highlight the roles of state DOTs and other state agencies in the transportation industry. Many of these plans share transportation priorities, such as congestion mitigation, environmental welfare, and intermodal and interregional connection. California and Florida also conduct substantial international trade, which is reflected in their state plans and planning priorities (Florida DOT 2010).

3.1.4 List of Public Functions

Table 3.1 identifies the functions associated with MPOs. The list was compiled from the Baltimore Region UPWP and refined by removing functions that were not relevant to freight or were deemed not specific enough for identifying cost data requirements. For example, the function "analysis of trends and policy issues" includes a broad set of cost data elements already covered by other, more specific functions.

The United Nations database, Classification of the Functions of Government, provided additional public-sector transportation functions, as listed in Table 3.2. Each of the five transportation modes (road, water, railway, air, and pipeline) are responsible for these main functions.

Freight plans published by several state DOTs were the source of additional information used to complete the working list of functions used by the research team. Table 3.3 lists these state DOT functions.

Table 3.1. MPO functions.

Selected	Not Selected (Reason)	
	Lacking Specificity for Cost Data Element	Not Freight Related
Congestion Management	Vision Planning	Bicycle and Pedestrian Planning
Operations Planning	Long-Range Transportation Planning	Human Service Transportation Coordination
Safety Planning and Analysis	Transit Coordination	
Freight Mobility Planning	Analysis of Trends and Policy Issues	2010 Census
Emergency Preparedness Planning	Travel Monitoring Program	
Modal Diversion Planning	Cooperative Forecasting	
Transportation Equity Planning	GIS Activities	
Economic Development Monitoring and Planning	Regional Database Integration	
Transportation and Land Use Planning Integration		
Environmental Planning		

Table 3.2. Functions of government.

UN Functions
Services
Regulation and Enforcement
Information
Financial Support

Source: United Nations (2010).

Based on the analysis of these public-sector functions and discussions with experts, the research team summarized these functions in Table 3.4. To avoid overlap, a few functions that serve the same goals were combined into more general functions. Such adjustments included:

- Services, operations planning, and operational performance were combined as one general function (operations/services), as all of these functions involve improvements in the safety, reliability, and effectiveness of the transportation system, as well as coordination of management and operations.
- Financial support and development of financial plans were combined into one general function (financial planning), as both functions strive to support the transportation system financially. Financial sources include taxes, fees, grants, loans, and such activities as collaborative partnerships (e.g., public-private partnerships).
- Modal diversion planning was combined with freight mobility planning, as its goals to improve the efficiency and effectiveness of specific freight modes are covered by the more general function, freight mobility planning.
- The information function was excluded, as the need for freight cost data in composing technical documents and statistics depends on the type of service provided by the agency.

Table 3.3. State DOT functions.

State DOT Functions
Development of Financial Plan
Intermodal Corridor Planning
Terminal and Border Access Planning
Security Planning
Hazardous Materials Planning
Roadway Pavement and Bridge Maintenance Planning
Inter-regional Connectivity
Modal Diversion Planning
Sustainable Transportation Investment
Operational Performance
Collaborative Partnerships

Table 3.4 contains a brief description of the 18 unique functions, as well as the level of government and the freight modes typically associated with each function.

3.2 Freight Cost Data Needs

Freight cost data are used to support a variety of public functions. Section 3.1 defined public-sector functions and identified those responsible for freight transportation planning. Section 3.2 will identify which freight cost data elements support those functions and examine the relative importance of each element. This section includes three subsections that describe the study's methodology; freight cost data needs for each identified government function based on existing studies and documents; and the findings based on previous analysis.

3.2.1 Methodology

The analysis of freight cost data needs was divided into eight steps. Step 1, a scan of TRB reports with a focus on freight transportation planning, provided insight into freight transportation planning considerations and forecasting methodologies. Relevant studies identified included:

- *NCHRP Report 570: Guidebook for Freight Policy, Planning, and Programming in Small- and Medium-Sized Metropolitan Areas* (Williamson et al. 2007)
- *NCHRP Report 594: Guidebook for Integrating Freight into Transportation Planning and Project Selection Processes* (Cambridge Systematics, Inc. 2007)
- *NCHRP Report 606: Forecasting Statewide Freight Toolkit* (Cohen, Horowitz, and Pendyala 2008)
- *NCHRP Synthesis 358: Statewide Travel Forecasting Models* (Horowitz 2006)
- *NCHRP Synthesis 384: Forecasting Metropolitan Commercial and Freight Travel* (Kuzmyak 2008)
- *NCHRP Web Doc 4: Multimodal Transportation Planning Data: Compendium of Data Collection Practices and Sources* (National Research Council 1997)
- *TRB Special Report 304: How We Travel – A Sustainable National Program for Travel Data* (TRB 2011)

Step 2 was a broader scan of NCHRP studies on freight transportation–related government functions. Several reports provide confirmation of the importance of certain freight cost data, including such measures as tour time, tour distance, maintenance costs, taxes, and fees. The analysis of broader NCHRP transportation studies included:

- *NCHRP Synthesis 319: Bridge Deck Joint Performance* (Russell and Rhys 2003)
- *NCHRP Synthesis 337: Cooperative Agreements for Corridor Management* (Williams 2004)

Table 3.4. Freight planning and decisionmaking, public-sector functions.

Function	Description	Mode	State/MPO	Source
Congestion Management	Identify and monitor recurring and non-recurring congestion along road corridors and evaluating and recommending mitigation strategies	Truck	Both	Baltimore UPWP
Operations/Services	Develop, operate and maintain transportation modes; improve the movement of goods and people and increase the safety and efficiency of the transportation system through enhanced management and operations coordination	All Modes	MPO	Baltimore UPWP
Safety Planning and Analysis	Implement and maintain integrated multimodal safety and transportation planning; the ultimate goal is to reduce crashes, injuries and fatalities	All Modes	Both	Baltimore UPWP
Freight Mobility Planning	Incorporate goods movement into the regional transportation planning process	All Modes	Both	Baltimore UPWP
Emergency Preparedness Planning	Increase the safety and security of the transportation system through enhanced coordination and communications amongst emergency responders	All Modes	Both, federal	Baltimore UPWP
Transportation Equity Planning	Incorporate transit equity principles and legislation such as SAFETEA-LU into regional transportation planning	Multimodal	MPO	Baltimore UPWP
Economic Development Planning	Involve the impacts of transportation planning on local population and employment	All Modes	MPO	Baltimore UPWP
Transportation and Land Use Planning Integration	Coordinate regional transportation planning and land use development	Multimodal	MPO	Baltimore UPWP
Environmental Planning	Involve such activities as mobile emissions planning, environmental protection, land use management, and air quality efforts	All Modes	Both	Baltimore UPWP
Regulation and Enforcement	Involve such activities as licensing, inspection, size and load specifications, work hours regulation, and taxes/fares	All Modes	State	UN COFOG
Financial Planning	Include grants, loans, and subsidies to support the transportation system; also involve tax policy, road user fee assessment, and other activities such as public-private partnerships	All Modes	Both	UN COFOG
Intermodal Corridor Planning	Develop intermodal corridors to ensure efficient freight movement and reduce congestion	All Modes	Both	Florida Plan
Terminal and Border Access Planning	Manage terminals and borders to ensure efficient movement of people and goods across modes	All Modes, Intermodal	Both, federal	California Plan
Security Planning	Integrate emergency response and other calculations into transportation planning	All Modes	Both, federal	Multiple Plans
Hazardous Materials Planning	Improve safe movement and monitoring of hazardous materials transported using the freight system	All Modes	State, federal	Multiple Plans
Roadway Pavement and Bridge Maintenance Planning	Study the effects of fleet use on infrastructure, such as expected pavement deterioration	Primarily Truck	State	Minnesota Plan
Interregional Connectivity	Facilitate efficient freight traffic while addressing community livability and land use concerns	Multimodal	Both	Florida Plan
Sustainable Transportation Investment	Investigate ways to fund the existing transportation system and future projects	All Modes	Both	Florida Plan

- *NCHRP Synthesis 367: Technologies for Improving Safety Data* (Ogle 2007)
- *NCHRP Report 388: A Guidebook for Forecasting Freight Transportation Demand* (Cambridge Systematics, Inc. 1997)
- *NCHRP Report 463: Economic Implications of Congestion* (Weisbrod, Vary, and Treyz 2001)
- *NCHRP Report 497: Financing and Improving Land Access to U.S. Intermodal Cargo Hubs* (Shafran and Strauss-Wieder 2003)
- *NCHRP Report 524: Safety of U-Turns at Unsignalized Median Openings* (Potts et al. 2004)
- *NCHRP Report 590: Multi-Objective Optimization for Bridge Management Systems* (Patidar et al. 2007)
- *NCHRP Report 618: Cost-Effective Performance Measures for Travel Time Delay, Variation, and Reliability* (Cambridge Systematics, Inc., et al. 2008)
- *NCHRP Report 661: A Guidebook for Corridor-Based Statewide Transportation Planning* (Carr, Dixon, and Meyer 2010)

Step 3 was an analysis of case studies at the state or local level. The cases provided insight on a range of freight transportation–related issues, challenges, and public policy responses. The main public-sector functions discussed in these cases were congestion management, corridor planning, operation/services, and terminal and border access planning. Studies examined included:

- Bay Bridge Corridor Congestion Study (San Francisco) (Bruzzone 2010)
- Transportation 2040: Toward a Sustainable Transportation System (Puget Sound Regional Council 2010)
- Congestion Management Process (New York Metropolitan Transportation Council 2010)
- Mitigating Diesel Truck Impacts in Environmental Justice Communities: Transportation Planning and Air Quality in Barrio Logan, San Diego (Karner et al. 2009)
- Interregional Transportation: Sacramento Region MTP 2035 Metropolitan Transportation Plan (Sacramento Area Council of Governments 2008)
- Road Pricing Simulations: Traffic, Land Use and Welfare Impacts for Austin, Texas (Gupta, Kalmanje, and Kockelman 2004)
- Northeast Corridor—Great Cincinnati Transit Benefit-Cost Analysis (HLB Decision Economics Inc. 2002)

Step 4 was a scan of public-sector agencies involved in freight transportation planning activities. The websites of councils of governments (COGs), state DOTs, MPOs, and port, airport, and roadway authorities provide a wealth of information on their goals and missions, policies and regulations, and past and current projects. Such information allowed the research team to better understand these agencies and their needs for freight cost data.

Step 5 was a survey of public-sector freight transportation data users. The research team interviewed planners and analysts in a number of state and local agencies, including state DOTs, city DOTs, MPOs, and port authorities.

Step 6 was an analysis of the cost data needs for each public-sector function. The analysis determined the relative importance of the cost data elements, ranking each as "crucial," "very important," "important," or "not generally used."

Step 7 was to present the relative importance of freight cost data elements for each public-sector function in a matrix to provide a visual interpretation of the findings.

Step 8, the final step of the methodology, was to draw conclusions from the analyses. Based on the cost-by-function matrix, the research team identified the data elements most and least commonly used to support freight transportation–related public-sector functions.

These steps are discussed in more detail in Section 3.2.3.

3.2.2 Cost Data Needs by Function

This subsection provides a function-by-function analysis of specific freight cost data elements for transportation planning decision-making functions. Cost data have been divided into three aggregate cost measures: company, vehicle, and route. These whole-cost measures are further divided into fixed, variable, and average costs, when appropriate. For clarity and simplicity, the trucking mode is used as an example. While aggregate cost measures simplify the exposition, each aggregate measure contains the following detailed cost elements:

- **Company Costs:** Building/land costs, utilities, special equipment costs, wages/benefits of administration staff, maintenance, company licenses/permits/insurance, and taxes/fees.
- **Vehicle Costs:** Driver- and crew-related labor costs, vehicle purchase costs, estimated salvage value, maintenance costs, depreciation, vehicle licenses/permits/insurance, taxes, energy consumption, monitoring devices, and communication system costs.
- **Route Costs:** Vehicle operating time and speed, travel time and distance, permits, tolls, and parking costs.

3.2.2.1 Congestion Management

The research team analyzed a number of studies to determine which cost data elements are needed for congestion management planning. The most important of these studies were:

- *NCHRP Report 463: Economic Implications of Congestion* (Weisbrod, Vary, and Treyz 2001)
- Bay Bridge Corridor Congestion Study (Bruzzone 2010)
- Fusing Public and Private Truck Data to Support Regional Freight Planning and Modeling (Liao 2010)

Route costs are critical data elements for congestion management planning. The three studies each discussed route variable costs and route average costs, so these data elements are identified as either crucial or very important. Vehicle cost data are less important and are not widely utilized. Company costs were not deemed important because none of the studies considered them.

- **Route Variable Costs (Crucial):** *NCHRP Report 463* used truck trip coverage and truck delivery delay data to analyze the impact of urban traffic congestion on producers of economic goods or services. The Bay Bridge Corridor Congestion study projected the corridor's freeway performance between the East Bay and San Francisco in terms of congestion reduction and transit reliability using data on travel time/delay. Liao's study used truck speed and travel time data, collected between Minneapolis/Saint Paul and Chicago, to assess the cost effectiveness of portable data collection GPS systems. These systems also are used in the State of Washington to measure freight movements and to identify corridor bottlenecks. Along with these researchers, public-sector planners also expressed the need for data on delay and congestion (e.g., travel time). For example, in an interview conducted for NCFRP Project 26, a staff member at a large MPO expressed an interest in congestion analysis, in which travel time and speed would be key inputs.
- **Route Average Costs (Important):** Data on travel speed were used in the Bay Bridge Corridor Congestion Study to project the corridor's freeway performance in terms of congestion reduction and transit reliability, and truck speed was used as an input in Liao's study of GPS systems.
- **Vehicle Fixed Costs (Important):** Vehicle fixed costs are collected and analyzed in a limited number of studies, including Liao's, and are identified as important cost elements in *NCFRP Report 22.*
- **Company Costs (Not Generally Used):** Since these studies do not mention company costs, the analysis determined that they are not generally required for congestion management planning.

3.2.2.2 Operation and Service Planning

The operation and service planning function covers a variety of freight transportation–related programs, including performance evaluation, corridor planning, and congestion management. Studies typical of this function included:

- *NCHRP Report 618: Cost-Effective Performance Measures for Travel Time Delay, Variation, and Reliability* (Cambridge Systematics, Inc., et al. 2008)
- FY-2008 Network Documentation: Highway and Transit Network Development (Draft). (Metropolitan Washington Council of Governments 2008)
- Mitigating Diesel Truck Impacts in Environmental Justice Communities: Transportation Planning and Air Quality in Barrio Logan, San Diego (Karner et al. 2008)

Analysis of these reports led to the conclusion that route costs are crucial to operation and service planning. Route costs data were used in each of the studies listed, as well as in other studies. Vehicle costs and company costs were not identified as important, as they went unmentioned in relevant studies.

- **Route Variable Costs (Crucial):** *NCHRP Report 618* used data on highway user costs, including tolls and permits, to analyze the framework and methodology for highway performance evaluation and estimation. The Metropolitan Washington Council of Governments collected data on existing tolls for high occupancy/toll (HOT) lanes in 2010 and made projections for tolls in years 2020 and 2030 because they plan to develop highways and transit networks in the area. The truck environmental impact study in San Diego identified potential traffic operational improvements using such data as distance traveled by truck. During an interview conducted as a part of the research for NCFRP Project 26, a state DOT employee stated there was a need for route variable cost data.
- **Route Average Costs (Important):** Route average costs were identified as important in operational and service planning. For example, data on truck speed was used by Karner and his colleagues to identify potential traffic operational improvements that would mitigate local impacts originating from diesel trucks.
- **Vehicle and Company Costs (Not Generally Used):** Few studies mentioned vehicle costs or company costs in relation to operation and service planning. However, such costs can be very important in assessing specific public-sector questions, such as changes in toll policies, new equipment requirements, and Hours-of-Service regulations.

3.2.2.3 Safety Planning and Analysis

The research team determined the cost data elements needed for safety planning and analysis through a literature review of government regulations and relevant studies. Important resources included:

- The National Transportation Safety Board (NTSB) website at: http://www.ntsb.gov
- The Surface Transportation Board (STB) website at: http://stb.dot.gov/stb/environment/rules.html

- The Highway Safety for Missouri Farm Trucks (Missouri DOT) website at: http://www.modot.org/mcs/documents/FarmTruckSafety07.pdf
- The Comprehensive Truck Size and Weight Study (FHWA 2000) website at: http://www.fhwa.dot.gov/policy/otps/truck/finalreport.htm
- *NCHRP Report 524: Safety of U-Turns at Unsignalized Median Openings* (Potts et al. 2004)

The types and granularity of safety data needed may vary considerably depending on the geographic scope of a study, as well as the issues. Based on these source materials, the research team concluded that route costs data are crucial for highway safety planning and analysis. Vehicle costs data, which are utilized less frequently, were identified as important rather than crucial. Because none of the studies mentioned company costs, they were not identified as important.

- **Route Average Costs (Crucial):** The NTSB discussed the need to use electronic onboard data recorders to maintain accurate records of driver hours of service. The Missouri study required all working hours, driving hours, and off-duty time to be documented with a logbook for safety regulation purposes. *NCHRP Report 524,* which covered a total of 918 unsignalized median openings in 62 arterial corridors in seven states, recommended that highway agencies consider the volume of turning and crossing large vehicles when they design the medians. Information on large truck operating days/hours might be useful in estimating the truck volume.
- **Route Variable Costs (Important):** The Missouri study utilized information on farm truck tour distance to analyze the safety of farm truck operations.
- **Vehicle Fixed Costs (Important):** The Missouri study mentioned truck insurance coverage in highway safety analysis. According to the study, higher public liability insurance may be required if trucks carry bulk or placarded hazardous materials.
- **Company Costs (Not Generally Used):** Company costs, mainly including labor costs on administration staff, building and utility costs, and number of vehicles, were not generally utilized for safety planning and analysis. However, as noted previously, specific analyses may consider the impacts of an action on company costs.

3.2.2.4 Freight Mobility Planning

Of the literature analyzed, these are the most important to determining the cost data elements needed for freight mobility planning:

- FHWA Freight Facts and Figures 2007 (updated annually)
- "Public Policy and Surface Transportation Capacity," presented at the Freight Transportation Productivity Summit, Atlanta, Georgia (Nober 2005)
- *NCHRP Report 657: Guidebook for Implementing Passenger Rail Service on Shared Passenger and Freight Corridors* (Bing et al. 2010)
- Rail to Truck Modal Shift: Impact of Increased Freight Traffic on Pavement Maintenance Costs (Steward et al. 2008)
- Fusing Public and Private Truck Data to Support Regional Freight Planning and Modeling (Liao 2010)

The research team concluded from this analysis that vehicle costs are crucial and route costs are very important in supporting freight mobility planning programs. The analysis did not identify company costs as important.

- **Route Variable Costs (Very Important):** Data on tour distance and tour time are very important for freight mobility planning. For example, the FHWA report presented data on truck travel distance in several figures; data on travel distance were used to calculate truck miles by average weight and truck miles by products carried.
- **Route Average Costs (Important):** Some studies required route average cost data, such as operational speed. *NCHRP Report 657* discussed state officials' awareness of leveraging rail mode and encouraging truck-to-rail or intermodal handling, and data on truck speed are necessary for the cost-benefit analysis of this type of modal shift.
- **Vehicle Fixed Costs (Important):** The presentation by Roger Nober, then Chairman of the STB, discussed several factors that limit truck capacity, including high insurance costs. Vehicle fixed cost data (e.g., insurance cost per vehicle power unit or trailer) are important for analyzing freight mobility. The research team interviewed an individual from a large turnpike authority who identified vehicle fixed cost data as one of the agency's current needs for freight cost data.
- **Vehicle Variable Costs (Crucial):** Fuel consumption and prices were discussed in many freight mobility studies. For example, the Rail to Truck Modal Shift study showed that trucking costs increased substantially in several years before 2008, partly due to escalating fuel prices that greatly influenced mode selection in freight transportation planning.
- **Company Costs (Not Generally Used):** Few studies mentioned company cost data in relation to freight mobility-related policies, which incorporate goods movement into the regional transportation planning process. However, as noted previously, specific analyses may consider the impacts of an action on company costs.

3.2.2.5 Emergency Preparedness Planning

The cost data needs of the emergency preparedness planning function are reflected in many freight transportation–related regulations and relevant analyses. Some important documents included:

- *A Guide to Updating Highway Emergency Response Plans for Terrorist Incidents* (Parsons Brinkerhoff–PB Farradyne 2002)
- Emergency Preparedness and Individuals with Disabilities. U.S.DOT website at: https://www.civilrights.dot.gov/page/emergency-preparedness
- Emergency Relief Manual (FHWA 2009b)
- "Communicating in a Crisis." DHS website at: http://www.dhs.gov/files/publications/gc_1262023179771.shtm

The research team concluded that vehicle average costs are crucial for emergency preparedness planning. Route variable costs are identified as important since they are likely to be used in detour route planning. Company costs are not discussed in relevant documents and studies, and so were not deemed important.

- **Vehicle Average Costs (Crucial):** Given that communication is discussed in almost every safety and emergency planning program, the costs for monitoring devices and communication systems were identified as crucial to this function. According to the U.S.DOT, in any emergency, communication about the incident and the means to remain safe are critical to avoid panic, minimize injuries, and save lives. To enhance emergency preparedness, DHS has organized a series of scenario-based workshops called "News and Terrorism: Communicating in a Crisis." According to the PB Farradyne report, a lack of communication lines and centers, along with incompatible technologies among public safety and transportation agencies, indicates the dangers inherent in institutional isolation, and interoperable communications systems for both data and voice are key to generally improved emergency management.
- **Route Variable Costs (Important):** Tour time was identified as important data for emergency preparedness and response efforts. FHWA suggests that detour routes need to be created to relieve excess traffic directly attributable to a disaster, and the PB Farradyne report also lists developing detour routings as an important responsibility of state DOTs in a highway emergency. The planning of detour routes may require congestion-related information such as tour time and tour distance.
- **Company Costs (Not Generally Used):** Emergency preparedness/response-related programs usually are focused on enhancing communication and coordination among emergency responders and are not focused on company costs. As noted previously, specific analyses may consider the impacts of an action on company costs.

3.2.2.6 Transportation Equity Planning

Among the resources analyzed to determine the cost data elements needed for transportation equity planning, the most important are:

- Evaluating Transportation Equity: Guidance for Incorporating Distributional Impacts in Transportation Planning (Litman 2012)
- Transportation Equity Project (Pratt Center for Community Development), website at: http://prattcenter.net/transportation-equity-project
- Transportation Equity (Baltimore Metropolitan Council), website at: http://www.baltometro.org/transportation-planning/transportation-equity

The research team concluded that vehicle costs are crucial for this government function, while route costs are important, as route costs are utilized less frequently. Company costs are not discussed in relevant studies, and therefore are not identified as important for this function.

- **Vehicle Variable Costs (Crucial):** Data on vehicle fuel consumption are crucial for transportation equity planning. According to the Baltimore Metropolitan Council website, a core principle of environmental justice and transportation is to avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority and low-income populations. The Pratt Center for Community Development website also lists environmental quality and pedestrian safety as a goal for the Transportation Equity Project in New York City.
- **Route Variable Costs (Important):** According to Litman (2012), some impacts of congestion (e.g., travel delays and accident risks) are monetized (measured in monetary units) for economic evaluation; however, adjustments are needed for comprehensive equity evaluation. For example, the fact that motorists impose far more delay and risk on non-motorized travelers than non-motorized travelers impose on motorists represents an inequity. For a comprehensive evaluation of the impacts of congestion delay, basic route variable cost data (e.g., tour time and tour distance) are important.
- **Company Costs (Not Generally Used):** Company costs are not generally used to support transportation equity planning activities, and new principles and legislation are unlikely to have a significant effect on company cost ele-

ments such as building, land, utilities, or maintenance. As a result, company costs are not identified as important for this function.

3.2.2.7 Economic Development Planning

Economic development planning involves a variety of freight transportation–related programs and has impacts on both the private and the public sector. The research team analyzed many case studies in order to identify important cost data elements for this public-sector function, including:

- "Transportation and the Economy," in *The Geography of Transport Systems* (Rodrigue, Comtois, and Slack 2009)
- Evaluating Transportation Economic Development Impacts (Litman 2010)
- Economic and Land Use Impacts Study of State Trunk Highway 29: Phase 1, Chippewa Falls to Abbotsford, Wisconsin (Leong 2003), website at: http://www.fhwa.dot.gov/planning/econdev/wis2911.htm
- Georgia's "Business Expansion Support" Act (Georgia Ports Authority), website at: http://www.gaports.com/SalesandMarketing/EconomicIndustrialDevelopment/BESTLegislation.aspx

The conclusion drawn from analyzing relevant reports is that route costs, vehicle costs, and company costs are all crucial for economic development planning.

- **Route Variable Costs (Crucial):** The work by Rodrigue, Comtois, and Slack (2009) divided economic impacts of transport into five categories: networks, performance, reliability, market size, and productivity. Route variable data, such as tour time and tour distance, are required to assess the improvements in the time performance in terms of punctuality as well as reduced loss or damage.
- **Route Average Costs (Crucial):** Data on operational speed are crucial for economic development planning. For example, the FHWA study on State Trunk Highway 29 showed that the expansion of Highway 29 in Clark County, Wisconsin, and the subsequent higher speed limit increased the reliability and efficiency of manufacturers delivering commodities. As a result, for-hire truck companies offered lower freight charges for deliveries, and manufacturers using these freight services saved money on delivery feeds.
- **Vehicle Variable Costs (Crucial):** Vehicle variable cost elements often are used to determine the relationship between transportation-related factors and other social factors. For example, to examine the relationship between mobility and economic productivity, Litman (2010) analyzed the correlation between per capita gross domestic product (GDP) and vehicle-miles traveled (VMT), and the correlation between GDP and fuel prices. The results indicated that economic productivity tends to increase with less motor vehicle travel and higher fuel prices. Vehicle variable costs—like miles traveled per year and unit cost of fuel—are vital, both for such economic impact analysis and for freight transportation decisionmaking in general.
- **Company Fixed Costs (Crucial):** The number of administrative employees and related labor costs were identified as crucial data for economic development planning. For example, Georgia's Business Expansion Support Act (BEST) provides highly competitive tax incentives to increase jobs while expanding port traffic. According to Rodrigue, Comtois, and Slack (2009), at the macroeconomic level, transportation and the mobility it provides are linked to a level of output—employment and income—within the national economy. Employment-related data are therefore crucial to analyze the economic impacts of freight transportation policies.

3.2.2.8 Transportation and Land Use Planning Integration

The integration of Transportation and Land Use (TLU) is a critical consideration for freight planning and decisionmaking. The following papers and studies, among others, were analyzed to determine which cost data elements are needed for TLU planning integration:

- *NCHRP Report 497: Financing and Improving Land Access to U.S. Intermodal Cargo Hubs* (Shafran and Strauss-Wieder 2003)
- *NCHRP Synthesis 320: Integrating Freight Facilities and Operations with Community Goals* (Strauss-Wieder 2003)
- Road Pricing Simulations: Traffic, Land Use and Welfare Impacts for Austin, Texas (Gupta, Kalmanje, and Kockelman 2004)
- *Land Use Transport Interaction: State of the Art* (Wegener and Fürst 1999)

The research team concluded that route variable costs are crucial for TLU planning integration purposes. All of the studies listed above used route variable costs, while vehicle cost data and company cost data were identified as less important.

- **Route Variable Costs (Crucial):** Data on tour distance and tour time were identified as crucial for TLU planning. *NCHRP Synthesis 320* discussed the impacts of trucking on communities, including congestion on local roads, highways, and at customer facilities. The University of Texas study assessed different tolling scenarios, and used tour distance data to evaluate toll rates based on travel distance.

The Land Use Transport Interaction study used tour time to analyze technical, behavioral, and institutional issues of land use transport interaction at the urban-regional level. The University of Texas project also involved travel cost data, which could cover several route variable cost elements such as permits, tolls, and parking. In the survey conducted for NCFRP Project 26, a respondent from a large MPO identified the importance of toll data in integrated planning.

- **Vehicle Costs (Important):** According to *NCHRP Report 497,* improved access to intermodal cargo hubs will increase the use of higher capacity equipment, such as longer trucks. Higher capacity equipment allows carriers to streamline their service routes by focusing on a few hubs to reduce costs and to increase the efficiency of their operations. The cost-benefit analysis of longer trucks requires all types of vehicle costs, including truck purchase costs (fixed costs), average service life (average costs), and maintenance costs (variable and average costs).
- **Company Variable Costs (Important):** As *NCHRP Report 497* indicated, the development of cargo hubs is likely to lead to an increase in higher capacity trucks, which will affect some company variable costs. Costs that are affected mainly include number of trucks by type, and number of truck miles transported.

3.2.2.9 Environmental Planning

The following reports and studies are the most important of those analyzed to determine which cost data elements are needed for environmental planning:

- *NCFRP Report 4: Representing Freight in Air Quality and Greenhouse Gas Models* (Browning et al. 2010)
- *NCHRP Report 388: A Guidebook for Forecasting Freight Transportation Demand* (Cambridge Systematics, Inc. 1997)
- Incentive Funding Opportunities for On-Road Diesel Vehicles (Air Resources Board 2009)
- A Multi-Track Future: An Analysis of the Social and Environmental Aspects of Railways and Public Transport (Ries 2007)

Both vehicle costs and route costs are crucial for environmental planning, while fuel consumption and operational speed data are important. Company costs are not identified as important to environmental planning.

- **Vehicle Variable Costs (Crucial):** Data on vehicle fuel consumption were widely used in environmental studies, and according to *NCFRP Report 4,* these data are required to determine the greenhouse gas emissions of the transportation sector. According to *NCHRP Report 388,* motor carriers are most affected by emissions controls and clean fuel requirements. The California Air Resource Board requires fuel consumption data from applicants for grants and loans to reduce the cost of replacing older trucks with more energy-efficient ones. In a social and environmental analysis, Ries assessed environmental risks in transportation investment based on vehicle data, including fuel consumption.
- **Vehicle Fixed Costs (Very Important):** *NCFRP Report 4* discusses methods of estimating greenhouse gas emissions for different types of trucks. Truck type is directly associated with truck purchase costs. In addition, the California Air Resource Board requires grant or loan applicants to provide information on purchase cost and estimated salvage value.
- **Vehicle Average Costs (Very Important):** In addition to vehicle fixed costs, truck type is also directly associated with vehicle average costs, such as average service life and maintenance costs.
- **Route Average Costs (Crucial):** As *NCFRP Report 4* indicates, data on truck operational speed are required to analyze truck greenhouse gas emissions.
- **Company Costs (Not Generally Used):** Although environmental planning may affect some company fixed costs, such as land/building costs, the majority of company costs will not be affected. Because these cost elements are not discussed in the literature reviewed, they were not identified as important for environmental planning purposes. For example, some environmental programs are now mandating that certain older trucks be banned from use at ports. Such policies can raise costs for individual companies, and are recognized as having that effect with programs offered to reduce the cost of acquiring newer trucks or retrofitting older equipment.

3.2.2.10 Regulation and Enforcement

To understand the data needs of the regulation and enforcement function, the research team analyzed freight transportation–related policies and regulations enforced by different levels of transportation authorities, as well as research papers that discussed regulation issues. Selected source materials are:

- Federal Motor Carrier Safety Regulations: Truck Driver Regulations (Federal Motor Carrier Safety Administration, U.S.DOT), website at: http://www.fmcsa.dot.gov/rules-regulations/truck/driver/truck-driver.htm
- Federal Motor Carrier Safety Regulations: Hours-of-Service Regulations. (Federal Motor Carrier Safety Administration), website at: http://www.fmcsa.dot.gov/rules-regulations/topics/hos/index.htm

- Commercial Vehicle Size and Weight Program. (FHWA), website at: http://ops.fhwa.dot.gov/freight/sw/overview/index.htm
- Road Pricing Simulations: Traffic, Land Use and Welfare Impacts for Austin, Texas (Gupta, Kalmanje, and Kockelman 2004)
- Positive Train Control Overview. (FRA), website at: http://www.fra.dot.gov/rrs/pages/fp_1265.shtml

From this analysis, the research team concluded that route costs are crucial for regulation and enforcement. They are required by the federal government and frequently used in policy analysis. Vehicle costs are important because they might be used to support the development of certain regulations. Based on the information reviewed, truck purchase and company costs are not generally used for this function.

- **Route Variable Costs (Crucial):** In the University of Texas study by Gupta et al. (2004), tolling information was used to analyze traffic, land use, and welfare impacts of road pricing in the Austin, Texas region. Title 49 "Transportation" in the Code of Federal Regulations also mentioned expenses data, such as permits, tolls, and parking costs.
- **Route Average Costs (Crucial):** The Federal Motor Carrier Safety Administration, an agency within the U.S.DOT, is responsible for setting and enforcing Hours-of-Service regulations that limit how long commercial motor vehicle drivers may drive. Such regulations involve such route average cost elements as number of days of operation, or operating hours per day. In the Positive Train Control Overview, FRA mentioned over-speed derailments, which require operational speed data.
- **Vehicle Fixed Costs (Not Generally Used):** Truck purchase costs are not collected or tabulated by the FHWA as part of the Commercial Vehicle Size and Weight Program.
- **Vehicle Variable Costs (Crucial):** Regulations on commercial vehicle weight and size affect many vehicle variable cost elements, including truck maintenance costs and fuel consumption. The analysis of Hours-of-Service regulations of the Federal Motor Carrier Safety Administration requires use of such vehicle variable data as truck driver wages and benefits. Analysis of the Hours-of-Service rules also involves vehicle fixed cost data such as training costs of truck drivers.
- **Vehicle Average Costs (Very Important):** Vehicle average cost elements, such as the average service life of power unit and trailer, are directly affected by regulations on truck size and weight.
- **Company Costs (Not Generally Used):** Given that company cost elements were rarely discussed in relevant documents, these are not likely to be required for the regulation and enforcement function. However, as noted previously, specific analyses may consider the impacts of a particular action on company costs.

3.2.2.11 Financial Planning

Financial planning covers policies and programs related to grants, loans, subsidies, and taxes, as well as such finance mechanisms as public-private partnerships. To determine the cost data elements needed for these activities, the research team analyzed information from a number of sources, including:

- *NCHRP Report 497: Financing and Improving Land Access to U.S. Intermodal Cargo Hubs* (Shafran and Strauss-Wieder 2003).
- Planning and Programming: State Transportation Improvement Program (Minnesota Department of Transportation), website at: http://www.dot.state.mn.us/planning/program/stipfunding.html
- The Future of Highway Funding (Utah State Legislature 2002)

The research team concluded that vehicle and route costs are generally very important for financial planning, whereas company costs are not.

- **Vehicle Variable Costs (Very Important):** Financial planning requires vehicle variable costs to analyze funding sources, and vehicle variable cost elements such as unit cost of fuel ($/gallon) and fuel consumption (gallons) for analyses. For example, the Utah legislature identified three sources to fund highway programs: (1) periodically increasing fuel tax rates; (2) creating an automatic rate adjustment (indexing) on fuel taxes; and (3) imposing a sales tax on the sale of fuel.
- **Vehicle Fixed Costs (Important):** Data on purchase costs are needed for cost-benefit analyses, such as in *NCHRP 497,* which identified that equipment with higher capacity (e.g., longer trucks) can reduce the number of hubs needed, which can then reduce costs and increase the efficiency of hubs.
- **Route Variable Costs (Very Important):** According to *NCHRP 497,* cargo hub access projects are currently supported mainly by available highway user taxes, and/or through the contributions of private, port, airport, or economic development programs. NCHRP used route variable data such as highway user taxes or tolls to reach its conclusions.
- **Company Costs (Not Generally Used):** Company costs were not discussed in relevant studies. However, as noted previously, while generally deemed not important, company costs may be considered in relation to a specific analysis.

3.2.2.12 Intermodal Corridor Planning

The primary source materials used to determine the cost data elements needed for intermodal corridor planning were:

- U.S. Intermodal Corridors (Huffman 2010)
- I-10 National Freight Corridor Study (Phase II Report) (Wilbur Smith Associates 2005)
- I-87 Multimodal Corridor Study (New York State DOT)

The conclusion from this is that route costs are important in intermodal corridor planning, to assess corridor capacity. Vehicle costs and company costs were not identified as important.

- **Route Variable Costs (Very Important):** The I-10 Corridor study used travel time and travel distance to measure scheduled and nonscheduled delays, while the I-87 Corridor study used data on the travel distance of truck and rail to estimate the capacity of existing intermodal facilities in the corridor. At the 2010 International Delegate Conference, Bob Huffman used the Heartland Corridor Double Stack Clearance Project to illustrate the benefits of such intermodal corridor projects. Congestion information, such as tour time and tour distance, is critical for the planning of such projects.
- **Route Average Costs (Important):** Average cost elements such as operational speed are often used in studies that evaluate rail-truck facilities.
- **Vehicle and Company Costs (Not Generally Used):** Neither vehicle costs nor company costs were discussed in these studies as corridor planning activities are unlikely to significantly affect equipment, labor, or overhead costs. However, as noted previously, specific analyses may consider the impacts of an action on company costs.

3.2.2.13 Terminal and Border Access Planning

The research team analyzed numerous studies and regulations in this field, many of which were established after September 2001, to determine the cost data elements needed for terminal and border planning. Typical source materials included:

- Integration and Consolidation of Border Freight Transportation Data for Planning Applications and Characterization of NAFTA [North American Free Trade Agreement] Truck Loads for Aiding in Transportation Infrastructure Management (FHWA 2008)
- NTSB website at: http://www.ntsb.gov
- Truck Terminal and Warehouse Survey Results (New York Metropolitan Transportation Council 1996), website at: http://ntl.bts.gov/lib/5000/5900/5939/789.pdf

The research team concluded that route variable costs are crucial in terminal and border planning, since they are used at both local and federal levels. Vehicle fixed costs were less frequently mentioned in the studies reviewed, but were deemed important, whereas company costs were not mentioned in terminal and border access planning activities.

- **Route Variable Costs (Crucial):** The FHWA report described the truck pilot program in 2007, which gave 100 Mexican and 100 U.S. trucks permission to operate beyond the commercial zones into the interior of Mexico and the United States. Route variable costs data, such as tour time and tour distance, were required for this program.
- **Vehicle Fixed Costs (Important):** Vehicle fixed costs were required for certain border planning programs. For example, truck traffic in Texas increased dramatically after the implementation of NAFTA, and the Texas DOT has identified the need for accurate information on truck characteristics for border planning. Such information might include truck purchase cost data.
- **Company Costs (Not Generally Used):** An increase in terminal and border access planning activities may require companies to complete more paperwork, thereby increasing their overhead costs. However, the research team estimated the impact of such an increase to be insignificant. As noted with other cost elements, however, specific analyses may consider the impacts of an action on company costs.

3.2.2.14 Security Planning

Many security considerations are related to hazardous material transportation. To determine the cost data elements needed for security planning, the research team analyzed a variety of regulations and reports, including:

- Assessment of Highway Mode Security: Corporate Security Review Results (TSA 2006)
- Highway Security-Sensitive Materials (HSSM) Security Action Items (SAIs) (TSA), website at: http://www.tsa.gov/highway-security-sensitive-materials-hssm-security-action-items-sais
- NTSB website at: http://www.ntsb.gov

Vehicle and route costs data, it was determined, are crucial and widely used for security planning, and company costs were identified as very important.

- **Vehicle Average Costs (Crucial):** Costs for monitoring devices and communication systems like vehicle tracking expenses and cell phones are crucial for security planning. According to the Assessment of Highway Mode Security, many states have implemented strong communication systems to help them respond effectively to incidents.
- **Route Variable Costs (Crucial):** Route variable costs are used to support en-route security management. TSA lists en-route security as a major category of security action

items, which refers to the actual movement and handling of motor vehicles containing highway security–sensitive materials. Therefore, en-route security planning is likely to involve data elements like cargo loading time at base, time to complete each stop, number of stops per trip, tour time, and tour distance.
- **Company Average Costs (Very Important):** Company average costs are required for highway security analysis. For example, the Assessment of Highway Mode Security discussed the overall conditions of the motor carrier freight industry, with company data including the number of trucks, number of hazmat trucks, and the number of workers. Company cost elements such as "number of trucks by type" and "number of administration staff" are therefore very important for highway security assessment. Additionally, security hardware costs play an important role in security planning.

3.2.2.15 Hazardous Materials Planning

To determine the cost data elements needed for hazardous materials planning, the research team analyzed hazardous material–related regulations and studies conducted by transportation authorities. Some typical references are:

- Freight Facts and Figures (FHWA 2007)
- Pipeline and Hazardous Materials Safety Administration (U.S.DOT), website at: http://www.phmsa.dot.gov/hazmat/training/requirements
- Trucks Transporting Hazardous Materials (Department of California Highway Patrol), website at: http://www.chp.ca.gov/publications/pdf/chp800c.pdf
- Comparative Risks of Hazardous Materials and Non-Hazardous Materials Truck Shipment Accidents/Incidents: Final Report (Battelle 2001)

Through this analysis, the research team concluded that data on vehicle costs are crucial for hazardous materials planning. Such data were discussed in each regulation or research program listed above. Route costs were identified as very important, and company costs are not generally required for this function.

- **Vehicle Fixed Costs (Crucial):** The federal hazardous materials transportation law requires training for all employees working with hazardous materials. Planning these training programs requires information on training-related costs. Battelle conducted a study to assist the U.S.DOT in reducing the rate and severity of accidents in hazardous materials transportation, and the study involved cleanup costs and property damage. Vehicle fixed costs, such as the purchase cost or specialized equipment cost, are required to estimate damages in dollar terms. In addition, certain regulation limitations are based on the amount of hazardous material transported, and the size of the truck. Truck size also directly impacts purchase costs.
- **Vehicle Variable and Average Costs (Very Important):** In addition to vehicle fixed costs, information on other costs such as maintenance, insurance, license, and permits is also necessary for the U.S.DOT to determine the dollar loss due to hazardous materials transportation accidents. Truck size, which is required for hazardous material planning, is also associated with variable and average costs, such as service life and maintenance costs.
- **Route Variable Costs (Very Important):** Route variable costs are often used to develop hazardous materials transportation-related measures. The FHWA report provided a summary of hazardous materials shipments by transportation mode. Measures such as ton-miles and average miles per shipment required data on vehicle travel distance.
- **Company Costs (Not Generally Used):** An increase in hazardous materials planning activities is likely to result in higher company costs. For example, regulations may require companies to provide more training for administration staff, which would increase the companies' overhead costs. However, as noted previously, specific analyses may consider the impacts of an action on company costs.

3.2.2.16 Roadway Pavement and Bridge Maintenance Planning

To understand the data needs of the roadway pavement and bridge maintenance function, the research team analyzed a variety of studies and reports, including:

- *NCHRP Synthesis 319: Bridge Deck Joint Performance* (Russell and Rhys 2003)
- Life-Cycle Cost Analysis in Pavement Design (FHWA 1998)
- Comprehensive Truck Size and Weight Study (FHWA), website at: http://www.fhwa.dot.gov/policy/otps/truck/finalreport.htm

Route costs are crucial for roadway pavement and bridge maintenance planning, while vehicle and company costs are not generally required.

- **Route Average Costs (Crucial):** Data on operating hours and travel speed were identified as crucial, since they reflect the amount of truck traffic. NCHRP 319 evaluated the performance of joint seals, which are considered one of the most serious issues in the operation of bridges. The report suggested that sliding plate joints are particularly unsatisfactory on highways with a significant amount of truck traffic, so data on operating time are required for

bridge maintenance planning. The Life-Cycle Cost Analysis in Pavement Design identified the need for user delay costs, which in turn necessitates data on route average costs such as travel speed.

- **Route Variable Costs (Very Important):** Route variable costs, such as tour time and tour distance, were identified as very important. For instance, the Life-Cycle Cost Analysis in Pavement Design discussed the assessment of user delay costs, which requires route variable cost data like tour time.
- **Vehicle and Company Costs (Not Generally Used):** Roadway pavement and bridge maintenance planning activities are mainly focused on transportation infrastructures, rather than vehicles, equipment, or company management. As a result, vehicle and company costs are not generally involved in such planning activities.

3.2.2.17 Interregional Connectivity

Among the important sources analyzed to determine the cost data elements needed for interregional connectivity planning were:

- Interregional Transportation: Sacramento Region MTP 2035 Metropolitan Transportation Plan. (Sacramento Area Council of Governments 2006)
- Action Strategy Paper: Inter-Regional Transportation Planning (prepared for the Chicago Metropolitan Agency for Planning by the Research and Innovative Technology Administration, U.S. Department of Transportation) (Rasmussen, Peirce, and Lyons 2009)
- Inter-Regional Report: Making Connections Across Regional Borders (Wilmington Area Planning Council 2008)

Route costs are crucial for interregional connectivity planning, vehicle costs are less important, and company costs are not generally required.

- **Route Variable Costs (Crucial):** Studies show that congestion is a critical consideration in interregional connectivity planning, and congestion data, such as tour distance and tour time, are essential. The Sacramento study analyzed the capacity of the region's interregional connections for passenger and goods movement and found that several interstate highways experience severe congestions during morning and afternoon commute times. In this study's survey, a member from a Transportation Planning Authority identified cost of delay as a major freight transportation data need for the agency, used to better analyze interregional connectivity.
- **Route Average Costs (Very Important):** In the Sacramento Region study, congestion information, including vehicle travel speed, was used to analyze the capacity of interregional connections. In addition, the Wilmington interregional transportation study used travel speed data as an input to evaluate projected demographic and travel behaviors from 2000 to 2030.
- **Vehicle Variable Costs (Important):** Data on fuel consumption and cost are used by the Chicago Metropolitan Agency for Planning to analyze the impact of fuel prices on interregional travel patterns.
- **Company Costs (Not Generally Used):** Interregional connectivity-related programs are largely intended to facilitate efficient freight traffic, address community livability, and assist land use decisionmaking. Although certain programs may have minor impact on land costs, most overhead costs will not be affected, so company cost data are not generally required for interregional connectivity development purposes.

3.2.2.18 Sustainable Transportation Investment

To determine the cost data elements needed for sustainable investment planning, the research team analyzed a variety of studies and reports, including:

- Toll Roads in the United States: History and Current Policy (FHWA), website at: http://www.fhwa.dot.gov/policyinformation/tollpage/documents/history.pdf
- Transportation Infrastructure and Sustainable Development: New Planning Approaches for Urban Growth (Boarnet 2008)
- Transportation 2040: Toward a Sustainable Transportation System (Puget Sound Regional Council 2010), website at: http://www.psrc.org/transportation/t2040/
- Job Types Related To Sustainable Transportation (Global Development Research Center [GDRC]), website at: http://www.gdrc.org/uem/sustran/job-types.html

The research team concluded that route costs and vehicle costs are both crucial for sustainable transportation investment. Company fixed costs are important as well, but sustainable transportation investment activities have a limited impact on these cost elements.

- **Route Variable Costs (Crucial):** Tolling information is required for cost-benefit and other analyses of toll roads, so these data elements are crucial in sustainable transportation investment. To assess the effectiveness of toll roads as a funding strategy, Boarnet examined the effect of the initial segments of the toll road network in Orange County, California, on urban growth patterns. Congestion data, such as travel time, were used in this study as well. The FHWA's report provides a detailed discussion of historical

and current policies on toll roads in the U.S., indicating the importance of toll data in long-term transportation planning.

- **Vehicle Variable Costs (Crucial):** Fuel consumption and fuel tax are crucial cost elements for sustainable transportation investment: Boarnet discussed the negative environmental impact of congestion in his paper on sustainable transportation development, and the Puget Sound Regional Council concluded from their research that fuel tax has been one of the principal transportation tax bases.
- **Company Fixed Costs (Important):** Researchers at the GDRC identified a variety of job types related to transportation in the areas of technology, services, maintenance, training, and production/manufacturing. To analyze the impact of transportation investment on the labor market requires company fixed cost data such as number of employees, wages, and benefits.

3.2.3 Cost Data Matrix

Based on the analysis of cost data needs by function, the research team determined the relative importance of freight cost data elements for each public-sector function. Costs were defined as follows:

- **Fixed Cost:** The summation of all fixed cost elements required to produce a set output.
- **Average Cost:** The total cost divided by the total output.
- **Variable Cost:** The costs that depend on the unit of output produced.

Table 3.5. Freight cost data needs.

Functions	Company			Vehicle			Route	
	Fixed Cost	Variable Cost	Average Cost	Fixed Cost	Variable Cost	Average Cost	Variable Cost	Average Cost
Congestion Management				○			●	○
Operation/Services							●	○
Safety Planning and Analysis				○			○	●
Freight Mobility Planning				○	●		◐	○
Emergency Preparedness Planning						●	○	
Transportation Equity Planning					●		○	
Economic Development Planning	●				●		●	●
Transportation and Land Use Planning Integration		○		○	○	○	●	
Environmental Planning				◐	●	◐		●
Regulation and Enforcement					●	◐	●	●
Financial Planning				○	◐		◐	
Intermodal Corridor Planning							◐	○
Terminal and Border Access Planning				○			●	
Security Planning			◐			●	●	
Hazardous Materials Planning				●	◐	◐	◐	
Roadway Pavement and Bridge Maintenance Planning							◐	●
Interregional Connectivity					○		●	◐
Sustainable Transportation Investment	○				●		●	

● = Crucial
◐ = Very Important
○ = Important

The results of the analysis are presented in Table 3.5. Each data element received a ranking of "crucial," "very important," "important," or "not generally used." Route variable cost data are the elements most needed and used for freight planning and decision-making functions. Within the category of variable cost data, the items most frequently used are tour time and tour distance. Route average cost data are also widely used to support government freight planning and decision-making functions, and most used within this category are operational speed and operating time (hours/days).

In contrast, company cost data are much less frequently used or required. Among all the freight planning and decision-making functions, only four identified some company cost elements as important. (Because vehicle costs are listed as an independent category of freight costs, company costs in this study mainly involve overhead-related inputs.) These inputs, such as land/building, utilities, maintenance, and administrative staff, are rarely affected by freight transportation planning activities. Possibly the use of company costs is limited due to data privacy issues, and these costs may be more widely used when new data-sharing tools are developed and accepted by the private sector.

This analysis of freight cost data needs also clarifies how interdependent some freight planning and decision-making functions are. For example, congestion is an important consideration in corridor planning activities, while such corridor planning strategies can be applied to improve congestion management. The hazardous materials planning function and the security planning function also have overlapping effects.

The analysis shows that regulation and enforcement and economic development require the broadest scope of freight cost data. These functions cover a wide range of activities that affect route costs, vehicle costs, and company costs.

CHAPTER 4

Public-Sector Future Cost Data Needs

The freight industry is dynamic in its use of equipment, its relationships with other freight transportation providers and customers, and its operating philosophies. The industry experiences major shifts in response to external and internal factors, such as economic conditions, government regulations, and changes in supply chains, locations, and production. The freight industry also must respond rapidly to unanticipated events, which requires a dynamism that can be challenging for public-sector agencies. As the nature of each new change becomes known, public-sector goals and functions must adjust accordingly. This chapter identifies evolving public-sector freight transportation planning and decision-making functions, and the cost data that might be used to support those functions as they evolve.

This chapter is divided into two sections. Section 4.1 identifies possible future scenarios that may affect current freight transportation functions or require the creation of new public-sector freight transportation functions. Section 4.2 identifies the cost data needed to support those changed or new public-sector freight transportation functions.

4.1 Potential Policy Scenarios

4.1.1 Methodology

A four-step methodology was used to identify evolving public-sector freight transportation planning functions:

Step 1: A broad search was conducted of documents that examine emerging trends or programs that affect freight transportation, with an emphasis on anticipated changes involving goods movement. The literature review included an exhaustive search of U.S.DOT publications and a thorough search of documents produced by TRB and the National Cooperative Research Programs. The team also utilized web searches to identify journals, periodicals, and news articles relevant to the project. The bibliographies of these documents were also reviewed to identify additional sources. Section 4.1.2 summarizes the sources used and provides a brief synopsis of the relevance of each source.

Step 2: The research team scanned each document, searching for emerging trends and changes to the industry. A second, more analytical reading was then completed to ensure that no overriding themes or implicit trends were missed.

Step 3: With several specific scenarios identified from each article, a composite list was compiled and the major implications were identified. Scenarios from individual sources were compared to scenarios described by other sources, and those mentioned repeatedly were selected to represent the topics most discussed by freight transportation experts and industry leaders. These topics include:

- Increased standards (federal and/or state)
- Technological innovations
- Increased renewable energy use
- Increased congestion pricing
- Increased intermodal development
- Freight industry consolidation
- Accelerated shipping times
- Increased/enhanced security measures
- Multi-stakeholder decisionmaking

Step 4: The selected scenarios were examined to see how they might affect public-sector freight-related functions and to determine the freight cost information potentially required. The list of functions provided in Section 3.1.4 was used. These functions cover all levels of the public sector. If a scenario had an effect on the activities required by a function, then the scenario was linked to that function. Examples of effects include adding activities, ending activities, and changing information requirements.

4.1.2 Literature Review

This section provides an overview of the key publications selected for their descriptions of evolving trends in freight transportation. *NCFRP Report 5: North American Marine Highways* provides extensive detail about the development

of a marine highway system in the United States (Kruse and Hutson 2010). The report covers topics ranging from capital costs to standardization of vessel size, and notes several steps that legislative, public-sector, and private-sector stakeholders could take to make a marine highway system easier to operate and more beneficial to the U.S. freight industry. The development of this system is also a large part of several multimodal freight transportation models.

Transportation's Role in Reducing US Greenhouse Gas Emissions presents current data on the levels of greenhouse gas emissions in the United States and projects future growth of emissions if no changes are made to U.S. policies (U.S.DOT 2010). The report suggests several courses of action to reduce emissions throughout the transportation industry, including within the freight transit sector. Congestion pricing, higher fuel taxes, carbon cap-and-trade programs, and investment in clean energy generation are all recommended to reduce greenhouse gas emissions.

Potential technological solutions are presented in the ITS Strategic Research Plan, 2010–2014, as well as a step-by-step plan regarding implementation of any and all new technologies related to the transportation sector (U.S.DOT 2009). The report provides broad overviews of initiatives that will affect commercial and private transportation in the coming years, the expected start dates of these technologies (if ready), and the research and testing schedules for still-developing technologies. The report can be regarded as a blueprint for public-sector technological changes for the freight transportation sector.

Estimated Cost of Freight Involved in Highway Bottlenecks attempts to value the freight industry's time and money lost to bottlenecks on U.S. highways (Cambridge Systematics 2008). The report's findings serve as support for the potential use of congestion pricing throughout the United States.

The *Status of the Nation's Highways, Bridges, and Transit* provides a comprehensive look at the current (2008) state of transportation in the United States (U.S.DOT 2008). This report provides the level of use, rate of deterioration, and future needs of the nation's transportation infrastructure. Several of the report's key points relate to how different levels of funding can correct or combat different transportation issues effectively. Potential short- and long-term solutions are presented regarding congestion, deterioration, new methods of transportation, and funding opportunities.

The Supply Chain Security report prepared for the U.S. Government Accountability Office (GAO) discusses the current ability of DHS to effectively scan all containers entering the United States (Caldwell 2010). It also presents a cost-benefit analysis framework for creating a better system to scan more containers in a more time- and cost-efficient manner. This technology supports additional security measures that the U.S. government may enforce/implement, and would reduce freight transportation transit times and facilitate faster freight disbursement to inland markets.

Freight Transportation: National Policy and Strategies Can Improve Freight Mobility offers a series of recommendations to the federal government on strategies that could increase the effectiveness of freight transportation polices throughout the United States (U.S. GAO 2008). A focus on intergovernmental cooperation is stressed, and GAO highly recommends engaging all stakeholders, including industry representatives, in the decision-making process.

GAO tackles the immense issue of financing and planning for freight transportation upgrades in Freight Transportation: Strategies Needed (U.S. GAO 2003). Key issues discussed are increased regulations and security measures that make freight transportation more expensive, and the lack of creative ways for local, regional, and state transportation departments to secure federal money for projects. Also noted is a lack of freight industry involvement in the planning process around transportation changes because there is an assumption that the changes will address solely passenger, not freight transportation issues.

EPA's SmartWay program, started in 2004, promotes environmentally friendly products and services in the transportation industry (EPA 2010). SmartWay Transport is a joint initiative of EPA and the freight sector to improve the fuel efficiency and performance metrics of the shipping industry. Participating companies are listed on the EPA website. The initiative includes the DrayFLEET emissions and activity model, which depicts drayage activity in terms of vehicle-miles traveled (VMT), emissions, cost, and throughput, and reliably reflects the impact of changing management practices, terminal operations, and cargo volume. EPA's program is another example of increased cooperation between industry and governments, and it is a change agent in the drive for increased fuel economy and emissions standards.

A report prepared by Informa Economics, Inc., on behalf of the Soy Transportation Coalition in 2009 discusses the potential positive and negative economic outcomes of allowing higher weight limits on the U.S. Highway System (Informa Economics 2009). Results from the study indicate that the potential efficiency gains and resulting savings may outweigh costs and risks, though the increase will likely necessitate renovation or rebuilding of some bridges and support structures.

TRB published *Special Report 267: Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles* in 2002 (National Research Council 2002). The report analyzes the costs and benefits associated with changing the specific regulations governing commercial trucks. The report findings state that significant efficiencies can be realized in commercial transportation, but only if changes are enacted in a manner that is coordinated with safety regulations and the general network management of U.S. highways. The report supports

either increased or changed standards governing freight transportation, as well as the idea that these standards need to be developed with a multi-stakeholder frame of reference.

The Texas Transportation Institute (TTI) report on modal comparisons of domestic freight transportation presents facts and figures supporting the development and revitalization of U.S. inland waterway systems (Kruse 2007). Central to this argument are the potential emission and congestion reductions that could be realized with an increase in waterway and a decrease in truck transportation of goods.

The article, "Wave of Consolidation Continues through Industry," describes the stress that has been placed on smaller, niche market trucking companies (Bearth 2004). As large national and international shipping companies continue to encroach on all markets, the less-than-truckload sector is expected to contract. In a conference in 2006, FedEx pointed out that freight consolidation could save 15% in transportation costs, and "there is a growing trend toward retailer-controlled freight and leveraging freight consolidation both domestically and internationally to drive down per unit transportation costs" (FedEx 2010). While these articles were written several years ago, the trends discussed are still relevant to forecasting potential future scenarios.

Goodwill lists what he and his associates consider the trends that will affect freight transportation in "Some Trends that Will Drive Freight Transportation in 2011" (Dan Goodwill & Associates 2010). Of particular note are (1) the expectations of retailers and other businesses to continue to reduce their promoted delivery times; (2) the increased likelihood of free trade agreements being forged; and (3) the increased development and use of intermodal shipping centers. It is important to note that this decrease in delivery time, combined with the overall continued increase in demand for shipped goods, is likely to continue to stress the already over-taxed freight truck drivers. A shortage of drivers could potentially slow freight movements from region to region, with the potential result of (at least temporary) higher wages for drivers until the demand can be met.

The report and presentation by Leonard describes the Gateway Cities Fleet Modernization Program that was in place from 2002 to 2008 in California (Leonard 2009). Funded by several state-level agencies and the ports of Los Angeles and Long Beach, the program provided grant money for trucking companies to upgrade their fleets with newer power units. More fuel-efficient trucks were purchased, and carriers committed to their upkeep and the promotion of the program for 5 years following their grant award. This program represents a strategy that local, state, and potentially federal organizations can employ in response to increased fuel economy and emissions standards. It also serves as a blueprint for increased participation through all levels of government and the private sector.

"Breathing Easier, Nationally" provides an independent critique of the Gateway Cities Program in California and a greater contextual understanding of the ways the program succeeded and where it could have gone further (Mongelluzzo 2011a). Mongelluzzo's article about the Port of Oakland receiving a grant from the Bay Area Air Quality Management District reflects an industry trend toward reducing the environmental effects of ports (Mongelluzzo 2011b). The grant is to help fund installation of a port-side electric grid for freight vessels to connect to. Vessels can turn off their diesel engines once connected, thus reducing pollution and emissions at the port. This project complements California's Air Resources Board regulations, which state that, by 2014, 50% of a fleet's vessels must operate on shore-side electric power.

NCHRP and AASHTO are working together to provide a series of papers that will address the major issues facing the transportation industry in the United States (NCHRP 2009). A series of seven reports are being crafted, each analyzing a different aspect of transportation (TRB 2010).

4.1.3 Scenarios Identified from the Literature Review

Table 4.1 summarizes the future freight scenarios that emerged from the literature review. A check mark indicates that a particular scenario was identified from the corresponding source document listed to the left.

All of the scenarios identified in Table 4.1 will be realized only if certain actions occur. Table 4.2 provides context to the scenarios by detailing the macro-level catalysts with the potential to initiate each scenario. These are events or activities with the potential to change the freight industry, as indicated by the scenario to which they are correlated. For example, a U.S. military conflict (e.g., in the Middle East) could cause the United States to adopt higher fuel economy and emissions standards.

Having considered the potential forces driving the future scenarios, the remainder of this section considers their potential policy or business impacts. The discussion also details the effect each scenario could have on public agency functions and decisionmaking.

4.1.3.1 Changes to Fuel Economy and Emissions Standards

Fuel economy and emissions standards have been a popular topic of debate for several years. In general, arguments in support of increased fuel economy and emissions standards for transportation vehicles value the potential benefits to the environment and efforts to become more energy independent. NHTSA and EPA are issuing a joint proposal to establish a new nationwide program for passenger cars and light trucks to improve fuel economy and reduce greenhouse gas

Table 4.1. Emerging/future freight scenarios.

Research Sources	Increased Fuel Standards	Technological Innovations	Increased Renewable Energy Use	Increased Congestion Pricing	Increased Use of Intermodal Systems	Freight Industry Consolidation	Reductions in Shipping Times	Increased & Enhanced Security	Multi-Stakeholder Decision-Making
NCFRP Report 5: Marine Highways		✓			✓		✓		✓
US DOT: Reduce GHGs	✓		✓	✓					✓
US DOT: ITS Research Plan		✓	✓				✓	✓	
US DOT: Highway Bottlenecks		✓		✓	✓	✓			✓
US DOT: Status of Highways		✓		✓	✓				
US GAO: Supply Chain Security		✓						✓	
US GAO: Freight Mobility		✓			✓				✓
US GAO: Financing Limits		✓			✓			✓	✓
US EPA: SmartWay Brand	✓	✓	✓			✓			
Tx Trans: Modal Comparison		✓			✓				
Bearth, Dan: Industry Consolidation						✓			
Dan Goodwill & Assoc.: 2011 Trends					✓		✓		✓
TIAX: Lessons from Gateway Program	✓	✓	✓						✓
Mongelluzzo: Breathe Easier									✓
Mongelluzzo: Port of Oakland		✓	✓						

Table 4.2. Macro-level catalysts.

		Policy & Industry Scenarios								
		Increased Standards	Technological Innovations	Industry Consolidation	Increased Renewable Energy Use	Reduced Shipping Times	Congestion Pricing Utilized	Intermodal Transportation System Developed	Enhanced Security Measures	Multi-stakeholder Decision Making
Macro-Level Catalysts	Climate Change	✓	✓		✓					
	Volatile Oil Prices/Availability	✓	✓		✓					
	Deterioration of Transportation Infrastructure		✓				✓	✓		
	US Military Conflict or Terrorist Attack	✓	✓						✓	✓
	Economic Uncertainty & Public Funding Crisis			✓			✓			✓
	Shifts in US Political or Cultural Structures	✓			✓					✓
	Scientific Breakthroughs		✓	✓		✓				
	US Participation in International Environmental Agreement	✓	✓		✓			✓		✓

emissions over Model Year 2012–2016, the first-ever joint proposal by NHTSA and any other agency (NHTSA 2010).

If national policy significantly increases the minimum fuel economy and emissions standards in the United States, public agencies will be responsible for the policy's implementation and enforcement, and for analyzing its effectiveness. All functions are critical, but implementation and enforcement will involve adjusting a fuel standard, not creating one for the first time. The analysis of the effectiveness of this policy would most affect data needs. For example, the environmental planning function would require data on the effects of these increased standards, and regulatory functions could also require new cost data related to changes in enforcement procedures or non-compliance penalties.

Another topic of debate within the industry is changes in regulations regarding weight and dimensions limits for trucks transporting freight across the United States. Several reports suggest that the economic benefits for increasing the allowable tonnage on U.S. roadways outweigh the potential safety and security risks, while other reports raise safety concerns with respect to the structural capacity of bridges. Organizations such as ASCE and AASHTO have conducted studies of U.S. infrastructure conditions. However, more up-to-date data and analysis might be needed by public-sector decisionmakers considering whether or not to increase the allowable weights.

4.1.3.2 Technological Innovations

The development of new or transformative technology is an ongoing future scenario, and one with the potential to drastically change how decisionmakers gather and analyze information. It is impossible to predict the new technologies that will emerge and significantly affect freight transportation. However, examples from the recent past illustrate how influential new technology can be. FHWA established a partnership with the American Transportation Research Institute (ATRI) to determine whether, and how, information from communications technologies could provide data to support freight performance measures (DeWitt 2005). The joint team has conducted research on the use of global positioning system (GPS) data to generate truck travel time/speed/reliability measures for North America.

A 2010 report on supply chain security provides another example, reviewing a more effective and efficient technological process to scan shipment containers before they enter U.S. ports (Caldwell 2010). The program

> has been successful in integrating outputs from the various types of scanning equipment used to scan cargo containers at foreign ports participating in the Secure Freight Initiative (SFI) program. CBP [Customs and Border Patrol] and DOE were able to integrate the outputs from RPM and NII equipment with the Automated Targeting System (ATS) so a CBP officer can review all the data and information associated with a container on a single screen. These officers could observe the scanning equipment outputs in combination with information from ATS to make determinations as to whether to request that the cargo container being scanned be more closely examined by host government personnel (Caldwell 2010).

The new scanning technology was able to provide faster, more accurate data, which allowed employees to process freight shipments more efficiently.

4.1.3.3 Increased Renewable Energy Usage

Considerable attention has been given to increasing the use of renewable energy products in the United States. Solar power, wind-generated power, and—to a lesser extent—hydroelectric and nuclear energy production have been cornerstones of political and business platforms for several years. Investment in these renewable power sources continues to grow, and the technology for utilizing these different power sources is becoming more affordable and widely available. For these reasons, it is plausible to foresee a future in which a major policy initiative is passed or enacted that stipulates widespread investment in or usage of these energy-generation tactics. Documentation of ongoing research has led to several governmental and educational reports calling for such policy action.

A U.S.DOT Center for Climate Change and Environmental Forecasting publication, *Transportation's Role in Reducing U.S. Greenhouse Gas Emissions,* states that environmental gains from renewable energy usage could be significant, provided that the research is validated and costs come down. The paper states that:

> if technical successes in fuel cell development and low-carbon hydrogen production, distribution, and onboard storage can be achieved, hydrogen fuel cell vehicles could reduce per vehicle GHG [greenhouse gas] emissions by 80% or more. Aggressive deployment could reduce total transportation emissions by 18 to 22 percent in 2050 (U.S.DOT 2010).

For public agency decisionmakers, one major concern is exactly where to invest time and money for renewable energy development and adaptation. The revenue source that would be lost if less diesel and gasoline are used is likely to be another concern now and in the future. In short, as technologies and methodologies advance, decisionmakers will need cost data to understand how to adapt existing infrastructure (i.e., fueling stations) to renewable fuel sources, and more generally, how to support the nation's ability to shift to these new energies.

4.1.3.4 Congestion Pricing

The widespread use of congestion pricing is a scenario that may develop in response to increasing delays on highways and

railways and at shipping ports. This strategy is also a potential revenue generator for local and state governments, with collections potentially funneled back (depending on state and federal laws) into infrastructure improvements.

U.S.DOT recognizes the potential of congestion pricing and has referenced it in several reports. For example, a 2010 report includes this statement: "Widespread congestion pricing, in which higher prices are charged for traveling in periods of high demand, would not only reduce VMT but also result in more efficient traffic operations" (U.S.DOT 2010). Another report states the following: "The trend toward tolling as an innovative finance technique has continued. Not only is there renewed emphasis on existing programs, such as the Congestion Pricing Pilot Program, but SAFETEA-LU also established several new innovative programs" (U.S.DOT 2008).

If utilized, congestion pricing would have local public policy and planning effects. From a city or regional planning perspective, congestion pricing could alter methods of forecasting and planning for infrastructure maintenance. For example, data like price elasticity might be required to better estimate the effects of price changes on traffic levels. On a state and national level, congestion pricing for one mode of transportation might affect utilization rates for other modes of transportation. This, in turn, could affect operational performance, delivery times, and freight mobility. Public agency decisionmakers would require a variety of cost data, on such topics as the value of time saved in delivery versus the cost of changing delivery patterns, or the anticipated costs (in time and money) that congestion pricing might incur on other modes of transportation, as well as additional operational costs (i.e., additional labor hours or new technological costs) that might be incurred.

4.1.3.5 Increased Use of Intermodal Systems

The integration of different modes of freight transportation is an attractive potential solution to the projected future congestion problems. In 2010, *NCFRP Report 5: North American Marine Highways* drew attention to the development of marine coastal highways that could connect the heavily populated coastal regions in the United States (Kruse and Hutson 2010). Goods from one area could be loaded and shipped to another, then offloaded and moved inland via truck or rail. The report states, "These marine highways could theoretically provide a low-cost and energy-efficient alternative for moving cargo, and would greatly expand the total transportation capacity of the United States" (Kruse and Hutson 2010). With increased use of intermodal systems, more research on highway bottlenecks at entrances to and exits from intermodal facilities may become necessary to understand and address the problem.

Any policy developed to enhance the use of intermodal systems for freight transportation will affect several freight transportation functions. For example, as planners work to ensure freight mobility throughout the United States, they will need to know potential delays or complications that could occur as freight is transferred from one mode to another, as well as highway bottlenecks at entrances to and exits from intermodal facilities. A comparison of congestion delays utilizing only one mode would then be weighed against transfer delays. Another function affected would be environmental planning, given that the development of stations and facilities to transfer goods may require changes to certain natural features like river channels and low-lying land.

4.1.3.6 Industry Consolidation

It seems counterintuitive to consider freight transportation experiencing an industry-wide consolidation, especially given the forecasted doubling of freight volume in the coming years. However, industry consolidation does not necessarily mean a reduction in capacity. The article by Bearth expands on this idea, stating that "[m]any carriers are in a [financial] position . . . which would enable them to take over weaker rivals and provide customers with additional freight-hauling capacity or services" (Bearth 2004). Although this statement was written in 2004, before the worldwide financial crisis, the U.S. economy has since returned to a growth stage, making this forecasted development relevant once again. Larger companies can potentially leverage their existing market power to acquire smaller, more regional freight transportation companies, resulting in fewer companies controlling a larger percentage of freight transportation throughout the United States.

These industry changes may not affect functions such as congestion management or roadway maintenance, but they could very well affect an agency decisionmaker's relationship with industry leaders, and his or her ability to form collaborative partnerships for city, regional, or larger area planning. It may also affect security planning because, as more freight flows through a smaller number of now-more-powerful companies, policies aimed at enhancing hiring standards or container searches could be thwarted by more influential lobbying efforts from these companies.

4.1.3.7 Accelerated Shipping Times as a Marketing Tool

As with industry consolidation, improved shipping times is another potential business and industry scenario that could impact the functions of freight transportation planning. Industry-wide competitive pricing, and faster and better technological services available to companies have fueled this trend in recent years. The article by Dan Goodwill & Associ-

ates links the trend to Internet sales. "Amazon.com launched Amazon Prime, its free shipping service which guarantees delivery of products within 2 days for an annual fee of $79. Wal-Mart Stores, Best Buy®, Target, and J.C. Penney® unveiled their free shipping programs for the holidays. A consortium of 20 retailers, including Barnes & Noble, Sports Authority and Toys "R" Us banded together to offer their own 'copycat' $79 2-day shipping programs" (Dan Goodwill & Associates 2010). As mentioned previously, these large companies may utilize programs such as those described in Goodwill's article as the catalyst for their own shipping divisions. *NCHRP Report 505: Review of Truck Characteristics as Factors in Roadway Design* identified growth in heavy truck traffic, largely due to economic factors such as just-in-time deliveries (Harwood 2003). The increased use of heavy trucks and the effort to increase truck dimensions will inevitably impose pressure on transportation infrastructure. Public agency decisionmakers may focus on business strategies such as Amazon's Prime program, for example, because such strategies could place more stress on freight transportation infrastructure.

4.1.3.8 Enhanced Security

Security issues involving the transportation of goods will always be a top priority for public agency decisionmakers. With more frequent and more sophisticated threats comes a desire for increased security across all modes of freight transportation. As described in the report, ITS Strategic Research Plan 2010–2014, significant effort will be placed on developing newer, faster, and more comprehensive technologies to keep freight transportation safe (U.S.DOT 2009). One example is a research program aimed at border crossing security:

> This system enables uniform and consistent application of policies and procedures related to safety and compliance assurance of cross-border commercial traffic. The data will be augmented to include verification of more than 20 additional screening factors and enable identification and full safety/compliance verification of carriers, trucks, trailers, and drivers electronically within 3 seconds or less of a truck's presentation at the processing point" (U.S.DOT 2009).

When developed, such a system will more accurately scan incoming freight vehicles at U.S. borders in a faster, more efficient manner, increasing security while maintaining freight mobility.

Public agency decisionmakers implementing security policies will affect almost all freight transportation functions because safety/security is a component of all goods transportation. Depending on how a new security policy is implemented, functions such as congestion management, terminal/border access, and hazardous materials planning could all be required to adapt.

4.1.3.9 Multi-Stakeholder Decisionmaking

Multi-stakeholder decisionmaking is not a policy that can be passed or enacted. Rather, this approach to planning attempts to recognize and place importance on the idea of cooperation and consensus building, between government agencies and between government and industry leaders. This topic was mentioned in some form in most of the research considered by the research team. For example, a GAO report states the following:

> Although stake-holders have taken steps to enhance freight mobility, public planners . . . face challenges when attempting to advance freight improvements. These challenges include competition for public funds from non-freight projects . . . [and] lack of coordination among various government entities and private-sector stakeholders. These challenges are exacerbated by the absence of a clear federal strategy for enhancing freight mobility (U.S. GAO 2008).

An earlier GAO report also found that industry involvement in planning processes provides for a much more complete policy that can satisfy both public and private desires, stating, "[a]ctive participation by the private sector in partnership with the public sector often helps to ensure a successful outcome. The private sector often can bring a more global view of freight needs to the planning process, can help identify and implement projects, and can provide new data for making more informed decisions" (U.S. GAO 2003).

FHWA also conducted a number of studies on stakeholder facilitation and engagement. A guidebook provided by the agency identified freight stakeholder groups at the federal, state, and regional levels, and outlined potential public- and private-sector challenges and issues related to these groups (FHWA 2009a).

These reports and studies appear to support multi-stakeholder participation across all functions of freight transportation policy. Each function could potentially be changed or influenced by other levels of government, or by private-sector industry. There is potential for such a process to provide better data for analysis, leading to better policies.

4.2 Looking Ahead: Cost Data for Assessing Future Freight Scenarios

The research team defined and presented several freight transportation public-sector functions and the cost data currently employed to perform them. A series of potential policy scenarios were identified as likely to significantly influence the activities of public agency functions and decisionmakers. The final step of this process was to link these potential policy scenarios with the likely cost data information requirements,

to provide insight into how cost data needs may change as freight transportation policy evolves.

4.2.1 Linking Scenarios and Cost Data

Table 4.3 summarizes the general findings on future scenarios, and the cost data needs anticipated to assess them. The first column provides the scenario; the second column identifies the level of government each scenario is likely to influence; and the third column identifies specific public-sector functions that are likely to be altered by each scenario. For example, increased fuel economy and emissions standards are likely to affect public decisions at all levels of government, and are most likely to influence decisions surrounding environmental, regulatory, and information planning. The far right column provides the general cost data needs likely to be needed when considering each scenario.

4.2.2 Analysis of Current Cost Data Importance

Freight cost data are often very difficult to obtain. Accordingly, it is useful to prioritize cost data needs to identify which will be most crucial to the analyses that must be undertaken. In Section 4.2.2, the needs associated with future freight scenarios analyses are compared to the cost data needed for current freight-related analyses.

Knowing that certain cost data may become more essential will enable public agencies to reconsider information collection priorities. With this in mind, the research team decided to keep cost data currently deemed crucial at the same level of importance. Cost data categorized as very important and important were then analyzed for their potential to increase in importance. In Table 4.4, cost data that was assessed as likely to increase in importance is identified with horizontal lines in the background of the cell. For example, route average costs for congestion management are currently considered to be very important. In the analysis of future scenarios, the research team moved its level of importance to crucial.

Newly identified or upgraded costs also were noted. For example, in Table 4.4 a dot is changed under the category vehicle fixed costs for the freight mobility planning function. In the table, cells with horizontal lines in the background denote upgraded data costs. Section 4.2.3 provides a summary of each changed or added cost element.

4.2.3 Descriptions of Potential Cost Data Changes by Function

Section 4.2.3 provides a detailed description for each change in the freight transportation cost data needs presented in Table 4.4.

Major changes in data needs were identified in nine public-sector functions related to freight transportation. The following subsections describe the changes in freight transportation cost data needs for the specific public-sector functions.

4.2.3.1 Congestion Management

- **Company Cost:** Several future scenarios (i.e., an increase in traffic due to a decrease in average delivery time, or the need to create additional funds to maintain infrastructure) could lead to the introduction of a congestion management pricing program. These programs could alter a freight transportation company's costs to the point that relocating the company's headquarters away from a route with a pricing program could be an effective cost reduction strategy. In Table 4.4, this potential movement is represented by the dots in the company fixed and company average cost categories.
- **Route Cost:** The research team increased the level of importance of route average costs within the congestion management function from important to crucial because congestion management pricing programs could alter important cost considerations, such as the number of days of operation per week and the hours that drivers operate. Congestion management will also affect the route variable cost category, given that it captures such costs as tour time and tolls. However, because this cost category was already deemed crucial, no change was made to the table.

4.2.3.2 Safety Planning and Analysis

- **Vehicle Cost:** The decision to upgrade the vehicle fixed cost category from important to very important is based on the potential mandatory increase in safety training that may be required of freight transportation companies due to increased security measures. These training classes and materials were previously captured within this category as an individual line item.
- **Route Cost:** Another potential result of an increased safety mandate could be a reduction in the allowable speed for freight transportation vehicles. This potential reduction could increase freight transport times. This, in turn, would increase the cost associated with each freight delivery, and these increased costs are reflected in the route variable cost category changing from important to very important.

4.2.3.3 Freight Mobility Planning

- **Vehicle Cost:** Additional training and education costs for drivers and crews are noted, along with the potential for an increase in specialized equipment costs. The training and education costs are based on the fact that freight mobility planning is projected to be influenced by the development

Table 4.3. Scenarios and functions.

Scenario	Level of Government Affected	Functions Affected	Generalized Cost-Data Needs
Changes to Fuel and Emissions Standards	* Federal * State * Local	* Environmental Planning * Regulation and Enforcement	* Value of fee/penalty for non-compliance * MPG standard by mode and relative costs
Technological Innovations	* Federal * State * Local	* Safety Planning and Analysis * Emergency Preparedness Planning * Security Planning * Transportation and Land Use Planning Integration * Environmental Planning * Financial Planning * Intermodal Corridor Planning * Sustainable Transportation Planning * Operational Performance * Collaborative Partnership in Planning Process	* Implementation costs * Educational costs * Costs associated with procedure change * Shelf-life of innovation
Increased Renewable Energy Usage	* Federal * State	* Environmental Planning * Regulations and Enforcement * Financial Planning	* Cost/Savings by mode * Aggregated cost/savings * Maintenance/service costs
Widespread Congestion Pricing	* Federal * State * Local	* Congestion Management * Freight Mobility Planning * Environmental Planning * Financial Planning * Intermodal Corridor Planning * Roadway/Bridge Maintenance Planning * Sustainable Transportation Planning * Operational Performance	* Value of time saved * Cost of changed delivery time * Operational costs (new hours, etc.) * Costs by mode * Costs to modes (i.e., delay in transfers)
Increased Use of Intermodal Systems	* Federal * State * Local	* Safety Planning and Analysis * Freight Mobility Planning * Emergency Preparedness Planning * Security Planning * Transportation and Land Use Planning Integration * Environmental Planning * Intermodal Corridor Planning * Terminal and Border Access Planning * Roadway/Bridge Maintenance Planning * Operational Performance * Collaborative Partnership in Planning Process	* Operational costs (between transfer modes) * Costs associated with delay
Industry Consolidation	* Federal * State * Local	* Economic Development Planning * Roadway/Bridge Maintenance Planning	* Labor costs/savings * Cost of loss of options
Improved Shipping Times	* Federal * State * Local	* Economic Development Planning * Interregional Connectivity	* Increase in costs of goods shipments * Industry response costs
Enhanced Security	* Federal * State * Local	* Congestion Management * Safety Planning and Analysis * Emergency Preparedness Planning * Security Planning * Regulation and Enforcement * Terminal and Border Access Planning * Hazardous Materials Planning	* Implementation costs * Procedural costs to time * Delay costs
Multi-Stakeholder Decisionmaking	* Federal * State * Local	* Safety Planning and Analysis * Freight Mobility Planning * Emergency Preparedness Planning * Security Planning * Transportation and Land Use Planning Integration * Regulation and Enforcement * Financial Planning * Intermodal Corridor Planning * Terminal and Border Access Planning * Hazardous Materials Planning * Sustainable Transportation Planning * Collaborative Partnership in Planning Process	* Capacity-building costs (education) * Employment costs * Cost of modified metrics * Cost of longer decision-making timeframe

Table 4.4. Anticipated future freight cost data needs.

Functions	Company			Vehicle			Route	
	Fixed Cost	Variable Cost	Average Cost	Fixed Cost	Variable Cost	Average Cost	Variable Cost	Average Cost
Congestion Management	○		○	○			●	●
Operation/Services							●	○
Safety Planning and Analysis				◐			◐	●
Freight Mobility Planning				◐	●		●	○
Emergency Preparedness Planning						●	○	
Transportation Equity Planning					●		○	
Economic Development Planning	●				●		●	●
Transportation and Land Use Planning Integration		○		○	○	○	●	
Environmental Planning	○	○	○	●	●	◐		●
Regulation and Enforcement				●	●	◐	●	○
Financial Planning	○		○	○	◐		◐	
Intermodal Corridor Planning				◐			●	○
Terminal and Border Access Planning				○			●	
Security Planning			◐			●	●	
Hazardous Materials Planning	○		○	●	◐	◐	●	
Roadway Pavement and Bridge Maintenance Planning							●	●
Interregional Connectivity					○		●	●
Sustainable Transportation Investment	○				●		●	

● = Crucial
◐ = Very Important
○ = Important

Vertical lines = New Critically
Horizontal lines = Increased Critically

of intermodal transportation systems and by the potential development of congestion management pricing programs. Individuals transporting freight within an intermodal system will be required to learn how to transition those goods from one mode to the next safely and efficiently. These training costs fall under the vehicle fixed cost category because they determine the wage that employees will earn. Specialized equipment costs also are captured in the vehicle fixed cost category because once any new equipment or technology is placed on the vehicle, the operation and maintenance of that equipment is likely to generate minimal costs. Thus, the bulk of the cost associated with equipment upgrades would be considered one-time and fixed. Staff turnover cost must also be considered.

- **Route Cost:** An important cost category that could become increasingly important to analyze when debating a potential intermodal transportation system is the time it would take to transfer goods from one mode to the next. An increase in time would result in an increase in costs for freight transportation companies. These costs are captured under the time components within the route variable cost category. The research team therefore increased this cost data figure from very important to crucial.

4.2.3.4 Environmental Planning

- **Company Cost:** Environmental planning is anticipated to be affected by several of the scenarios developed by the research team. The research team placed a new dot under the variable company cost category because the development of vehicles that run on renewable energy, such as ethanol or batteries, will add additional steps to the process of recording the number or vehicles by type. This cost is captured at the company overhead level. In addition to vehicles that run on new energy sources or at a higher emission rate, environmental planning can be affected by a congestion pricing

strategy. Potential company costs associated with this strategy are the relocation costs of freight companies moving away from corridors with congestion pricing.

- **Vehicle Cost:** The fixed costs associated with vehicles utilized to transport freight are anticipated to increase because of the potential of having to purchase new vehicles that comply with changes to fuel economy and engine emission standards. As with freight mobility planning, the development of intermodal transportation systems could also mean increased costs related to specialized equipment needed to transfer freight from one mode to the next. For these reasons, the research team increased this cost category from very important to crucial.

4.2.3.5 Financial Planning

- **Company Cost:** Public-sector financial planning could be affected by the development of a congestion pricing strategy as a means to increase revenue.

4.2.3.6 Intermodal Corridor Planning

- **Vehicle Cost:** An obvious impact on intermodal corridor planning would be the development of an intermodal transportation system, which could increase costs associated with the installation or upgrade to specialized or new equipment. As already mentioned, any additional training or education of staff members would also be captured by the vehicle fixed cost category.
- **Route Cost:** The time it takes to load goods from one mode onto the next is an important component of the route variable cost category. More time taken to transfer goods equates to additional costs for freight transportation companies, which was the basis of the decision to make this cost category crucial.

4.2.3.7 Hazardous Materials Planning

- **Company Cost:** A potential scenario that could affect hazardous materials planning and freight transportation companies would be increased security measures. These costs are allocated to a couple of different categories. Specialized handling or safety equipment falls under fixed and average company costs, and the cost of installing this equipment also falls within both cost sections. Furthermore, any additional insurance that freight transportation companies would be required to purchase (for their employees or for the hazardous freight itself) is a cost allocated to both fixed and average company costs. In Table 4.4, these new potential costs are represented by new dots located in these categories.
- **Route Cost:** Increased security measures would include a more comprehensive review of any freight deemed to be hazardous. The potential increase in the time it takes to scan, analyze, and/or inspect this type of freight can result in an increase in the time it takes for that material to be moved from one location to another. Therefore, the research team increased the importance of route variable cost from important to crucial when considering hazardous materials planning.

4.2.3.8 Roadway Pavement and Bridge Maintenance Planning

- **Route Cost:** Future roadway pavement and bridge maintenance planning decisions are likely to be influenced by decisions to incorporate intermodal transportation systems to existing infrastructure, as repairs and updates will be needed. As a result, the route time is likely to be affected for freight transportation companies in two ways: (1) the actual construction or renovation of the infrastructure can potentially cause delays in the delivery of freight, and (2) the transfer time of freight from one mode to another can potentially increase costs. Accordingly, the research team upgraded the route variable cost category from very important to crucial.

4.2.3.9 Interregional Connectivity

- **Route Cost:** As public agencies take steps to increase the connectivity of different regional areas, the potential exists for faster movement of freight from one area to another. As these new interregional corridors are opened, however, traffic could inundate the new route, leading to an increase in the number of hours spent on a specific route and reducing the average speed. These costs are captured in the route variable cost category, which is considered crucial, but some of these cost categories will also affect route average costs.

CHAPTER 5

Identification and Assessment of Data Sources

This chapter identifies and assesses the cost data sources available for the different freight modes. The term "data source" represents a wide array of materials, from one-time-reports collected using an informal data collection process to sources that are the result of statistically designed, regular data collection processes that guarantee a high standard of quality. Data sources also have different levels of geographic coverage, some local and others national in scope (though in some cases the data can be disaggregated at the local and regional level). Data collection frequency also varies, as some data sources are collected regularly while others are not.

There are also significant differences in the level of detail in the freight cost data available for each mode. These differences reflect the varying amounts of research conducted to compile the data. Not surprisingly, those modes that have been the subject of sustained research on freight cost estimation (truck, rail) have more highly detailed data cost data available than other modes where little research has been conducted. These differences in quality, coverage, frequency, and detail suggest that caution must be exercised when considering aggregate statistics about the number of data sources available for various modes.

The team identified the available sources of freight cost data and assessed their suitability beginning with a comprehensive search of the data sources regularly collected by public- and private-sector organizations, including the following:

- Reviews of federal agency websites and online data libraries.
- Internet keyword searches. General search terms such as "freight cost data" were used, but in most cases mode-specific searches and cost component searches were performed.
- Interviews with individuals from organizations that focus on the various freight modes.

Summary tables were then developed that outline the various data sources available for each mode of freight. The summary tables include the agency or organization that provides the data, description and observations of the data sources, key data words, geographical scope, number of data points, frequency and date of most recent publication, and the web address (URL) needed to access the information. The team found that some data sources are not regularly collected, but still provide good information about the costs for a freight mode, and these are presented as "one-time reports" in separate summary tables.

Once the data sources were identified, the team compiled a comprehensive list of cost data elements for each of the freight modes. These cost data elements are the specific costs that help determine the total cost of a freight movement; different cost elements might be used depending on the analysis.

The tables also separate the cost data elements into several main costs types, including: general, operational, overhead-related, equipment, and labor. The team reviewed the suitability of each cost data source to assess their applicability. The metrics used include:

- The type of cost data provided in the source.
- The level of detail provided.
- The reliability of the cost data source:
  - Are details available on the methodology used to assemble the information?
  - What is the industry coverage?
  - What is the sample size used?
- The geographical coverage of the cost data source.
- The age of the cost data source:
  - What is the most recent year available?
  - How often are the data updated?
- The cost of the cost data source:
  - Are the cost data available free of charge?
  - If a charge exists, what is it?

This analysis focused mainly on regularly published data sources; however, some one-time reports were included. The data in one-time reports should be used with caution, however,

as they may be out-of-date. Also, it is recommended that when using cost data, a review of new data sources should be completed, as future sources could prove beneficial.

The summary tables provide an idea of how many data sources provide data about specific cost elements. However, the fact that a cost element is found in a data source does not imply that the source completely fulfills the data needs for that cost element; it only establishes that the source contains some data about the cost data element.

The ranking of each data source shown in the summary tables is:

- **Excellent (Signified by a Black Circle ●):** The data source provides a reliable information source for a particular cost data element.
- **Medium (Signified by a Half-black Circle ◐):** The data source provides useful cost data, but the person using the data should exercise caution to ensure the information is what is needed for the analysis.
- **Minimal (Signified by a White Circle ○):** The data source may provide some insight into a particular data element, but the person using the data may need to obtain more data, either because the cost is an estimate, or because the sample size was small.
- **Blank:** If the cell has been left blank, no data are available for this particular cost element from this data source.

The performance of the various data sources was assessed. Each data source was evaluated on the following criteria: (1) data contents, (2) spatial coverage, (3) industry coverage, (4) data collection frequency, (5) data accuracy, (6) cost, and (7) data access. The results were summarized in a multi-criteria matrix for each freight mode, where each cell contains a qualitative assessment of how the data source scores on each criterion. The tables for each mode can be seen in their respective sections of this chapter.

5.1 Assessment of Data Sources for the Various Modes of Freight

5.1.1 Truck Freight

Trucking has the most available data sources of any freight mode, though a significant number of these sources are reports produced by trade groups, which only provide a national view. Given that the trucking industry is highly heterogeneous, a need clearly exists for local, regional, and industry-specific cost estimates. Information about data sources for trucking is summarized in Table 5.1.

Table 5.2 assesses the suitability of truck freight data sources. Most data sources do not cover all industry sectors, and those that have aggregate coverage by area do not perform well in terms of spatial coverage. Generally, the sources perform well in terms of data accuracy and accessibility, and they are available at a low cost to users (or no cost, for Internet sources).

Table 5.3 summarizes the number of cost data elements found in the sources evaluated and the level of detail of the sources for trucking, based on the rankings of the sources in Appendix B. The complete list of the cost data elements found in sources for trucking is presented in Appendix B.

No single source provides data for all truck freight cost data elements, but 63% of those elements can be found in at least one of the sources listed. Ancillary-related inputs (48%) and operational inputs (50%) have the lowest percentage of cost data elements found in the sources. Labor-related and equipment-related inputs have the highest percentage of cost data elements found in sources (67% and 71%, respectively).

Clearly, some assembling of data from different sources is required in estimating truck freight costs, but the process is further complicated by a lack of information about where to find the specific data needed.

5.1.2 Rail Freight

Rail freight is second only to trucking in terms of freight cost data sources available. Data are routinely provided by Class I railroads as part of their annual reports to the Surface Transportation Board (STB). As a result, the cost data available for rail freight is of significantly higher quality than what is available for any other freight mode. These R-1 reports contain aggregated financial data for each of the seven Class I railroads found in the United States, but they can also be useful as guides if a cost analysis is needed for a smaller railroad.

Table 5.4 shows the available data sources for rail cost data elements, and Table 5.5 assesses their suitability. Table 5.6 summarizes the number of rail cost data elements, and the level of detail found in the sources for rail freight, based on the rankings of the sources in Appendix B. The complete list of the cost data elements found in sources for rail freight is presented in Appendix B.

As is the case for trucking, most rail freight data sources perform well in terms of data contents, data accuracy, and industry coverage. Rail freight data sources also perform well in terms of spatial coverage. The costs associated with obtaining the data are minimal or free, and accessing the data is generally simple.

The coverage of rail freight cost data elements is fairly high compared with that of all other freight modes. Sources provide 87% of the data elements, though no single source provides a comprehensive data set. The quality of the data differs; for some cost elements the data quality is high, while for others it is much less so.

Table 5.1. Summary of data sources—trucking.

Data Source / Agency-Organization	Description / Observations	Key Data	Geographical Scope / # of Data Points	Frequency	URL
An Analysis of the Operational Costs of Trucking / ATRI	Characteristics of operational costs in trucking are described	Operational costs	National / 55,700 trucks	Yearly	http://www.atri-online.org/research/results/economicanalysis/Operational_Costs_OnePager.pdf
An Analysis of the Operational Costs of Trucking. A 2011 update / ATRI	Updated version of 2008 report. It describes the characteristics of operational costs in trucking.	Operational costs	National	Yearly	http://www.atri-online.org/index.php?option=com_wrapper&view=wrapper&Itemid=112
American Trucking Trends / ATA	Profile of the dynamics shaping the trucking industry.	Various trucking trends	National	Yearly	http://www.atabusinesssolutions.com/
Black Book / Official Medium and Heavy Duty Truck and Trailer Guide	Wholesale values and specific configurations for various classes of trucks and trailers. Fee based, $129 per year.	Truck and trailer resale values	National / over 3,800 trucks	Monthly	http://www.blackbookusa.com
Covered Employment & Wages Programs / BLS	Number of employers, monthly and average employment and wages. Tables by industry categories.	Employment, wages	State, MSAs, Counties	Quarterly and Yearly	http://www.labormarketinfo.com/qcew/
Employment Statistics / BLS	Statistics on occupational employment and wages, labor demand, and turnover.	Statistics	National, Regional, Urban	Monthly	http://www.bls.gov/bls/employment.htm
Highway Taxes and Fees / DOT	Data on fuel taxes and motor vehicles including registration costs by state.	Fuel taxes and registrations	National, State	Yearly	http://www.fhwa.dot.gov/ohim/hwytaxes/2008/index.cfm
Motor Carrier Annual Report / ATA	Tonnage, mileage, employees, and transportation equipment.	Operational costs	National	Yearly	http://www.atabusinesssolutions.com/
Official Commercial Truck Guide / NADA Guides	Resale values of various types of trucks and trailers. Fee based, $120 per year.	Truck and trailer resale values	National	Monthly	http://www.nadaappraisalguides.com/
Pay and Benefits / BLS	Wages, earnings and benefits of workers.	Wages	National	Yearly	http://www.bls.gov/bls/wages.htm

5.1.3 Waterborne Freight

Fewer sources are available for waterborne freight-specific data compared to trucking and railroads. The U.S. Coast Guard and the U.S. Army Corps of Engineers (USACE) are the two major data sources, and the annual 10-K financial statements filed by public waterway shipping companies are another source. These 10-K reports contain aggregated financial data, but may still be useful for a cost analysis done for a smaller waterway shipper.

Table 5.7 lists the available data sources for the waterborne freight cost data elements, and Table 5.8 assesses their suitability. Table 5.9 summarizes the number of cost data elements and the level of detail found in the waterborne freight sources, based on the rankings in in Appendix B. The complete list of the cost data elements found in sources for waterborne freight is presented in Appendix B.

In terms of data contents, data accuracy, and industry coverage, most of the waterborne freight data sources perform very well. The cost for the data sources is minimal or free, and the data is easily accessed.

In terms of data contents, accuracy, and industry coverage, most waterborne data sources perform very well. Accessing the data is generally simple, and can be done for free or at low cost.

Table 5.1. (Continued).

Data Source / Agency-Organization	Description / Observations	Key Data	Geographical Scope / # of Data Points	Frequency	URL
Producer Price Index / BLS	Average change over time in the selling prices received by domestic producers.	Prices index	National	Quarterly	http://www.bls.gov/pPI/
Productivity Statistics / BLS	Output per hour of labor and multifactor productivity output per unit of combined inputs.	Unit labor costs	National	Yearly	http://www.bls.gov/bls/productivity.htm
The U.S. Truck Driver Shortage / ATA *	Documentation on long-term issue of driver shortage and low retention rates.	Truck drivers	National	Once (2005)	http://www.truckline.com/StateIndustry/Documents/ATADriverShortageStudy05.pdf
Transportation Energy Data Book / DOE	Statistics and other information that characterize transportation activity and energy use.	Fuel mileage	National	Yearly	http://cta.ornl.gov/data/index.shtml
Truck Drivers, Heavy & Tractor-Trailer/ DOL	Estimates of mean national average pay for truck drivers.	Wages	National, State, MSAs	Yearly	http://www.bls.gov/oes/current/oes533032.htm
Truck Paper	List of new and used trucks of various types, conditions, and ages for sale.	Truck & trailer costs	National	Weekly	http://www.truckpaper.com/
Weekly On-Highway Diesel Prices / DOE	Retail on-highway diesel prices, including truck stops and service stations.	Diesel prices	National	Weekly	http://www.eia.doe.gov/oog/info/wohdp/diesel.asp

Notes: BLS: Bureau of Labor Statistics; DOE: Department of Energy; DOL: Department of Labor; ATA: American Trucking Associations; ATRI: American Transportation Research Institute; * One-time report

Table 5.2. Assessment of suitability of data sources—trucking.

	Evaluation criteria:						
Data source:	Data contents	Spatial coverage	Industry coverage	Data collection frequency	Data accuracy	Cost	Data access
An Analysis of the Operational Costs of Trucking	●	◐	◐	●	●	○	●
An Analysis of the Operational Costs of Trucking Update	●	◐	◐	●	●	○	●
American Trucking Trends: 2009-2010	●	◐	●	○	●	○	●
Black Book	●	◐	●	◐	●	○	●
Covered Employment and Wages	◐	●	◐	◐	◐	○	●
Employment Statistics	◐	●	◐	◐	◐	○	●
Highway Taxes and Fees	●	◐	◐	●	●	○	●
Motor Carrier Annual Report Summary Tables	●	◐	●	●	●	○	●
Official Commercial Truck Guide	●	◐	●	●	●	○	●
Pay and Benefits	●	◐	●	○	●	○	●
Producer Price Index	◐	◐	◐	◐	◐	○	●
Productivity Statistics	◐	◐	◐	○	◐	○	●
The US Truck Driver Shortage *	●	◐	●	○	◐	○	●
Transportation Energy Data Book	◐	◐	◐	○	◐	○	●
Truck Drivers, Heavy and Tractor-Trailer	●	●	●	●	●	○	●
Truck Paper	●	◐	◐	●	●	○	●
Weekly On-Highway Diesel Prices	●	◐	◐	●	◐	○	●

Notes: ● Excellent ◐ Medium ○ Minimal * One-time report

Table 5.3. Summary of cost data elements found in sources—trucking.

Level	Number of Cost Data Elements	Cost Data Elements Found in Sources	%	Data Quality		
				Excellent	Medium	Minimal
Operational inputs	12	6	50%	5	0	1
Ancillary related inputs	21	10	48%	17	2	0
Labor related inputs	12	8	67%	14	2	6
Equipment related inputs	49	35	71%	32	17	23
Total	94	59	63%	68	21	30

For waterborne freight, 68% of the cost data elements could be found in the available data sources, though no one source provided a comprehensive set, and the quality of the data was highly uneven. Only 47% of the cost data elements for ancillary inputs were found in at least one source, though greater than 80% of the labor-related and equipment-related inputs cost data elements were found in the sources examined.

5.1.4 Air Cargo

Air cargo operations are complex. Cargo can be transported in aircraft ranging from small propeller planes to huge specialty planes, in the bellies of passenger planes, or as part of integrated freight carriers (such as FedEx and UPS). Analyzing the data cost elements for air freight was a major challenge because cost data are not available, so the team decided to present a general list of air cargo cost categories based on their knowledge of air cargo and interviews with two leading air cargo managers. As with waterborne freight, air cargo moves using a mix of privately and publicly owned infrastructure. Accordingly, the cost elements include fees and costs for other governmental services, in addition to those associated with equipment and cargo facilities. An initial list of the cost categories is provided in Table 5.10.

This research indicates that:

- Costs vary by type of aircraft and whether the cargo is being moved in an all-cargo aircraft or as belly cargo.
- Costs are calculated by carriers on various bases, such as cost per mile/kilometer, cost per pound/kilo, and cost per container.
- Airport fees can be based on either the take-off or landing weight of the aircraft, which can significantly affect the amounts collected.

5.1.5 Freight Terminals

Analyzing the freight data cost elements for freight terminals was challenging because of the many different configurations used to handle the flow of cargo/containers, so the team decided to develop a general typology of the basic processes that take place at terminals. Regardless of the specifics of how the cargo is handled, or the equipment used, the flow of terminal activities can be delineated as:

- **Administrative Process for Entry/Exit of Cargo/Vehicles (Entry/Exit Processing, or EP):** These are routinely performed activities to ensure that the cargo and vehicles entering the terminal have the proper permissions to do so. In the case of marine terminals, for example, there are two sets of processes: one for the land modes (e.g., rail, trucks) and another for the marine side. Intermodal rail terminals also have two sets of processes: one for rail and another for the trucks entering and exiting the terminal. In trucking terminals, only one set of processes is used for entry and exit.
- **Internal Movements (IM):** These activities take into account the physical movement of the cargo inside the terminal. Depending on how the yard is set up, the internal movement might be performed with a road tractor, a yard tractor, with straddle carriers, or with other handling equipment. However, in all cases, equipment is used to transport the cargo from a gate (or other form of terminal entrance) to a storage location, and from there to another location or to the freight mode that will take the cargo out of the terminal.
- **Loading/Unloading of the Cargo (L/U):** This group of activities captures the physical transfer of the cargo when it is loaded/unloaded from one vehicle/mode to another, or to a storage location. Again, there could be many possibilities in terms of technologies, such as yard cranes, straddle carriers, and so on.
- **Sorting/Organization of Storage Areas (S/O):** At some point, both short-term and long-term storage areas have to be sorted and reorganized so that cargo can be retrieved and stored efficiently. Depending on the yard technology available at the terminal, yard cranes, straddle carriers, top loaders, or other equipment could be used.
- **Ancillary Functions (AF):** This set of activities represents all of the functions that are needed to ensure proper functioning of the freight terminal, including: security, insurance, administration, electricity, and administrative costs, among others.

Table 5.4. Summary of data sources—rail.

Data Source / Agency-Organization	Description / Observations	Key Data	Geographical Scope / # of Data Points	Frequency	URL
Class I Railroad Annual Report (R1) / STB	Railroad industry growth, financial stability, traffic, and operations.	Financial data	National	Yearly	http://www.stb.dot.gov/econdata.nsf/f039526076cc0f8e8525660b006870c9?OpenView
Covered Employment & Wages Programs / BLS	Number of employers, monthly and average employment, and wages. Tables by industry categories.	Employment, wages	State, MSAs, Counties	Quarterly and Yearly	http://www.labormarketinfo.com/qcew/
Employment Statistics / BLS	Statistics on occupational employment and wages, labor demand, and turnover.	Statistics	National, Regional, Urban	Monthly	http://www.bls.gov/bls/employment.htm
Pay and Benefits / BLS	Wages, earnings, and benefits of workers.	Wages	National	Yearly	http://www.bls.gov/bls/wages.htm
Producer Price Index / BLS	Average change over time in the selling prices received by domestic producers.	Prices index	National	Quarterly	http://www.bls.gov/pPI/
Productivity Statistics / BLS	Output per hour of labor and multifactor productivity output per unit of combined inputs.	Unit labor costs	National	Yearly	http://www.bls.gov/bls/productivity.htm
Railway Age	Articles and advertisements on current railroad practices, labor, and equipment.	Railroad costs	National	Monthly	http://www.railwayage.com/
Railway Track and Structures	Information up to date from engineering and maintenance-of-way.	Track and structures	National	Monthly	http://www.rtands.com/
Transportation Energy Data Book / DOE	Statistics and other information that characterize transportation activity and energy use.	Fuel mileage	National	Yearly	http://cta.ornl.gov/data/index.shtml
Railroad Ten-Year Trends / AARR	Economic overview of the US freight railroad industry.	Cost data	National	Yearly	http://www.aar.org/NewsAndEvents/Press-Releases/2011/04/27-Trends.aspx
Wage Statistics / STB	Wage statistics of Class I railroads in the United States.	Employees stats	National	Yearly	http://www.stb.dot.gov/econdata.nsf/WageStatistics?OpenView
Railroad Employment / STB	Current employment data trends for Class I line-haul railroads.	Number of employees	National	Monthly	http://www.stb.dot.gov/econdata.nsf/EmploymentData?OpenView
Study of Railroad Rates: 1985-2007	Latest findings on trends in freight railroad rates.	Rail Rates	National	Once (2009)	http://www.stb.dot.gov/stb/industry/1985-2007RailroadRateStudy.pdf
Notes: BLS: Bureau of Labor Statistics; DOE: Department of Energy; STB: Surface Transportation Board; AARR: Association of American Railroads					

Table 5.5. Assessment of suitability of data sources—rail.

Data source:	Evaluation criteria:						
	Data contents	Spatial coverage	Industry coverage	Data collection frequency	Data accuracy	Cost	Data access
Class I Railroad Annual Report (R1)	●	◐	●	●	●	○	●
Covered Employment and Wages	◐	●	◐	◐	◐	○	●
Employment Statistics	◐	●	◐	◐	◐	○	●
Pay and Benefits	●	◐	●	○	●	○	●
Producer Price Index	◐	◐	◐	◐	◐	○	●
Productivity Statistics	◐	◐	◐	○	◐	○	●
Railroad Ten-Year Trends	●	◐	●	●	●	○	●
Railway Age	○	◐	◐	◐	◐	○	◐
Railway Track and Structures	○	◐	◐	◐	◐	○	◐
Surface Transportation Board Economic Data	●	◐	●	○	●	○	●
Transportation Energy Data Book	◐	◐	◐	○	◐	○	●
Study of Railroad Rates: 1985-2007 *	◐	◐	◐	○	◐	○	●

Notes: ● Excellent ◐ Medium ○ Minimal * One-time report

Figure 5.1 depicts the basic processes and types of technologies/vehicles most typically used in terminals.

The basic processes depicted in Figure 5.1 could be tailored to the particular operations of any terminal. They are further illustrated with the following examples.

Example 1: An export container arrives at a marine terminal to be loaded onto a ship. Assume that, in this particular marine terminal, the container follows this sequence of events:

1. A truck with the container arrives at the gate, where the container is processed for entry.
2. The container is moved by truck to the storage yard, where a yard crane unloads and stacks it.
3. Later, a yard crane retrieves the container from the stack, and places it on top of a yard truck that moves it to the gantry (ship) crane.
4. The gantry crane picks the container from the yard truck and loads it onto the ship.
5. After all containers have been loaded, the ship leaves the port, after the paperwork has been completed and the applicable fees and taxes have been paid.

In this example, the various activities performed could be delineated as:

1. EP (entry/exit processing at the gate).
2. IM (internal movement by truck from the gate to the yard).
3. L/U (loading/unloading of the container at the storage yard by a yard crane to the storage yard).
4. L/U (loading/unloading of the container by a yard crane to a yard truck).
5. IM (internal movement of the container by the yard truck from storage yard to the gantry crane.
6. L/U (loading/unloading of the container by the gantry crane to the ship).
7. EP (entry/exit processing of the ship.

Table 5.6. Summary of cost data elements found in sources—rail.

Level	Number of Cost Data Elements	Cost Data Elements Found in Sources	%	Data Quality		
				Excellent	Medium	Minimal
General	7	7	100%	3	3	9
Operational inputs	26	23	88%	8	19	0
Ancillary related inputs	35	27	77%	13	28	15
Labor related inputs	10	10	100%	12	12	8
Equipment related inputs	21	19	90%	5	20	12
Total	99	86	87%	41	82	44

Table 5.7. Summary of data sources—waterborne.

Data Source / Agency-Organization	Description / Observations	Key Data	Geographical Scope / # of Data Points	Frequency	URL
Covered Employment & Wages Programs / BLS	Number of employers, monthly and average employment and wages. Tables by industry categories.	Employment, wages	State, MSAs, Counties	Quarterly and Yearly	http://www.labormarketinfo.com/qcew/
Employment Statistics / BLS	Statistics on occupational employment and wages, labor demand and turnover.	Statistics	National, Regional, Urban	Monthly	http://www.bls.gov/bls/employment.htm
Major Marine Shippers 10-K Financial Statements	Aggregated cost data for major marine shippers.	Financial data	National	Yearly	n/a
Pay and Benefits / BLS	Wages, earnings, and benefits of workers.	Wages	National	Yearly	http://www.bls.gov/bls/wages.htm
Producer Price Index / BLS	Average change over time in the selling prices received by domestic producers.	Prices index	National	Quarterly	http://www.bls.gov/pPI/
Shallow Draft Vessel Operating Costs / USACE	Inland vessel operating cost information based on annual surveys from the waterway freight community.	Vessel costs	National	Yearly	n/a
Waterborne Transportation Lines (Vol. 1) / USACE	Summary of the vessel data detailed in the waterborne transportation lines of the United States.	General vessel characteristics	National	Yearly	http://www.ndc.iwr.usace.army.mil/veslchar/veslchar.htm
Waterborne Transportation Lines (Vol. 3) / USACE	Lists the vessel companies and describes each vessel surveyed by different characteristics.	Detailed vessel characteristics	National	Yearly	http://www.ndc.iwr.usace.army.mil/veslchar/veslchar.htm
Waterways Journal	News and actions of organizations that support waterways interests in the United States.	Waterborne data	National	Weekly	http://www.waterwaysjournal.net/index.html
WorkBoat Magazine	Articles and advertisements on current waterway practices, labor, and equipment.	Waterborne data	National	Monthly	http://www.workboat.com/

Notes: BLS: Bureau of Labor Statistics; USACE: US Army Corps of Engineers

Table 5.8. Assessment of suitability of data sources—waterborne.

Data source:	Evaluation criteria:						
	Data contents	Spatial coverage	Industry coverage	Data collection frequency	Data accuracy	Cost	Data access
Covered Employment and Wages	◐	●	◐	◐	◐	○	●
Employment Statistics	◐	●	◐	◐	◐	○	●
Major Marine Shippers 10-K Financial Statements	●	◐	◐	●	●	○	◐
Pay and Benefits	●	◐	●	○	●	○	●
Producer Price Index	◐	◐	◐	◐	◐	○	●
Shallow Draft Vessel Operating Costs	●	◐	●	●	◐	○	●
Waterborne Transportation Lines (Volume 1)	●	◐	●	◐	●	○	●
Waterborne Transportation Lines (Volume 3)	●	◐	●	◐	●	○	●
Waterways Journal	●	◐	●	●	●	○	◐
WorkBoat Magazine	●	◐	●	◐	●	○	●

Notes: ● Excellent ◐ Medium ○ Minimal * One-time report

Throughout the entire movement of the containers, overhead costs associated with the ancillary functions (AF) would be accrued.

Example 2: A container is unloaded from ship to rail using yard trucks to transfer the containers. In this case, the sequence of moves is:

1. The ship arrives at the port.
2. The gantry crane picks the container from the hatch and loads it onto the yard truck.
3. A yard crane retrieves the container from the yard truck and loads it onto the train.
4. The yard truck comes back to the berth to pick up the next container.
5. The gantry crane picks up the container from the yard truck and loads it onto the ship.
6. After all containers have been loaded onto the train, the ship and train leave the port after the paperwork has been completed and the applicable fees and taxes have been paid.

In this example, the various activities performed in this chain of events could be delineated as:

1. EP (entry/exit processing at the port, to make sure the ship's paperwork is in order).
2. L/U (loading/unloading of the container by the gantry crane from the ship to the yard truck[s]).
3. IM (internal movement by the truck from the berth to the rail track).
4. L/U (loading/unloading of the container at the rail track by a yard crane from yard truck to train).
5. IM (internal movement of the yard truck from the rail track yard to the gantry crane).
6. EP (entry/exit processing of the ship).

Throughout the entire movement of the containers, overhead costs associated with the ancillary functions (AF) would be accrued.

Other freight terminal configurations could be easily accommodated within this framework by properly combining the appropriate processes.

Using this general classification of basic processes and the cost data sources available for the different types of technologies, an assessment could be performed for the different data sources on intermodal terminals based on the processes that

Table 5.9. Summary of cost data elements found in sources—waterborne.

Level	Number of Cost Data Elements	Cost Data Elements Found in Sources	%	Data Quality		
				Excellent	Medium	Minimal
Operational inputs	5	0	0%	0	0	0
Ancillary related inputs	19	9	47%	8	0	9
Labor related inputs	11	11	100%	7	11	14
Equipment related inputs	24	20	83%	14	17	38
Total	59	40	68%	29	28	61

Table 5.10. Air cargo cost categories.

Level	Cost Data Element	Observations
Aircraft	**Aircraft:**	
	Crew	
	Fuel	Depends on aircraft, length of flight, taxi times
	Aircraft Leasing	
	Maintenance/Downtime of Frame	
	Maintenance/Downtime of Engines	
	Insurance	
Cargo	**Cargo:**	
	Container Fees	For use of the container
Airport	**Airport:**	
	Landing Fees	
	On-Airport Drayage	Only for belly cargo
	Loading/Unloading Fees	Depends on aircraft and turnaround time
	Parking Fees	
	Storage/Demurrage Fees	
	On-Airport Building Lease	
	Interplane Fueling Fee	Charged by airport
	Security	
	Cargo Inspection	
	Cargo Handling	
	Data/Transaction Processing	
	Customs/Other Government Fees	Depends on origin/destination; type of cargo
Off-Airport	**Off-Airport:**	
	Cargo Handling	
	Off-Airport Building Lease	
	Cargo Inspection	
	Data/Transaction Processing	
	Freight Forwarder/3PL	

Notes: 1. Costs may be considered on a per mile/kilometer, per kilo basis, or a per revenue ton/kilometer, per container basis. 2. The loading/unloading fee can include a parking fee. 3. Data charges can include documentation and import service charges. 4. On-airport leases can include office space. 5. Fees vary based on whether take-off or landing weight is used as the basis.

apply in each case. Unfortunately, the research team found that all of the terminal cost data is proprietary and found no terminal-specific cost data publicly available. It was not possible to conduct an assessment of data sources, as none could be obtained. However, a detailed list of the cost data elements for each of the terminal functions is provided in Appendix B. It should be noted that the mode-specific cost data element assessments could be used for some of the general cost data elements, such as labor, fuel costs, and some equipment.

5.2 Gaps and Limitations in Freight Cost Data

Gaps and limitations clearly exist in the freight cost data available to practitioners. By prioritizing the importance of specific data, public agencies can determine which of those gaps and limitations are most critical to address. An ideal data set contains the needed content, collected in a timely manner, so in considering gaps and limitations two main aspects were considered: data content and timeliness. The former refers to the data cost elements included in a given data set, while the latter considers how timely the data are.

The individual cost data elements and available data sources evaluated in Section 5.1 were again used as the basis to evaluate data needs and gaps. The tables in the subsections below provide the summary results for each freight mode, while Appendix B contains more detailed tables for each mode.

The summary tables provide an overview of the data gaps for each freight mode by level of importance and the percentages for each level of importance with and without data gaps. Cost elements identified as "analyst provided" are unlikely to be found in any source, as they are company- or sector-specific; so if needed, they should be provided by

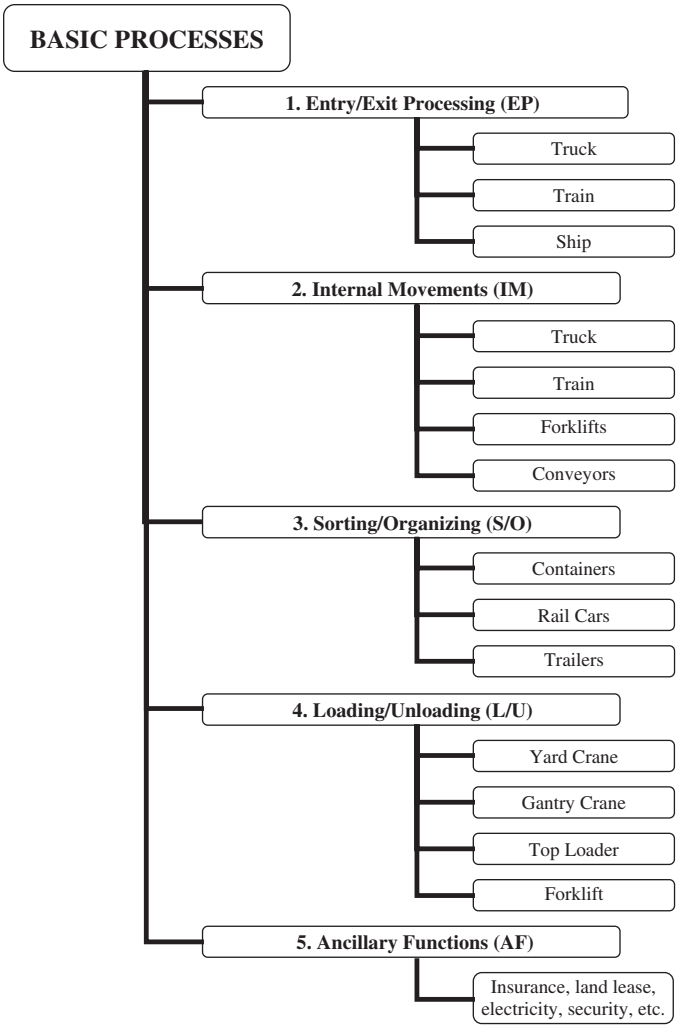

Figure 5.1. Basic processes (terminals).

the person conducting the analysis. The analyst provided fields are assumed to be available; therefore, they were not included in calculating the data gap percentages. It is also important to note that not all cost analyses will require all of the cost component inputs. For example, in trucking, if the cost analysis is for a single-unit truck using only local roads, then costs associated with tolls and trailers would not be necessary. Also, some of the items that have data gaps, such as permits and tolls, are normally easily accessed if the vehicle configuration and route are known in advance.

Appendix B includes tables that show both the current and future levels of importance for the cost elements, data gaps if any, and a remarks section. In Appendix B, the assessment of data gaps is based solely on current availability, because it is impossible to know what data sources will be available in the future, or how reliable they will be. The remarks column explains why the level of importance remains the same or changes between the current and future needs.

In the evaluation of current and future levels of importance, most cost components are expected to remain the same, except those listed previously, in Table 4.4. Cost data elements that are currently labeled as essential are expected to remain essential in the future; there were no downgrades in level of importance from current to future.

Within each table in this section (and in Appendix B), the following symbols have been used to evaluate the current and future levels of importance:

- **Essential (signified by a black circle ●):** Cost data elements of highest importance.
- **Important (signified by a half-black circle ◐):** Cost data elements that are significant.
- **Useful (signified by a white circle ○):** Cost data elements that would be helpful to have, but not necessary.

The following symbols have been used to evaluate data gaps:

- **Data Gap Exists (Signified by an "X"):** These are cost data elements for which no easily accessible data are available, or the available data sources are out-of-date.
- **Sufficient Data Available (Signified by a "✓"**): These are cost data elements that can reliably be found in one or more of the identified data sources, and the data is expected to be relatively current.
- **To Be Provided by Analyst (Signified by a "-"):** These are cost data elements in which specifics are based on the analyst's needs, and should be provided on a case-by-case basis.

5.2.1 Truck Freight

The trucking category contains 83 unique cost elements, 73.1% of which have data gaps, and 13.4% of these are considered essential (Table 5.11).

Table 5.11. Summary of data gaps–trucking.

		Data Gap			Total
		Data Gap (X)	No Data Gap (✓)	Analyst Provided	
Level of Importance	Essential (●)	**9** *13.4%*	**11** *16.4%*	**11** -	**31** *29.9%*
	Important (◐)	**18** *26.9%*	**4** *6.0%*	**5** -	**27** *32.8%*
	Useful (○)	**22** *32.8%*	**3** *4.5%*	**0** -	**25** *37.3%*
Total		**49** *73.1%*	**18** *26.9%*	**16** -	**83** *100.0%*

Table 5.12. Essential and important cost data elements—trucking.

Level of Importance	DATA GAPS	NO DATA GAPS
Essential	Permits (trip specific)	Driver wages
	Tolls (trip specific)	Purchase costs for power units and trailers
	Parking costs (including fines)	Purchase costs for specialized equipment
	Driver benefits and bonuses	Salvage value of power units and trailers
	Salvage value of specialized equipment	Average service life for power units and trailers
	Maintenance costs for power units and trailers	Fuel and oil costs ($/gallon)
	Insurance for both power units and trailers	Fuel consumption (MPH)
Important	Crew benefits and bonuses	Crew ($/hour or $/mile)
	Special aftermarket equipment	Specialized equipment (hours of service)
	Power unit, trailer, and specialized equipment	Tires (miles)
	Sales and Highway use tax	
	Power unit and trailer tires (# of tires)	
	Cellular phone expenses (per month)	
	Vehicle tracking expenses (per month)	

The 13.4% of essential and 26.9% of important cost data elements that have data gaps, as well as the 16.4% of essential and 6% of important items that have no data gaps, are shown in Table 5.12.

The truck freight-related cost data elements that are expected to increase in level of importance in the future include: ancillary-related costs that could be considered overhead costs; driver and crew training and safety costs; taxes, in particular fuel costs; tire costs; and oil consumption.

5.2.2 Rail Freight

The rail freight category contains 98 uniquely identified cost elements, of which 53.3% have data gaps, with 10% of these considered essential elements (Table 5.13).

The essential and important cost data elements that make up the 10.0% and 6.7% of cost elements with data gaps, respectively, as well as the 20.0% of essential and 13.3% of important items that have no data gaps, are shown in Table 5.14. Again, not all cost analyses will need every one of these inputs.

Table 5.13. Summary of data gaps—rail.

		Data Gap			Total
		Data Gap (X)	No Data Gap (✓)	Analyst Provided	
Level of Importance	Essential (●)	**6** *10.0%*	**12** *20.0%*	**32** -	**50** *30.0%*
	Important (◐)	**4** *6.7%*	**8** *13.3%*	**6** -	**18** *20.0%*
	Useful (○)	**22** *36.7%*	**8** *13.3%*	**0** -	**30** *50.0%*
Total		**32** *53.3%*	**28** *46.7%*	**38** -	**98** *100.0%*

The rail freight-related cost data elements that are expected to increase in level of importance in the future include: ancillary costs, such as infrastructure costs and maintenance; administrative expenses; and crew safety training.

5.2.3 Waterborne Freight

The waterborne freight category contains 59 identified unique cost elements, 72.7% of which have data gaps, with 12.7% of these considered essential components (Table 5.15).

The essential and important cost data elements that make up the 12.7% and 21.8% of cost data elements with gaps, as well as the 23.6% of essential items and 0% of important items that have no data gaps, respectively, are shown in Table 5.16.

The waterborne freight-related cost data elements expected to increase in level of importance in the future include: ancillary costs related to the companies' overhead; crew wages; operational expenses such as wharf, dockage, and terminal charges; safety and training of operators and crew members; equipment depreciation; and tracking and monitoring equipment.

5.2.4 Air Cargo

The research and discussions indicated that, with the possible exception of public-sector fees, air cargo cost information is not available. This information is considered highly confidential and appears to not be collected, or to be available only through industry associations. As a result, one of the research team's recommendations is to: (1) identify what air

Table 5.14. Essential and important cost data elements—rail.

Level of Importance	DATA GAPS	NO DATA GAPS
Essential	Average maintenance costs of locomotives	Wages for engineers and crew
	Average maintenance costs of rolling stock	Benefits and bonuses for engineers and crew
	Estimated salvage value of locomotives	Average service life of locomotives
	Estimated salvage value of rolling stock	Average service life of rolling stock
	Insurance costs for locomotives	Average purchase costs for locomotives
	Insurance costs for rolling stock	Average purchase costs for rolling stock
		Fuel and oil costs ($/gallon)
		Fuel consumption (gallons)
		Communication costs
Important	Locomotive lease/payment	Administration staff and other workers
	Rolling stock lease/payment	Administration staff ($/hour)
	Oil (gallons)	Other workers ($/hour)
		Administration staff benefits and bonuses
		Other workers benefits and bonuses
		Locomotive and rolling stock depreciation

Table 5.15. Summary of data gaps—waterborne.

		Data Gap			Total
		Data Gap (X)	No Data Gap (✓)	Analyst Provided	
Level of Importance	Essential (●)	**7** *12.7%*	**13** *23.6%*	**2** -	**22** *36.4%*
	Important (◐)	**12** *21.8%*	**0** *0.0%*	**2** -	**14** *21.8%*
	Useful (○)	**21** *38.2%*	**2** *3.6%*	**0** -	**23** *41.8%*
Total		**40** *72.7%*	**15** *27.3%*	**4** -	**59** *100.0%*

cargo cost information is most needed by agencies and transportation professionals; and (2) investigate mechanisms for obtaining the most critical information, while maintaining the confidentiality of individual company data.

5.2.5 Freight Terminals

Another finding from this research was that there are no regularly published data sources that provide sufficient data on freight terminal costs. One possible source that could be used to give an idea of upper bound costs are the tariffs published by specific ports and terminals. Depending on volume, a terminal may offer discounts on its tariffs. Because each

Table 5.16. Essential and important cost data elements—waterborne.

Level of Importance	DATA GAPS	NO DATA GAPS
Essential	Wages for operators and crew	Number of operators and crew per vessel
	Benefits for operators and crew	Number of towing vessels and barges
	Average maintenance costs for towing vessels	Average purchase cost for towing vessels and barges
	Average maintenance costs for towing barges	Estimated salvage value for towing vessels and barges
	Insurance for equipment	Average service life for towing vessels and barges
	Lock charges	Fuel and oil cost ($/gallon)
	Licenses for operation of equipment	Fuel consumption (miles/gallon)
Important	Wharf / dockage and steam ship charges	
	Terminal charges	
	Crew ($/hour)	
	Crew benefits and bonuses	
	Overhead	
	Towing vessels and barges purchase payment	
	Towing vessels and barges (hours)	
	Towing vessels and barges depreciation	
	Equipment tracking expenses (per month)	

Table 5.17. Summary of data gaps—terminals.

		Data Gap			Total
		Data Gap (X)	No Data Gap (✓)	Analyst Provided	
Level of Importance	Essential (●)	**13** *17.6%*	**8** *10.8%*	**39** -	**60** *28.4%*
	Important (◐)	**35** *47.3%*	**3** *4.1%*	**6** -	**44** *51.4%*
	Useful (○)	**15** *20.3%*	**0** *0.0%*	**0** -	**15** *20.3%*
Total		**63** *85.1%*	**11** *14.9%*	**45** -	**119** *100.0%*

terminal has its own tariffs, these data were not included in the evaluation of the cost data sources; however, they can normally be found on the terminal's website or by a simple Internet search.

Given that most terminals have unique characteristics, it is no surprise that this area has the most cost data elements that must be provided by the analyst. Of the category's 119 unique cost elements, 85.1% have data gaps, and 17.6% of these are considered essential elements (see Table 5.17).

As with air cargo, detailed cost data for terminals is rare. This lack of published data is unsurprising, given that most terminals are privately owned and operated; however, future studies should be undertaken to bridge this data gap.

CHAPTER 6

Addressing Freight Cost Data Gaps

This chapter discusses the need for the analyst to clearly identify what is expected from freight cost techniques; analyzes the role of alternative data collection techniques, ranging from web searches to random surveys; defines a basic set of alternative data collection frequencies; and suggests combinations of data collection techniques and data collection frequencies for the various data cost elements identified in previous chapters.

6.1 Means for Addressing Limitations and Gaps

Unfortunately, there is no all-inclusive way to address all of the limitations and gaps in freight cost data. In some cases, many different sources of cost data are available; however, quite frequently, these are one-time-publications for which the data is almost always tailored to the specific needs of the report. To address the limitations and gaps, data must be collected directly from the freight community. Depending on the need, the data might be collected from random surveys, convenience samples, technical reports, in-depth interviews with experts, trade publications, or from the Internet. Also, an evaluation of the available cost data sources should be conducted regularly to verify the continued availability of existing sources, identify new sources, and assess the applicability of any new sources.

6.2 Methods and Procedures

Section 6.2 summarizes a number of key questions analysts should address before undertaking freight cost analyses, including data collection techniques, data collection frequency, and other issues.

The starting point of an analysis should be a clear definition of its objective. This is important because it directly determines the most appropriate ways to collect the data and perform the cost estimation. More specifically, the analyst should answer the following set of questions:

- **What is the desired spatial coverage?** The answer to this question has a direct impact on data collection costs and data needs. For example, collecting data from a large area is more expensive than collecting data from a small one. Also, if the analysis includes international freight flows, currency exchange rates will need to be considered.
- **What are the industrial sectors?** The more limited and specific the sectors to be analyzed, the simpler and less expensive the data collection will be.
- **What freight modes are involved?** If more than one freight mode is involved, then different cost estimation techniques and data sources may be required for each segment. Furthermore, the intermodal exchange and overall administrative costs have to be considered in the cost analysis.
- **What is the level of accuracy desired?** The higher the level of accuracy desired, the higher the cost. This factor could have a direct impact on the sample size required to meet the anticipated needs.
- **What type of cost is desired?** The analyst must decide if the main focus is on marginal costs at the vehicle level, route-related costs, or average costs. The requirements of the analysis will affect the data collection procedures to be employed.
- **What is the desired time frame?** If an analyst is looking at historical trends and/or long-term future estimates, such factors as inflation adjustments will need to be taken into account.

Once these questions have been answered, the next step is to consider the various means to collect the data needed. In so doing, two important decisions need to be made: (1) which data collection technique to use; and (2) at which collection frequency will the data be updated. These aspects are discussed next.

6.2.1 Data Collection Techniques

Section 6.2.1 identifies each of the data collection techniques that could be used to obtain data for a particular cost data element. The technique used will ultimately depend on the particular needs of the analysis being performed. The techniques are:

- **Conducting Web Searches (W):** In some cases, performing a web search can provide the necessary cost data. The World Wide Web often is consulted as a source for general cost data and costs related to public agencies, such as vehicle registration costs, sales tax rates, and other data about permits and licenses. The posting agency or organization should be contacted to verify the information.
- **Consulting Trade Publications (TP):** For some of the freight modes, regularly published trade publications may provide general cost data, and can also provide contact information for gathering further data.
- **Consulting Reports (R):** This technique involves referring to published documents that are readily available for use. Reports that were found by the research team to have excellent or medium levels of detail for a particular cost data element are recommended.
- **Conducting Interviews (I):** Depending on the purpose of the analysis, interviews could be an efficient means of data collection. Interviews should target individuals familiar with the particular cost data elements, which might be specific to a certain freight sector. For example, if the purchase price of a new truck is sought, an interview with a knowledgeable truck salesperson might be all that is required to determine the cost. In other cases, it might be necessary to interview individuals at a specific company or people who work within a certain sector. The interview questions need to be well prepared and pretested to avoid confusion.
- **Obtaining Convenience Samples (CS):** In convenience sampling, the observations are not selected at random; rather, they are selected on the basis of what works best for the analyst. Convenience samples are an excellent method for obtaining data for cost data elements that are not expected to vary greatly from company to company or from region to region. If the cost data elements are expected to be similar regardless of sector or location, convenience samples are sufficient. It is important to mention that the analyst should try to ensure that the observations selected as part of the convenience sample represent a broad spectrum of cases.
- **Conducting Random Surveys (RS):** In random surveys, all observations have the same chance of being chosen. The populations in survey work contain a finite number of units, and random surveys are of particular interest when an unbiased sample is required. They can be used to collect most of the cost data, although—depending on the level of detail required—random surveys can be cost prohibitive and time prohibitive. Random surveys are most beneficial for cost data elements that might have fluctuations from company to company or region to region. Random surveys ensure that the range of costs in a particular freight mode will be illustrated. Random surveys must be carefully designed.

Table 6.1 summarizes the advantages and disadvantages of the different data collection techniques.

The various data collection techniques each have different implications in terms of associated cost and time required, overall level of effort, and accuracy of the data collected. Qualitatively, the techniques can be ranked in terms of these aspects. Figure 6.1 shows the ranking produced by the research team. For example, conducting web searches on the Internet requires minimal cost, time, and effort, though this technique also may have the lowest level of accuracy. By contrast, conducting random surveys to collect data is likely to entail the highest cost and require the most time and effort, though it may be the most accurate way to estimate freight data cost elements.

6.2.2 Data Collection Frequency

The frequency at which the data cost elements ought to be collected depends on both the analyses' objectives and the inherent volatility of the data. For example, some cost data elements, such as fuel prices, can change drastically within a short period of time while other cost data elements, such as the average service life of a piece of equipment, may change more slowly. To provide guidance to practitioners, the research team included recommendations for data collection frequency for the various data cost elements (see Table 6.2).

6.3 Suggested Approaches to Close Data Gaps

Table 6.2 summarizes the top data gaps identified for the "essential" cost data elements for different modes. The table shows the suggested data collection techniques and the frequency of data collection needed to close those data gaps. Appendix C shows the research team's suggestions for mechanisms to close the data gaps identified for trucking, rail, waterways, and freight terminals. It is important to keep in mind that these recommendations are general and could change depending on the specific needs of the analyses.

Table 6.1. Advantages and disadvantages of data collection techniques.

Technique	Advantages	Disavantages
Web Search	Low cost, less time to collect data, low level of effort required to gather data.	Low level of accuracy of data collection. It depends on the frequency of the publication.
Trade Publications	Low cost, less time to collect data, low level of effort required to gather data.	Low level of accuracy of data collection. It depends on the frequency of the publication.
Reports	Low cost, less time to collect data, low level of effort required to gather data.	Low level of accuracy of data collection.
Interviews	High accuracy of data collection, provides deep knowledge in a certain sector.	High data collection cost.
Convenience Samples	High accuracy of data collection, provides deep knowledge in a certain sector. They are great way to obtain cost data for cost data elements that are not expected to vary greatly from company to company or region to region.	High data collection cost.
Random Surveys	High accuracy of data collection, provides deep knowledge in a certain sector. They are the most beneficial for cost data elements that might have fluctuations from company to company or region to region. They are the most unbiased means for collecting data.	High data collection cost (cost prohibitive). Although random surveys are the most unbiased mean for collecting data, they could seriously bias the results if the sampled universe includes entities that do not meet stated criteria.

In the case of air transportation—because air freight operations are within the domain of the private sector—no publicly available data or information can be used to identify the corresponding freight data cost elements. Should transportation agencies want to step into this domain to produce air freight cost estimates, a significant amount of work would be required to identify the corresponding cost elements.

The research has shown that there is clearly a lack of freight cost data. For those data elements that are available, it is not always clear where to find the data or how to use the data in an efficient manner. Clearly there is a need to compile all of the cost data and cost models in a single repository, such as a research center that could serve as a clearinghouse for this type of data. Combinations of one-time and regular frequency studies exist that often contain useful data, but if the data are not consolidated, they are not very useful to the community at large. A clearinghouse could be responsible for continuously updating the available data sources, and could provide a "one-stop shop" for this type of data. The clearinghouse could also provide descriptions of the various data, models, and guidance to the end users of the data.

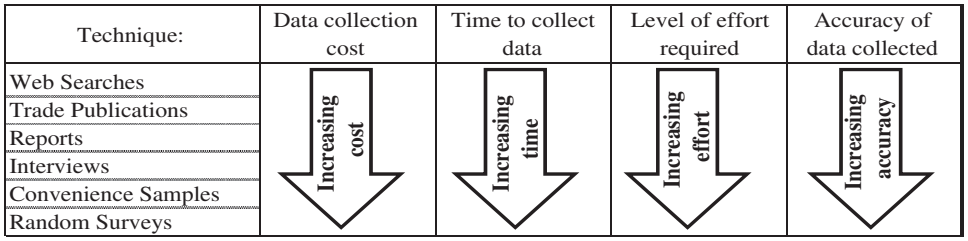

Figure 6.1. Relative performance of data collection techniques.

Table 6.2. Top data gaps for "essential" cost data elements.

Cost Data Element / Data Source	Data Collection Technique (✓Preferred, ✓ Method)						Data Collection Frequency (✓Preferred)				
Legend	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
Trucking											
Permits and tolls (trip specific)				✓	✓			✓			
Parking costs (including fines)				✓	✓			✓			
Driver benefits and bonuses			✓	✓	✓	✓				✓	
Salvage value of specialized equipment		✓	✓	✓	✓	✓			✓		
Maintenance costs for power units and trailers		✓	✓	✓	✓	✓		✓			
Insurance for both power units and trailers			✓	✓	✓	✓		✓			
Rail											
Estimated salvage value of locomotives and rolling stock	✓	✓	✓	✓	✓	✓			✓		
Average maintenance costs of locomotives and rolling stock		✓		✓	✓	✓			✓		
Insurance costs for locomotives and rolling stock		✓	✓	✓	✓	✓			✓		
Waterborne											
Wages for operators and crew			✓	✓	✓	✓			✓		
Benefits for operators and crew			✓	✓	✓	✓			✓		
Average maintenance costs for towing vessels and barges		✓	✓	✓	✓	✓	✓				
Insurance for equipment		✓		✓	✓	✓		✓			
Lock charges and licenses for operation of equipment	✓			✓	✓	✓		✓			
Terminals											
Average purchase cost	✓	✓		✓	✓	✓		✓			
Operating costs		✓		✓	✓	✓			✓		
Fuel or electricity consumption	✓	✓		✓	✓	✓		✓			
Fuel cost	✓	✓		✓	✓	✓					✓
Electricity cost	✓			✓	✓	✓				✓	
Estimated salvage value		✓		✓	✓	✓		✓			

CHAPTER 7

Conclusions

The picture that emerges from the research is that the transportation community does not have access to the freight cost data it needs to fulfill its obligation and mandate to increase the sustainability of transportation operations, maximize the economic contributions of the transportation system, steer the system toward increasing levels of safety and security, and define mechanisms to finance and maintain a state of good repair in the infrastructure. These efforts are hampered by a lack of freight cost data, data which is necessary to assess how policies and programs would impact the freight system, or predict how freight operators would react to public-sector policy, among other important considerations.

The research also makes clear that, already, 18 public-sector functions require freight cost data. These functions are:

1. Congestion management
2. Operation/services
3. Safety planning and analysis
4. Freight mobility planning
5. Emergency preparedness planning
6. Transportation equity
7. Economic development planning
8. Transportation and land use planning integration
9. Environmental planning
10. Regulation and enforcement
11. Financial planning
12. Intermodal corridor planning
13. Economic development planning
14. Security planning
15. Hazardous materials planning
16. Roadway pavement and bridge maintenance planning
17. Interregional connectivity
18. Sustainable transportation planning

In most cases, data needs for these functions are filled by informal data collection efforts, by simply "borrowing" data from another jurisdiction, or by relying on educated guesses. The expectation is that the needs will increase due to the combined effects of a number of emerging trends, including increased fuel economy and emissions standards, technological innovations, increased renewable energy usage, congestion pricing, increased use of intermodal systems, industry consolidation, enhanced security, multi-stakeholder decisionmaking, and accelerated shipping times. This is expected to be the case for nine of the 18 functions, including congestion management, safety planning and analysis, freight mobility planning, environmental planning, financial planning, intermodal corridor planning, hazardous materials planning, roadway pavement and bridge maintenance planning, and interregional connectivity.

The data sources currently available to fulfill the needs are very uneven in terms of data quality and coverage. At one end of the spectrum, in the case of rail freight, the annual reports submitted by the railroads to the Surface Transportation Board provide a regular and comprehensive data source. In the trucking sector, a large assortment of data sources provide bits and pieces of data of various degrees of usefulness and quality, but fail to provide a comprehensive and coherent picture. In the case of waterways, some publicly collected data are found, while for air freight and freight terminals (ports, intermodal, and the like), almost none are available. As a result, most modes do not have a single data source that could provide the freight cost data needed for the basic analyses. The fact that most data sources are either national or collected for rather specific uses makes it difficult for potential users to determine how applicable the data are for local and regional analyses.

A similar need exists for freight cost estimation tools. Freight cost data are needed because they are an input to a process of freight cost estimation that, in most cases, is intended to support other transportation analyses. As a result, enhancing freight cost data availability needs to be accompanied by the development of appropriate freight cost estimation tools that practitioners and researchers could readily use. As of now, the

only publicly available cost estimation models are the Uniform Rail Costing System (URCS) and the Intermodal Transportation and Inventory Cost Model (ITIC), both developed by the federal government. Developing comparable models for the other modes could contribute to the effective integration of freight into the transportation planning process.

The research shows that there is a significant lack of publicly available freight cost data. The data that exist often are difficult to find and use. To address these serious deficiencies, the team suggests the following actions:

- The creation of a freight cost data collection program that would gather the data needed to satisfy the needs of the key public-sector functions identified in the report.
- The development of freight cost estimation tools that use the data collected to produce the estimates of freight costs needed by practitioners and researchers.
- The establishment of a clearinghouse that can serve as a repository of data and models, be responsible for updating the available data, describe the data and models, and provide guidance.

Taken together, these measures could greatly improve the work of practitioners and researchers. An important component of the effort would be to develop long-term relations with freight companies and their trade groups to facilitate freight cost data collection efforts.

Gathering freight cost data has always been difficult. The freight industry is largely privately owned and primarily serves private-sector customers. As such, costs and rates often are confidential or quite difficult to obtain. The complexity and dynamic nature of the freight industry adds to the difficulty of obtaining up-to-date cost data. As demonstrated in this report, however, cost data are crucial to many public-sector analyses. In spite of the challenge, it is important that the research community redouble its efforts to create the foundation for a freight data collection program that addresses the nation's needs.

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APPENDIX A

Basic Cost Concepts, Definitions, and Glossary

Economic vs. Market Costs

Economists study two related—though different—concepts: market or private costs, and economic or resource costs. As the name implies, market or private costs refer to the price an individual or private sector firm pays for a good or service in a marketplace. The market cost is equal to the cost of the resources required to produce the good/service, plus other items such as taxes, duties, and fees that are internal transfers in the economy. If the market cost is denoted by *M*, the cost of the resources by *R,* and the transfers by *T*, then $M = R + T$. Of great importance for public sector economic analysis are the resource costs, *R*, which represent the costs to the economy. (Resource costs are also called economic costs).

Market costs represent the actual expenditures that a private venture or individual incur when purchasing a good or service. These costs are of great importance for private sector decision making. Public decision making, on the other hand, has a different set of needs that requires the use of both market and economic costs. For instance, when developing a freight demand model, market costs ought to be used as they reflect the actual costs to the industry and influence private sector behavior. However, for public sector cost-benefit analyses, using economic costs is the best practice because they are the ones that measure the cost to the economy. Figure A.1 represents an economy with one consumer that spends an amount, *M,* in transportation-related expenses. (For simplicity, value of time is disregarded.) These expenses include the cost of the resources used (e.g., gasoline, deterioration of the vehicle), as well as other transfers such as taxes, *T*. As shown, while the transfer *T* is a cost to the consumer, it is at the same time a revenue source for the government. However, from the standpoint of the entire economic system, the transactions involving the transfers cancel out. As a result, the only thing that matters is the economic cost of the resources, *R,* used by the consumer. This concept is important because the benefits produced by transportation projects are the difference between the resource costs before and after the project, which cannot be computed using the market costs before and after because the transfers introduce a distortion.

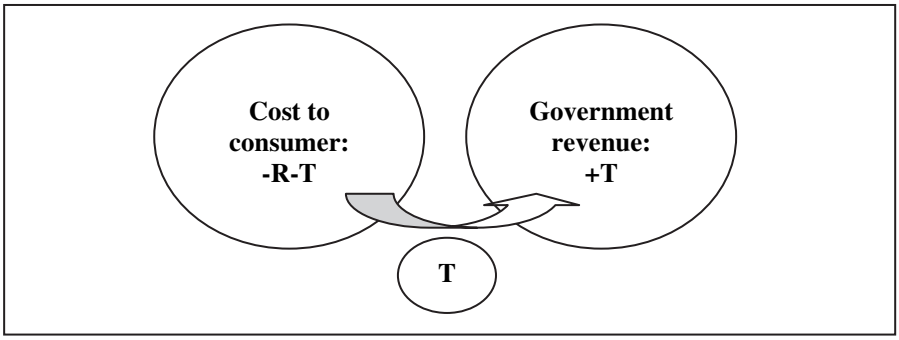

Figure A.1. Illustration of economic (resource), transfer, and market costs.

Social Costs = Private Costs + External Costs

Public sector decision making concerning freight transportation must consider the impacts that the different alternatives have on all stakeholders. Some of these impacts (e.g., the direct costs associated with making a delivery), are internalized by the participants in the transaction, while others (e.g., the pollution or noise generated by the truck) are not. The former costs are referred to as "private" and the latter as "external." The summation of private and external costs are the social costs of that particular economic activity (Varian 1992). Since a fundamental tenet of public sector decision making is to maximize the net social benefits of its actions, planners should have a solid knowledge of all components of social costs. This is a challenge because of the inherent difficulties associated with getting access to data about the private costs of freight activity and with valuating the externalities produced by freight.

It is important to mention that in some cases the distinction between private and external costs is quite nuanced. A good example is accident costs. One could argue that at least part of the accident costs are internalized by the freight industry via the insurance rates. At the same time, the accident costs associated with the congestion produced by freight traffic remains external.

Market Rates (Prices) vs. Costs

Market rates (prices) and costs are two interrelated concepts that provide different pieces of information about the functioning of an economic system. Taken together, they play a key role in explaining freight industry behavior. For that reason, it is important to discuss them in some detail. Costs capture the value of the resources and transfers used to produce a given amount of a product or service. Costs are usually represented using a function that captures the relationship between the output of the process and the corresponding inputs.

Costs can be classified in different ways. In terms of the relationship to the output unit, costs can be classified as either fixed (not dependent on output level) or variable (dependent on the output). As a result, the total cost is equal to the fixed cost plus the variable cost associated with producing an output, Q. An important concept is that of marginal cost, which equals the cost of producing one additional unit of output. On the basis of the planning horizon, costs may be considered short term (if some input factors, such as facility costs, cannot be changed), or long term (if all input factors are variable). Most analyses concerning freight are based on short-term principles.

Figure A.2 shows the cost components involved with both economies and diseconomies of scale, as represented by the unit costs as a function of output Q. The figure illustrates that (1) the unit fixed cost gets smaller as the output increases; (2) the variable cost increases with output and, once in the diseconomies range, it increases even faster; and (3) the marginal cost intersects the average cost at its minimum value, which also takes place at the intersection of fixed and variable costs. Figure A.2 also shows two distinct regions: (1) scale economies, where increasing output reduces average costs, and (2) diseconomies of scale, where increasing output increases average costs. In scale economies, the average costs are larger than marginal costs (something of great significance to the study of freight in a deregulated market like that in the United States); while in regions that feature diseconomies of scale the opposite happens as marginal costs exceed average costs. *This means that companies operating in the efficient range of scale economies are not likely to make money, as the marginal cost is lower than the amount they need to recoup the costs (i.e., average cost).* There is clear evidence that this is the case in some segments of the freight industry.

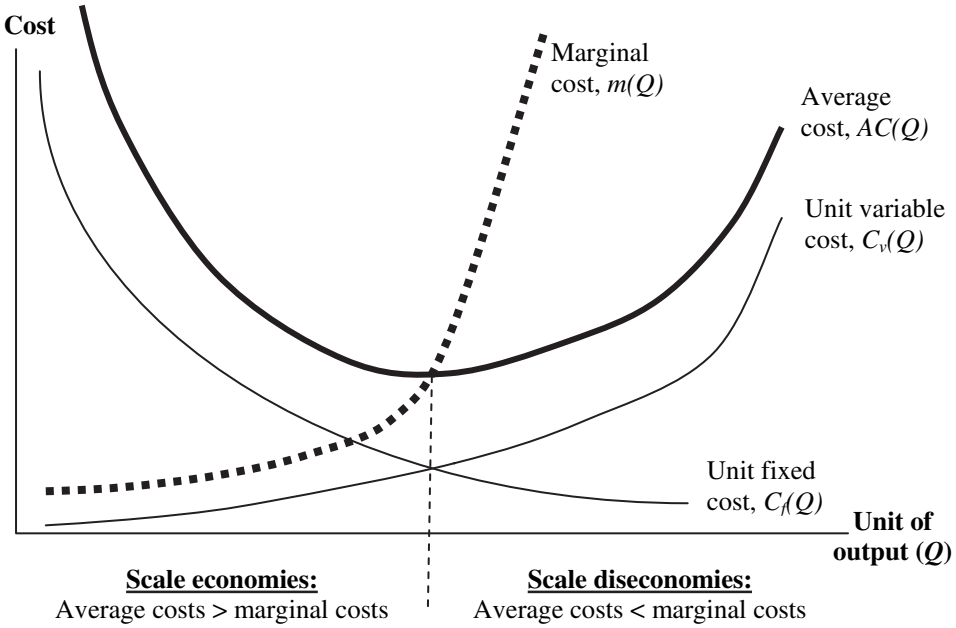

Figure A.2. Basic relations among cost components.

As the name implies, market prices/rates reflect the results of the competition among the participants in a marketplace. It is widely acknowledged that the most efficient market (i.e., the one that maximizes economic welfare) is the one under perfect competition, which is referred to in the economic literature as the "competitive market." For such a market to arise, the following conditions are needed: (1) there are many buyers and many sellers, making it so that no individual agent could exercise market power; (2) the products being transacted are homogeneous; (3) there are low entry and exit barriers that allow losers to exit the market, and new entrants to come in; (4) there is perfect information (i.e., all participants are aware of the market conditions); and (5) all firms are attempting to maximize their profits (Varian 1992). The existence of a competitive market is a matter of the degree to which these conditions are met. Of great importance is the number of agents that participate in the market.

The focus will be on three key cases: monopolistic, oligopolistic, and competitive markets. It could be proven (Varian 1992) that the optimal prices/rates that a firm could charge in these markets follow well-established economic rules. A monopoly could charge a markup (an amount above production cost) that is bounded by the inverse of the demand elasticity. (The more inelastic the demand, the higher the markup.) In an oligopoly, the markup is constrained by the firm's market share. (The larger the share, the larger the markup.) Finally, no markup is possible in a competitive market, as the price equals the marginal cost. Mathematically, these three cases are shown below.

$$\frac{P-m}{P}=\frac{1}{|\eta|} \quad \text{(Monopoly)} \tag{1}$$

$$\frac{P_k-m_k}{P_k}=\frac{s_k}{|\eta|} \quad \text{(Oligopoly)} \tag{2}$$

$$P = m \quad \text{(Competitive market)} \tag{3}$$

where P = the market rate,

m = the marginal cost,

η = the elasticity of demand, and

s_k = the market share of producer k.

As shown, equations (1) and (3) could be obtained from equation (2) by setting s_k equal to 1 and 0, respectively. The term $(P - m)/P$ is referred to as the *markup*.

The fact that no markup is possible in a competitive market has major implications in freight transport. As illustrated in Figure A.2, the average costs of firms operating in the scale economies range are larger than their marginal costs. As a result, freight companies that participate in a competitive market and charge their clients at marginal costs will not be able to recoup their fixed costs. In the parlance of the trucking industry, these firms "eat their trucks." Far from being a theoretical curiosity, ample evidence suggests that this condition exists in the freight industry.

In the case of rail freight, "With excess capacity [and competition], railroads could ignore the cost of infrastructure and price at marginal cost; however, as volume grew [and competition for cargo decreased], excess capacity disappeared, and railroads needed to price at average costs—a higher threshold" (Prince 2008). Prince's description indicates the role played by the economic conditions that prompted the rail industry to set rates at marginal costs, even when doing so led them to lose money. Something similar happens in the urban delivery industry, as evidenced by the fact that the data show that only 9% of the carriers could pass time-of-day tolls to their customers. Not surprisingly, these carriers belong to industry segments in which individual firms have market power, such as the construction industry, food, and electronics (Holguín-Veras 2008). The remaining 91% of carriers had major difficulties in passing the toll costs to their customers because their contracts are based on distance, and do not allow for the inclusion of tolls (i.e., the tolls are a fixed cost that do not depend on the unit of output) (Holguín-Veras 2008; Holguín-Veras 2009).

Glossary

Activity-based costing (ABC): Approaches that match costs with the activities that cause those costs. [1]

Classification of the functions of government (COFOG): A United Nations database that describes the broad objectives of government.

Cost: The amount of monetary resources required to produce a set amount of a good or service.

Cost-benefit analysis (CBA): A formal procedure to estimate an indicator of economic performance that takes into account the costs and benefits brought about by a project during its economic life.

Data cost elements: The various inputs that enter into total cost.

Econometric cost estimation: Techniques that rely on the use of formal statistical procedures to estimate cost functions.

[1] Source: http://www.businessdictionary.com/definition/activity-based-costing-ABC.html

Economic costs: The actual costs of each activity without internal markups, transfers, or profits.

External costs: The costs that are not internalized by the participants in an economic transaction.

Fixed costs: The costs that do not depend on the output produced.

Freight planning activities: Activities related to the process by which freight issues and concerns are addressed in the statewide or metropolitan transportation planning activities and documents.

Freight policy activities: Activities related to the development of specific policy guidance concerning freight movements. Freight policy activities are designed to help metropolitan planning organizations (MPOs) assess their roles in addressing freight issues, and help focus metropolitan freight planning efforts.

Freight programming activities: Activities that involve the ways in which MPOs commit funds to freight specific projects.

Function: A group of related actions that contribute to a larger purpose or objective.

Inventory costs: The costs associated with storing and maintaining a stock of goods.

Logistics costs: The summation of transportation and inventory costs.

Long run: The period of time after which all input factors are variable.

Market costs (rates): The costs actually paid by the consumers in the market, equal to the sum of economic costs, transfers, and profits.

Markup: The additional amount a producer is able to extract from a consumer above and beyond the production cost. The profit associated with the rate charged to customers is generally considered part of the markup.

Metropolitan freight planning programs: Programs that integrate freight planning activities, freight policy activities, and freight programming activities into a comprehensive, continuous process.

Metropolitan planning organizations (MPOs): Federally mandated and federally funded transportation policy-making organizations made up of representatives from local governments and governmental transportation authorities.

Operational costs: Those expenses incurred in the daily running of a business, which may also be referred to as operating expenses.

Price: The amount of money expected, required, or given in payment for something.

Private costs: The costs that are incurred internally within the organizations of the participants in a transaction.

Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU): Federal legislation signed in 2005 to guarantee funding for highways, highway safety, and public transportation, with a total budget of $244.1 billion. SAFETEA-LU represents the largest surface transportation investment in the history of the United States.

Short run: The period of time during which some input factors are fixed.

Social costs: The summation of private and external costs.

Short-run average costs: Short-run total cost divided by the total output.

Short-run fixed costs: The summation of all fixed costs required to produce a set output.

Short-run marginal costs: The increment in total costs associated with an increase in total output. At the limit it is equal to the first derivative of total costs.

Short-run total (private) cost: The summation of fixed and variable costs.

Short-run unit fixed costs: The total fixed costs divided by the total output.

Short-run unit variable costs: The total variable costs divided by the total output.

Short-run variable costs: The summation of all variable costs required to produce a set output.

Unified planning work program (UPWP): A work program that lists the transportation studies and tasks to be performed by an MPO or one of the local jurisdictions.

(Transportation) user costs: The monetary expenses associated with the use or provision of transportation service.

Variable costs: The costs that depend on the unit of output produced by the firm.

Willingness to accept (WTA): The amount of money a consumer is willing to accept in exchange for a deteriorated condition.

Willingness to pay (WTP): The amount of money a consumer is willing to part with in exchange for an improved condition.

APPENDIX B

Cost Data Elements

TRUCKING

Trucking – Operational Inputs

Level	Task	Data Sources															Identification of Data Gaps			
	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal															● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
OPERATIONAL INPUTS	**Number of Days of Operation:**																			
	Per week																◐	◐	–	(1)
	Operating Hours:																			
	Per day																●	●	–	(1)
	Per year																◐	◐	–	(1)
	Operational Speed:																			
	Power unit										○						●	●	–	(1)
	Time Components:																			
	Cargo loading time at base (min.)															●	●	●	–	(1)
	Time to complete each stop (min.)															●	●	●	–	(1)
	Number of stops per trip															●	●	●	–	(1)
	Tour time															●	●	●	–	(1)
	Tour distance (miles)															●	●	●	–	(1)
	Trip Related Expenses:																			
	Permits (trip specific)																●	●	**X**	(2)
	Tolls																●	●	**X**	(2)
	Parking costs per stop (including tickets)																●	●	**X**	(2)

Trucking – Ancillary Related Inputs

Level	Task / Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
ANCILLARY RELATED INPUTS	**Building / Land Costs:**																			
	Office space								●								○	◐	**X**	(3)
	Warehouse space								●								○	◐	**X**	(3)
	Land Lease																○	◐	**X**	(3)
	Utilities:																			
	Power																○	◐	**X**	(3)
	Heating / Cooling																○	◐	**X**	(3)
	Water																○	◐	**X**	(3)
	Special Equipment:																			
	Handling equipment								●								○	◐	**X**	(3)
	Snow plowing equipment																○	◐	**X**	(3)
	Safety equipment																○	◐	**X**	(3)
	Number of Employees:																			
	Administration staff					●											○	◐	**X**	(3)
	Other workers					●											○	◐	**X**	(3)
	Wages:																			
	Administration staff		◐	●				●		●		●				●	○	◐	✓	(3)
	Other workers		◐	●				●		●		●				●	○	◐	✓	(3)

(continued on next page)

	Task	Data Sources															Identification of Data Gaps			
Level	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
ANCILLARY RELATED INPUTS	**Benefits and Bonuses:**																			
	Administration staff							●								●	○	◐	**X**	(3)
	Other workers							●								●	○	◐	**X**	(3)
	Maintenance																			
	Office space																○	◐	**X**	(3)
	Warehouse space																○	◐	**X**	(3)
	Licensing / Permits / Insurance																			
	Workers' compensation insurance																○	◐	**X**	(3)
	Health insurance																○	◐	**X**	(3)
	Property insurance																○	◐	**X**	(3)
	Other taxes & fees				●											●	○	◐	**X**	(3)

Trucking – Labor Related Inputs

Level	Task	Data Sources															Identification of Data Gaps			
	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
LABOR RELATED INPUTS	**Number of Employees per Trip:**																			
	Driver					●										●	●	●	-	(4)
	Crew					●										●	◐	◐	-	(4)
	Wages:																			
	Drivers ($/hour or $/mile)		◐	●				●		●		●		○		●	●	●	✓	(4)
	Crew ($/hour or $/mile)		◐	●				●		●		●		○		●	◐	◐	✓	(4)
	Benefits and Bonuses:																			
	Drivers							●						○		●	●	●	**X**	(4)
	Crew							●						○		●	◐	◐	**X**	(4)
	Training / Safety:																			
	Drivers (annual cost)													○			○	◐	**X**	(5)
	Crew (annual cost)													○			○	◐	**X**	(5)
	Overhead:																			
	Percentage*																◐	●	**X**	(4)
	Calculated*																◐	●	**X**	(4)

* For Overhead only “percentage” or “calculated” is needed, not both.

Trucking – Equipment Related Inputs

Level	Task	Data Sources															Identification of Data Gaps			
	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Average Purchase Cost:**																			
	Power unit	●					●		●				●	◐			●	●	✓	(6)
	Trailer								●				●	◐			●	●	✓	(6)
	Specialized equipment								●				◐	◐			●	●	✓	(6)
	Special aftermarket equipment													○			◐	◐	**X**	(6)
	Estimated Salvage Value:																			
	Power unit	●					●						●	○			●	●	✓	(6)
	Trailer												●	○			●	●	✓	(6)
	Specialized equipment												●	○			●	●	**X**	(6)
	Lease / Purchase Payments:																			
	Power unit								◐								◐	◐	**X**	(6)
	Trailer								◐								◐	◐	**X**	(6)
	Specialized equipment								◐								◐	◐	**X**	(6)
	Number of Miles Per Year:																			
	Power unit					●			○								◐	◐	**-**	(7)
	Trailer					●			○								◐	◐	**-**	(7)

	Task	Data Sources															Identification of Data Gaps			
Level	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Average Service Life:**																			
	Power unit (miles)	◐				●							◐	◐			●	●	✓	(6)
	Trailer (miles)	◐				●							◐	◐			●	●	✓	(6)
	Specialized equipment (hours of service)					●								○			◐	◐	✓	(6)
	Tires (miles)					●								◐			◐	◐	✓	(6)
	Average Maintenance Costs:																			
	Power unit								○					○			●	●	**X**	(8)
	Trailer								○					○			●	●	**X**	(8)
	Specialized equipment								○					○			◐	◐	**X**	(8)
	Depreciation:																			
	Power unit																◐	◐	**X**	(6)
	Trailer																◐	◐	**X**	(6)
	Specialized equipment																◐	◐	**X**	(6)
	Tires (if separated)																○	○	**X**	(6)
	Insurance / Licenses / Permits:																			
	Power unit								○					○			●	●	**X**	(9)
	Trailer								○					○			●	●	**X**	(9)

(continued on next page)

	Task	Data Sources															Identification of Data Gaps			
Level	Cost Data Element	Black Book	Covered Employment and Wages	Employment Statistics	Highway Taxes and Fees	Motor Carrier Annual Report	Official Commercial Truck Guide	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Truck Drivers, Heavy and Tractor-Trailer	TruckPaper.com	Commercial Carrier Journal	Weekly On-Highway Diesel Prices	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ●Excellent ◐ Medium ○ Minimal															● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Taxes:**																			
	Sales tax				●											●	◐	◐	**X**	(10)
	Fuel tax				●											●	◐	●	**X**	(10)
	Highway use tax				●											●	◐	◐	**X**	(10)
	Unit Costs:																			
	Fuel ($/gallon)								◐					○	●		●	●	✓	(11)
	Oil ($/gallon)													○	◐		●	●	✓	(11)
	Tires ($/tire)													◐			◐	●	✓	(11)
	Consumption:																			
	Fuel (gallons)										●			○			●	●	✓	(12)
	Oil (gallons)										●			○			○	◐	✓	(12)
	Power unit tires (# of tires)													○			◐	◐	**X**	(12)
	Trailer tires (# of tires)													○			◐	◐	**X**	(12)
	Trailer Configuration Mileage:																			
	Trip miles for single trailers					●											●	●	**–**	(7)
	Trip miles for double trailers					●											●	●	**–**	(7)
	Trip miles for triple trailers					●											●	●	**–**	(7)
	Monitoring Devices and Communication System Costs:																			
	Cellular phone expenses (per month)								●								◐	◐	**X**	(13)
	Vehicle tracking expenses (per month)																◐	◐	**X**	(13)

Trucking – Remarks

	Remarks
(1)	Operational costs are expected to maintain their same level of importance in the future.
(2)	Specialized operational costs are expected to continue to be of high importance in the future.
(3)	Freight markets are expected to become even more competitive in the future. Therefore, overhead-related costs are expected to increase in importance in the future.
(4)	As new regulations and policies are introduced, the labor-related costs are expected to continue to have the same level of importance as they have currently.
(5)	As new regulations are introduced and insurance costs continue to rise, the costs associated with proper training are expected to increase; however, the cost to a shipment should be minimal.
(6)	Equipment-related costs are expected to maintain the same level of importance in the future. The equipment costs represent a substantial fixed cost and must accurately be reflected.
(7)	Operational costs are expected to maintain the same level of importance in the future; the number of miles per year will affect the salvage value and service life.
(8)	Maintenance costs are expected to keep the same level of importance in the future. As freight market competitiveness grows, companies will continue to maintain their equipment so they can maximize its useful life.
(9)	Insurance premiums and government fees are expected to continue to rise in the future and will continue to be critical cost components.
(10)	Government taxes and fees are expected to maintain the existing level of importance in the future. If there is an increase or a restructuring in the fuel tax, then it is expected that the cost of fuel will increase, therefore making this cost item more important in the future.
(11)	As natural resources continue to be depleted and oil prices remain volatile, it is expected that these costs will remain a critical focus in the future.
(12)	As the awareness of environmental concerns continues to grow, the consumption of oil and rubber products will remain a key focus.
(13)	Communication costs are an essential cost for freight companies. It is expected that these companies will continue to have up-to-date systems to more efficiently move their goods.

RAIL

Rail – General

	Task	Data Sources													Identification of Data Gaps			
Level	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
GENERAL	**Length of Haul:**																	
	Length of haul	●	◐							○	○			○	●	●	-	(1)
	Car Ownership:																	
	Railroad supplied	●	◐											○	●	●	-	(1)
	Privately owned	●	◐											○	●	●	-	(1)
	Train Type:																	
	Single car movement													○	◐	◐	-	(1)
	Multi-car movement													○	◐	◐	-	(1)
	Unit Train movement													○	◐	◐	-	(1)
	Intermodal shipment													○	◐	◐	-	(1)

Rail – Operational Inputs

Level	Task	Data Sources													Identification of Data Gaps			
	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
OPERATIONAL INPUTS	**Train Makeup:**																	
	Number of engines	●													●	●	-	(1)
	Number of freight cars	●													●	●	-	(1)
	Car days loading/unloading	●													●	●	-	(1)
	Time Components:																	
	Running car days	◐													●	●	-	(1)
	Total car days in yard	◐													●	●	-	(1)
	Car days loading/unloading	◐													●	●	-	(1)
	Charge per car day for railroad owned car	◐													●	●	-	(1)
	Trailer days per origination or termination event														●	●	-	(1)
	Switch engine minutes														●	●	-	(1)

(continued on next page)

Level	Task: Cost Data Element	Data Sources: Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Identification of Data Gaps: Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
OPERATIONAL INPUTS	**Mileage Components:**																	
	Empty miles per car day	◐													●	●	-	(1)
	Loaded miles per car day	◐													●	●	-	(1)
	Total miles per car day	◐	◐												●	●	-	(1)
	Car miles per switch	◐													●	●	-	(1)
	Private freight car, car mile rental charge	◐													●	●	-	(1)
	Way train miles including circuitry	◐		◐											●	●	-	(1)
	Average miles between interchanges	◐													●	●	-	(1)
	Charge per car mile for railroad owned car	◐													●	●	-	(1)
	Through train miles including circuitry	◐													●	●	-	(1)
	Line haul miles per trailer day	◐													●	●	-	(1)
	Unit train miles including circuitry	◐													●	●	-	(1)
	Load Components:																	
	Tons handled	●	◐												●	●	-	(1)
	Average tare weight of an empty freight car	●													●	●	-	(1)
	Average gross tons for a unit train	●													●	●	-	(1)
	Average gross tons for a way train	●	◐												●	●	-	(1)
	Average gross tons for a through train	●													●	●	-	(1)
	Average tare weight for trailer/container														●	●	-	(1)

Rail – Ancillary Related Inputs

Level	Task	Data Sources													Identification of Data Gaps			
	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
ANCILLARY RELATED INPUTS	**Building / Land / Infrastructure Costs:**																	
	Office space	○						◐							○	◐	✓	(3)
	Track	○		●											○	◐	✓	(3)
	Switches	○													○	◐	X	(3)
	Bridges	○													○	◐	X	(3)
	Culverts	○													○	◐	X	(3)
	Yards	○													○	◐	X	(3)
	Other buildings / structures	○		◐											○	◐	X	(3)
	Warehouse space	○						◐							○	◐	X	(3)
	Land Lease	○													○	◐	X	(3)
	Utilities:																	
	Power									○					○	◐	X	(3)
	Heating / Cooling														○	◐	X	(3)
	Water														○	◐	X	(3)

(continued on next page)

	Task	Data Sources													Identification of Data Gaps			
Level	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
ANCILLARY RELATED INPUTS	**Special Equipment:**																	
	Handling equipment		◐					◐							○	○	X	(3)
	Snow plowing equipment														○	○	X	(3)
	Inspection vehicles		◐												○	○	X	(3)
	Safety equipment		◐												○	○	X	(3)
	Number of Employees:																	
	Administration staff										◐		○		◐	◐	✓	(3)
	Other workers										◐		○		◐	◐	✓	(3)
	Wages:																	
	Administration staff ($/hour)	◐			◐	●	●				◐	◐		◐	◐	◐	✓	(3)
	Other workers ($/hour)	◐			◐	●	●				◐	◐		◐	◐	◐	✓	(3)
	Benefits and Bonuses:																	
	Administration staff	◐					●				◐			◐	◐	◐	✓	(3)
	Other workers	◐					●				◐			◐	◐	◐	✓	(3)

Level	Task	Data Sources													Identification of Data Gaps			
Level	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
ANCILLARY RELATED INPUTS	**Maintenance:**																	
	Office space														○	◐	X	(3)
	Track	●		◐											○	◐	✓	(3)
	Switches	●													○	◐	✓	(3)
	Bridges	●													○	◐	✓	(3)
	Culverts	●													○	◐	✓	(3)
	Yards	●													○	◐	✓	(3)
	Other buildings / structures	●		◐											○	◐	✓	(3)
	Warehouse space														○	◐	X	(3)
	Licensing / Permits / Insurance:																	
	Federal Employers' Liability Act (FELA)														○	◐	X	(3)
	Health insurance	○									◐				○	◐	X	(3)
	Property insurance	○									○				○	◐	X	(3)
	Security equipment														○	◐	X	(3)
	Other taxes & fees														◐	◐	X	(3)

Rail – Labor Related Inputs

Level	Task	Data Sources													Identification of Data Gaps			
	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
LABOR RELATED INPUTS	**Number of Employees per Train:**																	
	Engineer		○										○		●	●	-	(4)
	Crew		○										○		◐	◐	-	(4)
	Wages:																	
	Engineer ($/hour)	●			◐	●	●		●		◐	◐		◐	●	●	✓	(4)
	Crew ($/hour)	●			◐	●	●		●		◐	◐		◐	●	●	✓	(4)
	Benefits and Bonuses:																	
	Engineer	◐					●				◐			◐	●	●	✓	(4)
	Crew	◐					●				◐			◐	●	●	✓	(4)
	Training / Safety:																	
	Engineer (annual cost)		○												○	◐	**X**	(5)
	Crew (annual cost)		○												○	◐	**X**	(5)
	Overhead:																	
	Percentage*	●									○				●	●	-	(4)
	Calculated*	●									○				●	●	-	(4)

* For Overhead only “percentage” or “calculated” is needed, not both.

Rail – Equipment Related Inputs

Level	Task	Data Sources													Identification of Data Gaps			
	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Average Purchase Cost:**																	
	Locomotive	●	○					●			◐				●	●	✓	(6)
	Rolling stock	●	○												●	●	✓	(6)
	Estimated Salvage Value:																	
	Locomotive	○	○								◐				●	●	**X**	(6)
	Rolling stock	○	○												●	●	**X**	(6)
	Lease / Purchase Payments:																	
	Locomotive	◐						●							◐	◐	**X**	(6)
	Rolling stock	◐													◐	◐	**X**	(6)
	Number of Miles Per Route:																	
	Locomotive		○								○				◐	◐	-	(7)
	Rolling stock		○								○				◐	◐	-	(7)
	Average Service Life:																	
	Locomotive	◐									◐				●	●	✓	(6)
	Rolling stock	◐									◐				●	●	✓	(6)

(continued on next page)

	Task	Data Sources													Identification of Data Gaps			
Level	Cost Data Element	Class I Railroad Annual Reports (R-1)	Railway Age	Railway Track and Structures	Covered Employment and Wages	Employment Statistics	Pay and Benefits	Producer Price Index	Productivity Statistics	Transp. Energy Data Book	Railroad Ten-Year Trends	Wage Statistics	Railroad Employment	One-time reports	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal													● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--** : to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Average Maintenance Costs:**																	
	Locomotive							◐							●	●	X	(8)
	Rolling stock														●	●	X	(8)
	Depreciation:																	
	Locomotive	◐													◐	◐	✓	(6)
	Rolling stock	◐													◐	◐	✓	(6)
	Insurance / Licenses / Permits:																	
	Locomotive	◐						◐							●	●	X	(9)
	Rolling stock	◐						◐							●	●	X	(9)
	Energy Unit Costs:																	
	Fuel ($/gallon)	◐						◐			◐				●	●	✓	(11)
	Oil ($/gallon)	◐													●	●	✓	(11)
	Energy Consumption:																	
	Fuel (gallons)									○	◐				●	●	✓	(12)
	Oil (gallons)														◐	◐	X	(12)
	Monitoring Devices and Communication System Costs:																	
	Communications and signals	●	○												●	●	✓	(13)

Rail – Remarks

	Remarks
(1)	Operational costs are expected to maintain the same level of importance in the future.
(2)	Specialized operational costs are expected to continue to be of high importance in the future.
(3)	Freight markets are expected to become even more competitive in the future. Therefore, overhead-related costs are expected to increase in importance in the future.
(4)	As new regulations and policies are introduced, the labor-related costs are expected to continue to have the same level of importance as they have currently.
(5)	As new regulations are introduced and insurance costs continue to rise, the costs associated with proper training are expected to increase; however, the cost to a shipment should be minimal.
(6)	Equipment-related costs are expected to maintain the same level of importance in the future. The equipment costs represent a substantial fixed cost and must accurately be reflected.
(7)	Operational costs are expected to maintain the same level of importance in the future; the number of miles per year will affect the salvage value and service life.
(8)	Maintenance costs are expected to keep the same level of importance in the future. As freight market competitiveness grows, companies will continue to maintain their equipment so they can maximize its useful life.
(9)	Insurance premiums and government fees are expected to continue to rise in the future and will continue to be critical cost components.
(10)	Government taxes and fees are expected to maintain the existing level of importance in the future. If there is an increase or a restructuring in the fuel tax, then it is expected that the cost of fuel will increase, therefore making this cost item more important in the future.
(11)	As natural resources continue to be depleted and oil prices remain volatile, it is expected that these costs will remain a critical focus in the future.
(12)	As the awareness of environmental concerns continues to grow, the consumption of oil and rubber products will remain a key focus.
(13)	Communication costs are an essential cost for freight companies. It is expected that these companies will continue to have up-to-date systems to more efficiently move their goods.

WATERWAYS

Waterways – Operational Inputs

Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
OPERATIONAL INPUTS	**Time Components:**														
	Time to travel between terminals											●	●	-	(1)
	Time to load / unload boat / barge											●	●	-	(1)
	Other Expenses:														
	Wharf / dockage charges											◐	●	**X**	(2) (16)
	Steam ship charges											◐	●	**X**	(2)
	Terminal charges											◐	●	**X**	(2) (16)

Waterways – Ancillary Related Inputs

Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
ANCILLARY RELATED INPUTS	**Building / Land Costs:**														
	Office space			○								○	◐	**X**	(3)
	Land			○								○	◐	**X**	(3)
	Utilities:														
	Power											○	◐	**X**	(3) (11)
	Heating / Cooling											○	◐	**X**	(3) (11)
	Water											○	◐	**X**	(3) (11)
	Security Costs:														
	Security guards											○	◐	**X**	(3)
	Security systems											○	◐	**X**	(3)
	Number of Employees:														
	Administration staff			○								○	◐	**X**	(3)
	Other workers			○								○	◐	**X**	(3)
	Wages:														
	Administration staff	●	●	○	●							○	◐	✓	(3)
	Other workers	●	●	○	●							○	◐	✓	(3)

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Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
ANCILLARY RELATED INPUTS	**Benefits and Bonuses:**														
	Administration staff			○	●							○	◐	**X**	(3)
	Other workers			○	●							○	◐	**X**	(3)
	Maintenance:														
	Office space											○	◐	**X**	(3)
	Licensing / Permits / Insurance:														
	Federal Employers' Liability Act (FELA)											○	◐	**X**	(3)
	Health insurance											○	◐	**X**	(3)
	Property insurance											○	◐	**X**	(3)
	User taxes (i.e., locks, etc.)											○	◐	**X**	(3) (16)
	Environmental regulations			○								○	◐	**X**	(3) (9)

Waterways – Labor Related Inputs

Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
LABOR RELATED INPUTS	**Number of Employees:**														
	Operators (Captains & Pilots)			○			●					●	●	✓	(4) (15)
	Crew			○			●					●	●	✓	(4) (15)
	Wages:														
	Operators (Captains & Pilots) ($/hour)	◐	◐	○	●		◐			○	○	●	●	**X**	(4) (15)
	Crew ($/hour)	◐	◐	○	●		◐			○	○	◐	●	**X**	(4) (15)
	Benefits and Bonuses:														
	Operators (Captains & Pilots)			○	●		◐					●	●	**X**	(4) (15)
	Crew			○	●		◐					◐	●	**X**	(4) (15)
	General benefits (i.e., food, etc.)				●		◐					○	○	**X**	(4) (15)
	Training / Safety:														
	Operators (Captains & Pilots)									○	○	○	◐	**X**	(5) (9)
	Crew (annual cost)									○	○	○	◐	**X**	(5) (9)
	Overhead:														
	Percentage*						◐					◐	●	**X**	(4) (16)
	Calculated*						◐					◐	●	**X**	(4) (16)

* For Overhead only "percentage" or "calculated" is needed, not both.

Waterways – Equipment Related Inputs

Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
EQUIPMENT RELATED INPUTS	**Number of Pieces of Equipment:**														
	Towing vessels			◐				◐	●	○	○	●	●	✓	(6)
	Barges			◐				◐	●	○	○	●	●	✓	(6)
	Average Purchase Cost:														
	Towing vessels			○		◐	●			○	◐	●	●	✓	(6)
	Barges			○		◐	●			○	◐	●	●	✓	(6)
	Estimated Salvage Value:														
	Towing vessels						●			○	○	●	●	✓	(6)
	Barges						●			○	○	●	●	✓	(6)
	Charters / Purchase Payments:														
	Towing vessels											◐	●	**X**	(6)
	Barges											◐	●	**X**	(6)
	Operating Days Per Year:														
	Towing vessels (hours)			○			●					◐	●	-	(1)
	Barges			○			●					◐	●	-	(1)
	Average Service Life:														
	Towing vessels (hours)			○				◐	●	○	○	●	●	✓	(6)
	Barges			○				◐	●	○	○	●	●	✓	(6)

Level	Task	Data Sources										Identification of Data Gaps			
	Cost Data Element	Covered Employment and Wages	Employment Statistics	Major Marine Shippers 10-K Financial Statements	Pay and Benefits	Producer Price Index	Shallow Draft Vessel Operating Costs	Waterborne Transportation Lines (Volume 1)	Waterborne Transportation Lines (Volume 3)	Waterways Journal	WorkBoat Magazine	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	Level of Detail: ● Excellent ◐ Medium ○ Minimal										● Essential ◐ Important ○ Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
	Average Maintenance Costs:														
	Towing vessels						●				○	●	●	X	(7)
	Barges						●				○	●	●	X	(7)
	Depreciation:														
	Towing vessels			○			◐			○	○	◐	●	X	(6)
	Barges			○			◐			○	○	◐	●	X	(6)
	Insurance / Licenses / Permits:														
	Equipment			○			◐					●	●	X	(8)
	Licenses for operation											●	●	X	(8) (16)
	Lock charges											●	●	X	(8) (16)
	Unit Costs:														
	Fuel ($/gallon)			◐		●	◐			○	○	●	●	✓	(10) (11)
	Oil ($/gallon)					●				○	○	●	●	✓	(10) (11)
	Consumption:														
	Fuel (gallons/hour)			◐			◐			○	○	●	●	✓	(11)
	Oil (gallons)									○	○	○	◐	X	(11)
	Monitoring Devices and Communication System Costs:														
	Equipment tracking expenses (per month)										○	◐	●	X	(12)

Waterways – Remarks

	Remarks
(1)	Operational costs are expected to maintain the same level of importance in the future.
(2)	Specialized operational costs are expected to continue to be of high importance in the future.
(3)	Freight markets are expected to become even more competitive in the future; therefore, overhead-related costs are expected to increase in importance in the future.
(4)	As new regulations and policies are introduced, the labor-related costs are expected to continue to have the same level of importance as they have currently.
(5)	As new regulations are introduced and insurance costs continue to rise, the costs associated with proper training are expected to increase; however, the cost to a shipment should be minimal.
(6)	Equipment-related costs are expected to maintain the same level of importance in the future. The equipment costs represent a substantial fixed cost and must be reflected accurately.
(7)	Maintenance costs are expected to keep the same level of importance in the future. As freight market competitiveness grows, companies will continue to maintain their equipment so they can maximize its useful life.
(8)	Insurance premiums and government fees are expected to continue to rise in the future and will continue to be critical cost components.
(9)	The waterway freight transportation sector is subject to regulation by the USCG, federal laws, state laws, and certain international conventions, as well as environmental regulations.
(10)	As natural resources continue to be depleted and oil prices remain volatile, it is expected that these costs will remain a critical focus in the future.
(11)	As the awareness of environmental concerns continues to grow, the consumption of oil products will remain a key focus.
(12)	Communication costs are an essential cost for freight companies. It is expected that these companies will continue to have up-to-date systems to more efficiently move their goods.
(13)	This sector is subject to risks associated with possible climate change legislation, regulation, and international accords.
(14)	The sector could be adversely impacted by a marine accident or spill event.
(15)	The sector is dependent on its ability to adequately crew towing vessels.
(16)	The inland waterway infrastructure is aging and may result in increased costs and disruptions to the maritime transportation sector.

TERMINALS

Terminals – Gate Processing (GP)

	Task	Identification of Data Gaps			
Level	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Gate Processing	**Time Spent at Gate:**				
	Inbound	◐	◐	**X**	(1)
	Outbound	◐	◐	**X**	(1)

Terminals – Internal Movements (IM)

Level	Task	Identification of Data Gaps			
	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Internal Movements (IM)	**Type of Equipment Used:**				
	Truck	●	●	-	(1)
	Train	●	●	-	(1)
	Forklift	●	●	-	(1)
	Conveyor	●	●	-	(1)
	Equipment - General:				
	# of pieces of a particular type of equipment	◐	◐	-	(2)
	Average time to complete an IM	●	●	-	(2)
	Equipment Fixed Costs:				
	Average purchase cost	●	●	**X**	(6)
	Estimated salvage value	◐	◐	**X**	(6)
	Taxes	◐	◐	**X**	(10)
	Insurance / Licenses / Permits	◐	●	**X**	(9)
	Equipment Variable Costs:				
	Operating costs	●	●	**X**	(1)
	Fuel or electricity consumption	◐	●	**X**	(12)
	Average maintenance costs	○	◐	**X**	(8)
	Depreciation	◐	◐	**X**	(6)
	Fuel cost	●	●	✓	(11)
	Electricity cost	●	●	✓	(11)
	Tire cost	◐	◐	✓	(11)
	Equipment Labor Costs:				
	# of operators needed	●	●	-	(4)
	# of ground workers needed	●	●	-	(4)
	Operator time consumed for movement	●	●	-	(4)
	Ground worker time consumed for movement	●	●	-	(4)
	Wages for operators	●	●	✓	(4)
	Wages for ground workers	●	●	✓	(4)
	Benefits / bonuses for operators	◐	◐	**X**	(4)
	Benefits / bonuses for ground workers	◐	◐	**X**	(4)
	Training for operators	○	◐	**X**	(4)
	Training for ground workers	○	◐	**X**	(4)

Terminals – Sorting / Organizing (S/O)

Level	Task	Identification of Data Gaps			
	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Sorting / Organizing (S/O)	Containers	◐	◐	-	(1)
	Rail cars	◐	◐	-	(1)
	Trailers	◐	◐	-	(1)
	Type of Equipment Used:				
	Yard crane	●	●	-	(1)
	Overhead crane	●	●	-	(1)
	Forklift	●	●	-	(1)
	Locomotive	●	●	-	(1)
	Truck	●	●	-	(1)
	Equipment - General:				
	# of pieces of a particular type of equipment	●	●	-	(2)
	Average time to complete S/O	●	●	-	(2)
	Equipment Fixed Costs:				
	Average purchase cost	●	●	**X**	(6)
	Estimated salvage value	◐	●	**X**	(6)
	Taxes	◐	●	**X**	(10)
	Insurance / Licenses / Permits	◐	●	**X**	(9)

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	Task	Identification of Data Gaps			
Level	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Sorting / Organizing (S/O)	**Equipment Variable Costs:**				
	Operating costs	●	●	**X**	(1)
	Fuel or electricity consumption	●	●	**X**	(12)
	Average maintenance costs	◐	◐	**X**	(8)
	Depreciation	◐	◐	**X**	(6)
	Fuel cost	●	●	**X**	(11)
	Electricity cost	●	●	**X**	(11)
	Tire cost	◐	◐	**X**	(11)
	Equipment Labor Costs:				
	# of operators needed	●	●	**-**	(4)
	# of ground workers needed	●	●	**-**	(4)
	Operator time consumed for movement	●	●	**-**	(4)
	Ground worker time consumed for movement	●	●	**-**	(4)
	Wages for operators	●	●	✓	(4)
	Wages for ground workers	●	●	✓	(4)
	Benefits / bonuses for operators	◐	◐	**X**	(4)
	Benefits / bonuses for ground workers	◐	◐	**X**	(4)
	Training for operators	○	◐	**X**	(4)
	Training for ground workers	○	◐	**X**	(4)

Terminals – Loading / Unloading (L/U)

Level	Task	Identification of Data Gaps			
	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Loading / Unloading (L/U)	**Mode of Transportation Being Loaded / Unloaded:**				
	Ship	●	●	-	(1)
	Barge	●	●	-	(1)
	Truck	●	●	-	(1)
	Rail cars	●	●	-	(1)
	Type of Commodity Being Loaded / Unloaded:				
	Containers	●	●	-	(1)
	Trailers	●	●	-	(1)
	Dry Bulk	●	●	-	(1)
	Special equipment	●	●	-	(1)
	Liquid	●	●		(1)
	Gantry crane	●	●	-	(1)
	Overhead crane	●	●	-	(1)
	Yard crane	●	●	-	(1)
	Forklift	●	●	-	(1)
	Equipment - General:				
	# of pieces of a particular type of equipment	●	●	-	(2)
	Average time to complete L/U	●	●	-	(2)
	Equipment Fixed Costs:				
	Average purchase cost	●	●	**X**	(6)
	Estimated salvage value	●	●	**X**	(6)
	Taxes	◐	●	**X**	(10)
	Insurance / Licenses / Permits	◐	●	**X**	(9)

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Level	Task	Identification of Data Gaps			
	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Loading / Unloading (L/U)	**Equipment Variable Costs:**				
	Operating costs	●	●	**X**	(1)
	Fuel or electricity consumption	●	●	**X**	(12)
	Average maintenance costs	◐	◐	**X**	(8)
	Depreciation	◐	◐	**X**	(6)
	Fuel cost	●	●	**X**	(11)
	Electricity cost	●	●	**X**	(11)
	Tire cost	◐	◐	**X**	(11)
	Equipment Labor Costs:				
	# of operators needed	●	●	-	(4)
	# of ground workers needed	●	●	-	(4)
	Operator time consumed for movement	●	●	-	(4)
	Ground worker time consumed for movement	●	●	-	(4)
	Wages for operators	●	●	✓	(4)
	Wages for ground workers	●	●	✓	(4)
	Benefits / bonuses for operators	◐	◐	**X**	(4)
	Benefits / bonuses for ground workers	◐	◐	**X**	(4)
	Training for operators	○	◐	**X**	(4)
	Training for ground workers	○	◐	**X**	(4)

Terminals – Ancillary Related Inputs

Level	Task	Identification of Data Gaps			
	Cost Data Element	Current Level of Importance of Cost Elements	Future Level of Importance of Cost Elements	Data Gap	Remarks
	Legend	●Essential ◐Important ○Useful **X**: data gap exists, ✓: no data gap exists, **--**: to be provided from analyst			
Ancillary Related Inputs	**Building / Land Costs:**				
	Office space	◐	●	**X**	(3)
	Warehouse space	◐	●	**X**	(3)
	Land Lease	◐	●	**X**	(3)
	Maintenance facilities	◐	●	**X**	(3)
	Utilities:				
	Power	○	◐	**X**	(3)
	Heating / Cooling	○	◐	**X**	(3)
	Water	○	◐	**X**	(3)
	Security Costs:				
	Fence and gate costs	○	◐	**X**	(3)
	Security guards	○	◐	**X**	(3)
	Security systems	○	◐	**X**	(3)
	Special Equipment:				
	Snow plowing equipment	○	○	**X**	(3)
	Safety equipment	○	○	**X**	(3)
	Number of Employees:				
	Administration staff	◐	◐	**-**	(3)
	Other workers	◐	◐	**-**	(3)
	Wages:				
	Administration staff	◐	◐	✓	(3)
	Other workers	◐	◐	✓	(3)
	Benefits and Bonuses:				
	Administration staff	◐	◐	**X**	(3)
	Other workers	◐	◐	**X**	(3)
	Maintenance:				
	Office space	◐	◐	**X**	(3)
	Warehouse space	◐	◐	**X**	(3)
	Licensing / Permits / Insurance:				
	Workers' compensation insurance	◐	●	**X**	(3)
	Health insurance	◐	●	**X**	(3)
	Property insurance	◐	●	**X**	(3)

Terminals – Remarks

	Remarks
(1)	Operational costs are expected to maintain the same level of importance in the future.
(2)	Specialized operational costs are expected to continue to be of high importance in the future.
(3)	Freight markets are expected to become even more competitive in the future; therefore, overhead-related costs are expected to increase in importance in the future.
(4)	As new regulations and policies are introduced, the labor-related costs are expected to continue to have the same level of importance as they have currently.
(5)	As new regulations are introduced and insurance costs continue to rise, the costs associated with proper training are expected to increase; however, the cost to a shipment should be minimal.
(6)	Equipment-related costs are expected to maintain the same level of importance in the future. The equipment costs represent a substantial fixed cost and must be reflected accurately.
(7)	Operational costs are expected to maintain the same level of importance in the future, and the number of miles per year will affect the salvage value and service life.
(8)	Maintenance costs are expected to keep the same level of importance in the future. As freight market competitiveness grows, companies will continue to maintain their equipment so they can maximize its useful life.
(9)	Insurance premiums and government fees are expected to continue to rise in the future and will continue to be critical cost components.
(10)	Government taxes and fees are expected to maintain the existing level of importance in the future. If there is an increase or a restructuring in the fuel tax, then it is expected that the cost of fuel will increase, therefore making this cost item more important in the future.
(11)	As natural resources continue to be depleted and oil prices remain volatile, it is expected that these costs will remain a critical focus in the future.
(12)	As the awareness of environmental concerns continues to grow, the consumption of oil and rubber products will remain a key focus.
(13)	Communication costs are an essential cost for freight companies. It is expected that these companies will continue to have up-to-date systems to more efficiently move their goods.

APPENDIX C

Data Collection Techniques

TRUCKING

Trucking – Operational Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
OPERATIONAL INPUTS	**Number of Days of Operation:**											
	Per week					✔	✓		✔			
	Operating Hours:											
	Per day					✔	✓		✔			
	Per year					✔	✓		✔			
	Operational Speed:											
	Power unit				✔	✓	✓	✔				
	Time Components:											
	Cargo loading time at base (min.)				✓	✔	✓		✔			
	Time to complete each stop (min.)				✓	✔	✓		✔			
	Number of stops per trip				✓	✔	✓		✔			
	Tour time				✓	✔	✓			✔		
	Tour distance (miles)				✓	✔	✓			✔		
	Trip Related Expenses:											
	Permits (trip specific)				✔	✓			✔			
	Tolls				✔	✓			✔			
	Parking costs per stop (including tickets)				✔	✓			✔			

Trucking – Ancillary Related Inputs

		Data Collection Technique (✓ Preferred, ✓ Method)						Data Collection Frequency (✓ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
ANCILLARY RELATED INPUTS	**Building / Land Costs:**											
	Office space			✓✓	✓	✓	✓		✓✓			
	Warehouse space			✓✓	✓	✓	✓		✓✓			
	Land Lease					✓✓	✓		✓✓			
	Utilities:											
	Power					✓✓	✓			✓✓		
	Heating / Cooling					✓✓	✓			✓✓		
	Water					✓✓	✓			✓✓		
	Special Equipment:											
	Handling equipment				✓	✓✓	✓	✓✓				
	Snow plowing equipment				✓	✓✓		✓✓				
	Safety equipment				✓	✓✓			✓✓			
	Number of Employees:											
	Administration staff					✓✓	✓		✓✓			
	Other workers					✓✓	✓		✓✓			
	Wages:											
	Administration staff			✓✓		✓	✓		✓✓			
	Other workers			✓✓		✓	✓		✓✓			
	Benefits and Bonuses:											
	Administration staff			✓✓		✓	✓		✓✓			
	Other workers			✓✓		✓	✓		✓✓			
	Maintenance											
	Office space					✓✓	✓		✓✓			
	Warehouse space					✓✓	✓		✓✓			
	Licensing / Permits / Insurance											
	Workers' compensation insurance				✓✓	✓	✓		✓✓			
	Health insurance				✓	✓✓	✓		✓✓			
	Property insurance				✓	✓✓	✓		✓✓			
	Other taxes & fees				✓	✓✓	✓		✓✓			

Trucking – Labor Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
LABOR RELATED INPUTS	**Number of Employees per Trip:**											
	Driver		✔	✔		✓	✓				✔	
	Crew		✔	✔		✓	✓				✔	
	Wages:											
	Drivers ($/hour or $/mile)		✔	✓		✔	✓				✔	
	Crew ($/hour or $/mile)		✔	✓		✔	✓				✔	
	Benefits and Bonuses:											
	Drivers			✓	✔	✓	✔				✔	
	Crew			✓	✔	✓	✔				✔	
	Training / Safety:											
	Drivers (annual cost)		✓		✔	✓	✓	✔				
	Crew (annual cost)		✓		✔	✓	✓	✔				
	Overhead:											
	Percentage*						✔			✔		
	Calculated*						✔			✔		

*For Overhead only “percentage” or “calculated” is needed, not both.

Trucking – Equipment Related Inputs

Cost Data Element	Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
Average Purchase Cost:											
Power unit	✓	✔	✓	✔	✓	✓			✔		
Trailer	✓	✔	✓	✔	✓	✓			✔		
Specialized equipment	✓	✔	✓	✔	✓	✓			✔		
Special aftermarket equipment		✓		✔	✓	✓			✔		
Estimated Salvage Value:											
Power unit		✔	✓	✔	✓	✓			✔		
Trailer		✔	✓	✔	✓	✓			✔		
Specialized equipment		✔	✓	✔	✓	✓			✔		
Lease / Purchase Payments:											
Power unit			✓	✔	✓	✓			✔		
Trailer			✓	✔	✓	✓			✔		
Specialized equipment			✓	✔	✓	✓			✔		
Number of Miles Per Year:											
Power unit			✔		✔	✓			✔		
Trailer			✔		✔	✓			✔		
Average Service Life:											
Power unit (miles)		✔		✔	✓	✓	✔				
Trailer (miles)		✔		✔	✓	✓	✔				
Specialized equipment (hours of service)		✔		✔	✓	✓	✔				
Tires (miles)		✔		✔	✓	✓	✔				
Average Maintenance Costs:											
Power unit		✓	✓	✔	✓	✓		✔			
Trailer		✓	✓	✔	✓	✓		✔			
Specialized equipment		✓	✓	✔	✓	✓		✔			

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semi-annual	Monthly	Weekly
EQUIPMENT RELATED INPUTS	**Average Purchase Cost:**											
	Power unit	✓	✔	✓	✔	✓	✓			✔		
	Trailer	✓	✔	✓	✔	✓	✓			✔		
	Depreciation:											
	Power unit				✔	✓	✓			✔		
	Trailer				✔	✓	✓			✔		
	Specialized equipment				✔	✓	✓			✔		
	Tires (if separated)				✔	✓	✓			✔		
	Insurance / Licenses / Permits:											
	Power unit			✓	✓	✔	✓		✔			
	Trailer			✓	✓	✔	✓		✔			
	Taxes:											
	Sales tax	✔		✔	✓	✓	✓				✔	
	Fuel tax	✔		✔	✓	✓	✓				✔	
	Highway use tax	✔		✔	✓	✓	✓				✔	
	Unit Costs:											
	Fuel ($/gallon)	✔		✓	✓	✓	✓					✔
	Oil ($/gallon)	✔		✓	✓	✓	✓					✔
	Tires ($/tire)	✔		✓	✔	✓	✓				✔	
	Consumption:											
	Fuel (gallons)	✓	✔	✔	✔	✓	✓			✔		
	Oil (gallons)		✔	✓	✔	✓	✓		✔			
	Power unit tires (# of tires)		✔		✔	✓	✓		✔			
	Trailer tires (# of tires)		✔		✔	✓	✓		✔			
	Trailer Configuration Mileage:											
	Trip miles for single trailers					✔	✓			✔		
	Trip miles for double trailers					✔	✓			✔		
	Trip miles for triple trailers					✔	✓			✔		
	Monitoring Devices and Communication System Costs:											
	Cellular phone expenses (per month)			✓		✔	✓			✔		
	Vehicle tracking expenses (per month)		✔			✓	✓			✔		

RAIL

Rail – General

		Data Collection Technique (✓ Preferred, ✓ Method)						Data Collection Frequency (✓ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
GENERAL	**Length of Haul:**											
	Length of haul			✓	✓	✓	✓				✓	
	Car Ownership:											
	Railroad supplied			✓	✓	✓	✓			✓		
	Privately Owned			✓	✓	✓	✓			✓		
	Train Type:											
	Single car movement			✓	✓	✓	✓				✓	
	Multi-car movement			✓	✓	✓	✓				✓	
	Unit Train movement			✓	✓	✓	✓				✓	
	Intermodal shipment			✓	✓	✓	✓				✓	

Rail – Operational Inputs

		Data Collection Technique (✓ Preferred, ✓ Method)						Data Collection Frequency (✓ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
OPERATIONAL INPUTS	**Train Makeup:**											
	Number of engines				✓	✓	✓			✓		
	Number of freight cars				✓	✓	✓				✓	
	Car days loading/unloading			✓	✓	✓	✓				✓	
	Time Components:											
	Running car days				✓	✓	✓				✓	
	Total car days in yard				✓	✓	✓				✓	
	Car days loading/unloading				✓	✓	✓				✓	
	Charge per car day for railroad owned car				✓	✓	✓				✓	
	Trailer days per origination or termination event				✓	✓	✓				✓	
	Switch engine minutes				✓	✓	✓				✓	
	Mileage Components:											
	Empty miles per car day				✓	✓	✓				✓	
	Loaded miles per car day				✓	✓	✓				✓	
	Total miles per car day				✓	✓	✓				✓	
	Car miles per switch				✓	✓	✓				✓	
	Private freight car, car mile rental charge				✓	✓	✓				✓	
	Way train miles including circuitry				✓	✓	✓				✓	
	Average miles between interchanges				✓	✓	✓				✓	
	Charge per car mile for railroad owned car				✓	✓	✓				✓	
	Through train miles including circuitry				✓	✓	✓				✓	
	Line haul miles per trailer day				✓	✓	✓				✓	
	Unit train miles including circuitry				✓	✓	✓				✓	
	Load Components:											
	Tons handled			✓	✓	✓	✓					✓
	Average tare weight of an empty freight car	✓	✓	✓	✓	✓			✓			
	Average gross tons for a unit train	✓	✓	✓	✓	✓			✓			
	Average gross tons for a way train	✓	✓	✓	✓	✓			✓			
	Average gross tons for a through train	✓	✓	✓	✓	✓			✓			
	Average tare weight for trailer/container	✓	✓	✓	✓	✓			✓			

Rail – Ancillary Related Inputs

		Data Collection Technique (✓ Preferred, ✓ Method)						Data Collection Frequency (✓ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
ANCILLARY RELATED INPUTS	**Building / Land / Infrastructure Costs:**											
	Office space					✓	✓		✓			
	Track					✓	✓		✓			
	Switches					✓	✓		✓			
	Bridges					✓	✓		✓			
	Culverts					✓	✓		✓			
	Yards					✓	✓		✓			
	Other buildings / structures					✓	✓		✓			
	Warehouse space					✓	✓		✓			
	Land Lease					✓	✓		✓			
	Utilities:											
	Power					✓	✓			✓		
	Heating / Cooling					✓	✓			✓		
	Water					✓	✓			✓		
	Special Equipment:											
	Handling equipment		✓		✓	✓	✓	✓				
	Snow plowing equipment		✓		✓	✓	✓	✓				
	Inspection vehicles		✓		✓	✓	✓	✓				
	Safety equipment		✓		✓	✓	✓	✓				
	Number of Employees:											
	Administration staff					✓	✓		✓			
	Other workers					✓	✓		✓			
	Wages:											
	Administration staff ($/hour)			✓	✓	✓	✓		✓			
	Other workers ($/hour)			✓	✓	✓	✓		✓			
	Benefits and Bonuses:											
	Administration staff			✓	✓	✓	✓		✓			
	Other workers			✓	✓	✓	✓		✓			
	Maintenance:											
	Office space				✓	✓	✓		✓			
	Track				✓	✓	✓		✓			
	Switches				✓	✓	✓		✓			
	Bridges				✓	✓	✓		✓			
	Culverts				✓	✓	✓		✓			
	Yards				✓	✓	✓		✓			
	Other buildings / structures				✓	✓	✓		✓			
	Warehouse space				✓	✓	✓		✓			
	Licensing / Permits / Insurance:											
	Federal Employers' Liability Act (FELA)				✓	✓	✓		✓			
	Health insurance				✓	✓	✓		✓			
	Property insurance				✓	✓	✓		✓			
	Security equipment				✓	✓	✓		✓			
	Other taxes & fees				✓	✓	✓		✓			

Rail – Labor Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
LABOR RELATED INPUTS	**Number of Employees per Train:**											
	Engineer			✔	✓	✓	✓				✔	
	Crew			✔	✓	✓	✓				✔	
	Wages:											
	Engineer ($/hour)			✔	✔	✓	✓				✔	
	Crew ($/hour)			✔	✔	✓	✓				✔	
	Benefits and Bonuses:											
	Engineer			✓	✔	✓	✓				✔	
	Crew			✓	✔	✓	✓				✔	
	Training / Safety:											
	Engineer (annual cost)	✓	✓		✔	✓	✓	✔				
	Crew (annual cost)	✓	✓		✔	✓	✓	✔				
	Overhead:											
	Percentage*						✔			✔		
	Calculated*						✔			✔		

*For Overhead only “percentage” or “calculated” is needed, not both.

Rail – Equipment Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
EQUIPMENT RELATED INPUTS	**Average Purchase Cost:**											
	Locomotive		✔	✓	✔	✓	✓			✔		
	Rolling stock		✔	✓	✔	✓	✓			✔		
	Estimated Salvage Value:											
	Locomotive	✓	✔	✓	✔	✓	✓			✔		
	Rolling stock	✓	✔	✓	✔	✓	✓			✔		
	Lease / Purchase Payments:											
	Locomotive				✔	✓	✓			✔		
	Rolling stock				✔	✓	✓			✔		
	Number of Miles Per Route:											
	Locomotive				✓	✔	✓				✔	
	Rolling stock				✓	✔	✓				✔	
	Average Service Life:											
	Locomotive		✔	✓	✔	✓	✓	✔				
	Rolling stock		✔	✓	✔	✓	✓	✔				
	Average Maintenance Costs:											
	Locomotive		✓		✔	✓	✓			✔		
	Rolling stock		✓		✔	✓	✓			✔		
	Depreciation:											
	Locomotive			✓	✔	✓	✓		✔			
	Rolling stock			✓	✔	✓	✓		✔			
	Insurance / Licenses / Permits:											
	Locomotive		✓	✓	✓	✔	✓			✔		
	Rolling stock		✓	✓	✓	✔	✓			✔		
	Energy Unit Costs:											
	Fuel ($/gallon)	✔		✓	✓	✓	✓					✔
	Oil ($/gallon)	✔		✓	✓	✓	✓					✔
	Energy Consumption:											
	Fuel (gallons)		✔		✔	✓	✓		✔			
	Oil (gallons)		✔		✓	✓	✓	✔				
	Monitoring Devices and Communication System Costs:											
	Communications and signals		✔	✓	✓	✔	✓			✔		

WATERWAYS

Waterways – Operational Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
OPERATIONAL INPUTS	**Time Components:**											
	Time to travel between terminals				✔	✓	✔				✔	
	Time to load / unload boat / barge				✔	✓	✔				✔	
	Other Expenses:											
	Wharf / dockage charges	✔			✔	✓	✓			✔		
	Steam ship charges	✔			✔	✓	✓			✔		
	Terminal charges	✔			✔	✓	✓			✔		

Waterways – Ancillary Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
ANCILLARY RELATED INPUTS	**Building / Land Costs:**											
	Office space			✔		✔	✓		✔			
	Land			✔		✔	✓		✔			
	Utilities:											
	Power					✔	✓		✔			
	Heating / Cooling					✔	✓		✔			
	Water					✔	✓		✔			
	Security Costs:											
	Security guards					✔	✓		✔			
	Security systems					✔	✓		✔			
	Number of Employees:											
	Administration staff				✓	✔	✓		✔			
	Other workers				✓	✔	✓		✔			
	Wages:											
	Administration staff			✔	✓	✓	✓		✔			
	Other workers			✔	✓	✓	✓		✔			
	Benefits and Bonuses:											
	Administration staff			✔	✓	✔	✓		✔			
	Other workers			✔	✓	✔	✓		✔			
	Maintenance:											
	Office space				✓	✔	✓		✔			
	Licensing / Permits / Insurance:											
	Federal Employers' Liability Act (FELA)				✔	✓	✓		✔			
	Health insurance				✔	✔	✓		✔			
	Property insurance				✔	✔	✓		✔			
	User taxes (i.e., locks, etc.)	✔			✔	✓	✓			✔		
	Environmental regulations				✔	✓	✓		✔			

Waterways – Labor Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
LABOR RELATED INPUTS	**Number of Employees:**											
	Operators (Captains & Pilots)			✔	✓	✓	✓		✔			
	Crew			✔	✓	✓	✓		✔			
	Wages:											
	Operators (Captains & Pilots) ($/hour)			✓	✓	✔	✓			✔		
	Crew ($/hour)			✓	✓	✔	✓			✔		
	Benefits and Bonuses:											
	Operators (Captains & Pilots)			✓	✔	✓	✔			✔		
	Crew			✓	✔	✓	✔			✔		
	General benefits (i.e., food, etc.)				✔	✓	✔			✔		
	Training / Safety:											
	Operators (Captains & Pilots)		✓		✔	✓	✓		✔			
	Crew (annual cost)		✓		✔	✓	✓		✔			
	Overhead:											
	Percentage*			✓		✓	✔		✔			
	Calculated*			✓		✓	✔		✔			

*For Overhead only “percentage” or “calculated” is needed, not both.

Waterways – Equipment Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
EQUIPMENT RELATED INPUTS	**Number of Pieces of Equipment:**											
	Towing vessels	✓	✔	✓	✔	✓	✓			✔		
	Barges	✓	✔	✓	✔	✓	✓			✔		
	Average Purchase Cost:											
	Towing vessels		✔	✓	✔	✓	✓			✔		
	Barges		✔	✓	✔	✓	✓			✔		
	Estimated Salvage Value:											
	Towing vessels		✔	✓	✔	✓	✓			✔		
	Barges		✔	✓	✔	✓	✓			✔		
	Charters / Purchase Payments:											
	Towing vessels				✔	✓	✓			✔		
	Barges				✔	✓	✓			✔		
	Operating Days Per Year:											
	Towing vessels (hours)				✓	✔	✓			✔		
	Barges				✓	✔	✓			✔		
	Average Service Life:											
	Towing vessels (hours)	✓	✔	✓	✔	✓	✓	✔				
	Barges	✓	✔	✓	✔	✓	✓	✔				
	Average Maintenance Costs:											
	Towing vessels		✓	✓	✔	✓	✓	✔				
	Barges		✓	✓	✔	✓	✓	✔				
	Depreciation:											
	Towing vessels		✓	✓	✔	✓	✓		✔			
	Barges		✓	✓	✔	✓	✓		✔			
	Insurance / Licenses / Permits:											
	Equipment		✓		✓	✔	✓		✔			
	Licenses for operation	✓			✓	✔	✓		✔			
	Lock charges	✓			✓	✔	✓		✔			
	Unit Costs:											
	Fuel ($/gallon)	✔	✓	✓	✓	✓						✔
	Oil ($/gallon)	✔	✓		✓	✓						✔
	Consumption:											
	Fuel (gallons/hour)		✔	✔	✔	✓	✓			✔		
	Oil (gallons)		✔		✔	✓	✓			✔		
	Monitoring Devices and Communication System Costs:											
	Equipment tracking expenses (per month)				✓	✔	✓		✔			

TERMINALS

Terminals – Gate Processing (GP)

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element / Data Source	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
Gate Processing (GP)	**Time Spent at Gate:**											
	Inbound				✔	✓	✓		✔			
	Outbound				✔	✓	✓		✔			
	Personnel:											
	# of staff members working				✔	✓	✓		✔			
	Average wages of staff members				✔	✓	✓		✔			
	Benefits / bonuses for staff members				✔	✓	✓		✔			
	Infrastructure / Technology:											
	Depreciation/maintenance cost-infrastructure				✔	✓	✓		✔			
	Depreciation/maintenance cost-technology				✔	✓	✓		✔			

Terminals – Internal Movements (IM)

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element / Data Source	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
Internal Movements (IM)	**Type of Equipment Used:**											
	Truck	✔			✔	✓	✓	✔				
	Train	✔			✔	✓	✓	✔				
	Forklift	✔			✔	✓	✓	✔				
	Conveyor	✔			✔	✓	✓	✔				
	Equipment - General:											
	# of pieces of a particular type of equipment				✔	✓	✓	✔				
	Average time to complete an IM				✔	✓	✓		✔			
	Equipment Fixed Costs:											
	Average purchase cost	✓	✔		✓	✓	✓		✔			
	Estimated salvage value	✓	✔		✓	✓	✓		✔			
	Taxes				✔	✓	✓		✔			
	Insurance / Licenses / Permits				✓	✔	✓		✔			
	Equipment Variable Costs:											
	Operating costs		✓		✔	✓	✓			✔		
	Fuel or electricity consumption	✓	✓		✔	✓	✓		✔			
	Average maintenance costs				✔	✓	✓		✔			
	Depreciation		✓		✔	✓	✓		✔			
	Fuel cost	✔	✓		✓	✓	✓					✔
	Electricity cost	✔			✓	✓	✓				✔	
	Tire cost	✓	✔		✓	✓	✓		✔			
	Equipment Labor Costs:											
	# of operators needed		✓		✔	✓	✓	✔				
	# of ground workers needed		✓		✔	✓	✓	✔				
	Operator time consumed for movement				✔	✓	✓		✔			
	Ground worker time consumed for movement				✔	✓	✓		✔			
	Wages for operators			✓	✔	✓	✓		✔			
	Wages for ground workers			✓	✔	✓	✓		✔			
	Benefits / bonuses for operators				✔	✓	✓		✔			
	Benefits / bonuses for ground workers				✔	✓	✓		✔			
	Training for operators		✔		✓	✓	✓	✔				
	Training for ground workers		✔		✓	✓	✓	✔				

Terminals – Sorting / Organizing (S/O)

		Data Collection Technique (✓ Preferred, ✓ Method)						Data Collection Frequency (✓ Preferred)				
	Cost Data Element / Data Source	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
Sorting / Organizing (S/O)	**Type of Sorting:**											
	Containers	✓			✓	✓	✓		✓			
	Rail cars	✓			✓	✓	✓		✓			
	Trailers	✓			✓	✓	✓		✓			
	Type of Equipment Used:											
	Yard crane	✓	✓		✓	✓	✓		✓			
	Overhead crane	✓	✓		✓	✓	✓		✓			
	Forklift	✓	✓		✓	✓	✓		✓			
	Locomotive	✓	✓		✓	✓	✓		✓			
	Truck	✓	✓		✓	✓	✓		✓			
	Equipment - General:											
	# of pieces of a particular type of equipment				✓	✓	✓		✓			
	Average time to complete S/O				✓	✓	✓		✓			
	Equipment Fixed Costs:											
	Average purchase cost		✓		✓	✓	✓		✓			
	Estimated salvage value		✓		✓	✓	✓		✓			
	Taxes				✓	✓	✓		✓			
	Insurance / Licenses / Permits				✓	✓	✓		✓			
	Equipment Variable Costs:											
	Operating costs		✓		✓	✓	✓			✓		
	Fuel or electricity consumption	✓	✓		✓	✓	✓		✓			
	Average maintenance costs				✓	✓	✓		✓			
	Depreciation		✓		✓	✓	✓		✓			
	Fuel cost	✓	✓		✓	✓	✓					✓
	Electricity cost	✓			✓	✓	✓				✓	
	Tire cost	✓	✓		✓	✓	✓		✓			
	Equipment Labor Costs:											
	# of operators needed		✓		✓	✓	✓	✓				
	# of ground workers needed		✓		✓	✓	✓	✓				
	Operator time consumed for movement				✓	✓	✓		✓			
	Ground worker time consumed for movement				✓	✓	✓		✓			
	Wages for operators			✓	✓	✓	✓		✓			
	Wages for ground workers			✓	✓	✓	✓		✓			
	Benefits / bonuses for operators				✓	✓	✓		✓			
	Benefits / bonuses for ground workers				✓	✓	✓		✓			
	Training for operators		✓		✓	✓	✓	✓				
	Training for ground workers		✓		✓	✓	✓	✓				

Terminals – Loading / Unloading (L/U)

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element / Data Source	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
Loading / Unloading (L/U)	**Mode of Transportation Being Loaded / Unloaded:**											
	Ship	✔			✔	✓	✓		✔			
	Barge	✔			✔	✓	✓		✔			
	Truck	✔			✔	✓	✓		✔			
	Rail cars	✔			✔	✓	✓		✔			
	Type of Commodity Being Loaded / Unloaded:											
	Containers	✔			✔	✓	✓			✔		
	Trailers	✔			✔	✓	✓			✔		
	Dry bulk	✔			✔	✓	✓			✔		
	Special equipment	✔			✔	✓	✓			✔		
	Liquid	✔			✔	✓	✓			✔		
	Type of Equipment Used:											
	Gantry crane	✔			✔	✓	✓	✔				
	Overhead crane	✔			✔	✓	✓	✔				
	Yard crane	✔			✔	✓	✓	✔				
	Forklift	✔			✔	✓	✓	✔				
	Equipment - General:											
	# of pieces of a particular type of equipment				✔	✓	✓		✔			
	Average time to complete L/U				✔	✓	✓		✔			
	Equipment Fixed Costs:											
	Average purchase cost		✔		✓	✓	✓		✔			
	Estimated salvage value		✔		✓	✓	✓		✔			
	Taxes				✔	✓	✓		✔			
	Insurance / Licenses / Permits				✓	✔	✓		✔			
	Equipment Variable Costs:											
	Operating costs		✓		✔	✓	✓			✔		
	Fuel or electricity consumption	✓	✓		✔	✓	✓		✔			
	Average maintenance costs				✔	✓	✓		✔			
	Depreciation		✓		✔	✓	✓		✔			
	Fuel cost	✔	✓		✓	✓	✓					✔
	Electricity cost	✔			✓	✓	✓				✔	
	Tire cost	✓	✔		✓	✓	✓		✔			
	Equipment Labor Costs:											
	# of operators needed		✓		✔	✓	✓	✔				
	# of ground workers needed		✓		✔	✓	✓	✔				
	Operator time consumed for movement				✓	✔	✓		✔			
	Ground worker time consumed for movement				✓	✔	✓		✔			
	Wages for operators			✓	✓	✔	✓		✔			
	Wages for ground workers			✓	✓	✔	✓		✔			
	Benefits / bonuses for operators				✓	✔	✓		✔			
	Benefits / bonuses for ground workers				✓	✔	✓		✔			
	Training for operators		✔		✓	✓	✓	✔				
	Training for ground workers		✔		✓	✓	✓	✔				

Terminals – Ancillary Related Inputs

		Data Collection Technique (✔ Preferred, ✓ Method)						Data Collection Frequency (✔ Preferred)				
	Cost Data Element / Data Source	Web Search	Trade Publication	Report	Interview	Convenience Sampling	Random Survey	Biennial	Annual	Semiannual	Monthly	Weekly
ANCILLARY RELATED INPUTS	**Building / Land Costs:**											
	Office space					✔	✓	✔				
	Warehouse space					✔	✓	✔				
	Land Lease					✔	✓	✔				
	Maintenance facilities					✔	✓	✔				
	Utilities:											
	Power					✔	✓	✔				
	Heating / Cooling					✔	✓	✔				
	Water					✔	✓	✔				
	Security Costs:											
	Fence and gate costs		✓		✔	✓	✓	✔				
	Security guards		✓		✔	✓	✓	✔				
	Security systems		✓		✔	✓	✓	✔				
	Special Equipment:											
	Snow plowing equipment		✓		✔	✓	✓	✔				
	Safety equipment		✓		✔	✓	✓	✔				
	Number of Employees:											
	Administration staff				✓	✔	✓	✔				
	Other workers				✓	✔	✓	✔				
	Wages:											
	Administration staff			✔		✓	✓		✔			
	Other workers			✔		✓	✓		✔			
	Benefits and Bonuses:											
	Administration staff					✔	✓		✔			
	Other workers					✔	✓		✔			
	Maintenance:											
	Office space					✔	✓	✔				
	Warehouse space					✔	✓	✔				
	Licensing / Permits / Insurance:											
	Workers' compensation insurance				✓	✔	✓		✔			
	Health insurance				✓	✔	✓		✔			
	Property insurance				✓	✔	✓		✔			

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation