CAMBRIDGE SYSTEMATICS

NCFRP-05, Framework and Tools for Estimating Benefits of Specific Freight Network Investment Needs

executive

summary

prepared for

Transportation Research Board

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Executive Summary

Introduction and Background

Over the last several years, freight planning and investment activities have evolved considerably. The previous 10 to 15 years saw states and metropolitan planning organizations (MPOs) undertaking efforts to learn about freight movements, freight stakeholders, and freight impacts; and to more explicitly incorporate freight-related issues within existing transportation planning and programming activities. As a result, these public-sector agencies are now more aware of how freight movements impact the condition and performance of their systems, and how improving freight efficiency can impact business attraction and retention efforts, regional and state economies, and quality of life.

Now, many states and MPOs have moved beyond the planning stage, and are interested in how to address freight-specific needs and implement improvement projects. These agencies are considering where and how it makes sense to invest public dollars in freight improvement projects, who should be involved, and how risks and rewards should be allocated. Attitudes and activities among private-sector freight investment decision-makers have evolved, as well. Railroads, for instance, have shown a willingness to partner with public-sector entities to make system investments that have demonstrable public and private benefits. In addition, there is increasing interest by private infrastructure developers and concessionaires in making freight transportation investments that promise favorable returns to shareholders.

These and other freight stakeholders have begun to realize that freight system investments must involve partnerships: partnerships between the public sector and the private sector, partnerships among a variety of different private-sector entities, and partnerships across public-sector jurisdictions and agencies. Developing and sustaining these partnerships require analytical tools that can provide insights into the nature and allocation of freight benefits and costs; and how they accrue across modal, jurisdictional, and interest (public/private) boundaries.

This National Cooperative Freight Research Program (NCFRP) research, *Framework and Tools for Estimating Benefits of Specific Freight Network Investment Needs*, resulted such a tool. Through the identification of best practices, interviews with public and private freight stakeholders, and an assessment of the data and methods used to evaluate freight investments, this project has developed a Freight Evaluation Framework that represents an integrated analytical approach to supporting and evaluating complex freight investment decisions. This Framework defines a wide range of public and private benefits and impacts of freight infrastructure investments, and identifies the tools and supporting

data necessary to evaluate these benefits and impacts. It is capable of handling projects that span all of the different freight modes, and is able to assess benefits from a variety of project types and scales. It distinguishes how benefits and impacts are evaluated at the local, regional, state, and national level; and in so doing recognizes the role that different public-sector entities play in making funding decisions for freight investments.

The Framework was developed, and is designed to be applied, with three main functions in mind:

1. **To enhance public planning and decision-making processes regarding freight**. State departments of transportation (DOTs) and MPOs are increasingly facing freight planning issues – which by their very nature involve a combination of public interests, private operator interests, and shipper/industry interests. As a result, freight planners face a growing need to consider the roles and perspectives of these other parties in their public agency decision-making processes, but are often not equipped to do so. The Freight Evaluation Framework provides a common method to help planners understand the wide range of perspectives and interests in potential freight investments, and more effectively integrate those interests within a decision-making process.

2. **To supplement benefit-cost assessment with distributional impact measures.** The traditional form of benefit-cost analysis, which compares total benefits and total costs of alternatives, may work for projects that are publicly financed, built, owned, and operated. However, that form of analysis is not always sufficient for freight projects that often require public-sector negotiation with private infrastructure owners and freight service providers. In those situations, there is a real need to consider the distribution of cost burdens and benefits among parties, particularly those that have a role in project funding and implementation.

3. **To advance public-private cooperation.** Often, freight projects can only be implemented if there is cooperation between public agencies and private parties in terms of responsibility for infrastructure facility financing, development, operation, and maintenance. And that requires some degree of trust that neither party is taking advantage of the other. So, in order to craft appropriate financial and operating agreements, both public agencies and private companies need a framework and process that *both* can accept to provide transparency and enable understanding of the concerns of the other.

The remaining sections of this Executive Summary describe the key issues and challenges in evaluating freight investments, and how these challenges were addressed during the development of the Evaluation Framework. An overview of the Framework itself, along with supporting data and tools that can be used in its application, are also presented. The full NCFRP-05 Project Report describes in more detail the development, testing, and use of the Framework in assessing freight investments; it also presents case studies illustrating how the Framework can be applied and used for various project types.

Key Issues and Challenges in Evaluating Freight Projects

Both public- and private-sector freight stakeholders face a number of different challenges when evaluating potential freight investments. The Freight Evaluation Framework was developed to explicitly address these challenges, described below, within an integrated analytical approach.

Addressing the Motivations of Different Types of Stakeholders

Many previous research efforts have discussed "stakeholder types" that are involved in the identification, planning, financing, and implementation of freight improvement projects. Typically, these efforts have categorized freight stakeholders as public or quasi-public (i.e., DOTs, MPOs, port authorities) and private (i.e., shippers and carriers). This structure, however, does not fully account for the broad range of stakeholders who stand to gain or lose from freight transportation investments, which provides the foundation for determining appropriate benefits and impacts. In addition, it does not fully recognize emerging public/private partnerships and interactions, which are an important (and growing) aspect of freight projects, and have blurred the distinctions between public- and private-sector roles.

This research has resulted in a more nuanced understanding of the types of freight stakeholders involved in freight investment decisions, as well as their concerns and interests. This definition was critical in understanding the types of benefits these stakeholders are most concerned about, the methods used to measure them, and how those issues could be addressed within an integrated evaluation framework. In general, freight projects can affect four types of stakeholders, which are grouped as follows:

1. **Asset providers**, which develop, lease, maintain, or finance freight investments (both fixed and mobile);

2. **Service providers**, which provide transportation or logistics services for freight shipments;

3. **End users**, which include both shippers/consignees, as well as end customers for finished goods; and

4. **Other impacted parties**, which include neighborhood/community interests, environmental/land use interests, business interests, and others.

Table ES.1 describes the typical public- and private-sector roles of these stakeholder types.

Table ES.1 Freight Investment Stakeholder Types

Stakeholder Type	Stakeholder Examples
Asset Provider	State DOT
	Concessionaire
	Railroad
	Financier
	Commercial Real Estate Developer
	Port
Service Provider	Railroad
	Trucking Company
	Logistics Provider
End User	Freight shipper/consignee
	End customer
Other Impacted Party	Neighborhood/Community Residents & Property Owners
	Environmental Resource Agency
	Chamber of Commerce/Economic Development Agency
	Commercial Real Estate Developer

It is important to note that some freight stakeholders play dual roles. Railroads, for instance, are both asset providers and service providers; commercial real estate developers provide infrastructure and can be impacted by the freight investment decisions made (or not made) by service providers or end users; and government agencies may be both an asset provider and an impacted party representing its citizens. Understanding these and other interrelationships is important when assessing the types of benefits different stakeholders are concerned with at different points in the investment decision-making process.

Stakeholder Perspectives

It is also critically important to describe the interest points and perspectives of different stakeholder types – essentially, what "stake" these stakeholders have in the success of a freight improvement project. Understanding the perspectives of different stakeholders – and how they can change depending on the type of project and/or role the stakeholder is playing in the project development – is important in developing an understanding of the types of benefits they are most concerned with and the adequacy of tools, techniques, and processes to measure them.

This research identified the following four types of stakeholder interest/perspectives:

1. Parties with a **Direct Financial Stake** in the development and performance of a freight investment. These are primarily asset providers (both development and ongoing maintenance/operation) that have a vested financial interest in a freight improvement project. These stakeholders are providing capital (public funding, in the case of a state DOT; private capital in the case of a concessionaire or developer) in the hope of attaining particular goals, missions, or mandates. Without this group's concurrence on how a proposed improvement meets criteria for moving forward, there is no project.

2. Parties that have an **Indirect Financial Stake** in the result of a freight investment. These stakeholders typically consist of service providers that operate transportation services on freight infrastructure, as well as shippers who are the true "users" of freight infrastructure capacity and services. In practice, these two groups are connected because service carriers pass on a significant share of their net costs to shippers. Together, these parties that have a financial interest in the project outcome, but no direct investment stake in the project itself. However, the interests of these parties are an important consideration in making investment decisions, as impacts and benefits to these stakeholders can influence the net benefit-cost calculation made by those with direct financial stakes.

3. Parties that have a **Major Nonfinancial Stake** in the result of a freight investment. These typically include nearby landowners and occupants affected by access, noise, safety, or livability impacts; or community organizations or resource agencies concerned about broader environmental impacts related to the construction or operation of facilities. There is a clear path in which the project may affect these parties, and those concerns need to be considered as factors in project design and decision-making. These impacts can be quantified in monetary terms, though it is sometimes desirable to consider them in context of nonfinancial tradeoffs.

4. Parties that have a **Tangential Stake** in the result of a freight infrastructure project, either financial or nonfinancial. These stakeholders may include private companies (or a consortium of companies) affected by indirect and induced economic growth impacts; or local or regional taxpayers affected by project financing strategies. Many of their interests are likely to be in the form of concerns (that can potentially be addressed) and more general policy interests, rather than measurable direct effects of an individual project. These stakeholders should be kept informed and given the opportunity to air their views and provide input to the decision process.

Table ES.2 describes the interest/perspectives of different stakeholder types.

Table ES.2 Interest/Perspectives of Stakeholder Types

Stakeholder Type	Interest/Perspective			
	Category 1 (Direct Financial)	**Category 2 (Indirect Financial)**	**Category 3 (Major Nonfinancial)**	**Category 4 (Tangential)**
Asset Provider	●			
Service Provider	●	●		
End User		●	*	●
Other Impacted Party			●	●

* End users that are shippers or consignees generally translate all impacts into revenue or cost (Category 2) changes. However, infrastructure improvements also may affect passenger travel; in which case, there may be personal time or convenience impacts that fall into Category 3.

Evaluating Different Investment Types

Previous research has focused on classifying freight projects into three types: 1) infrastructure enhancements, 2) capacity upgrades, or 3) operational improvements. However, this structure does not fully account for the sophistication of freight decision-making processes, the relationships among different project types, and the sheer number of stakeholder types that they can include.

Despite the growing sophistication of freight investment decisions and partnerships, the justification for any investment is still fairly simple – and can usually be explained in terms of enhanced capacity. In fact, though different types of freight stakeholders may explain it using different terms – for example, carriers may discuss improved reliability, while shippers may talk of a decreased need to hold inventory and a DOT may refer to system efficiency – these stakeholders are all, in essence, concerned with enhancing the capacity of the freight system within four typical project types:

1. **Physical infrastructure.** Projects that enhance the capacity, design speed, or volume of freight infrastructure;

2. **Productivity.** Projects that increase the size, weight, or volume of freight vehicles;

3. **Reliability and density.** Projects that affect the utilization or safety of freight vehicles; and

4. **Integration and consolidation.** Projects that allow for more efficient communication or transfer of materials between freight vehicles, infrastructure, and facilities.

Dividing projects into these four types allows us to view the many types of freight investments in a simpler context that focuses on effective core functionality, rather than long lists of project types. Sample projects that may be included for different modes for each of these four project types are summarized below in Table ES.3.

Table ES.3 Capacity Enhancement Project Types

Project Type	Sample Project Types Across Different Transportation Modes
Physical infrastructure	• Expanding marine terminals • Increasing highway lane width/adding highway capacity • Redesigning interchanges or addressing localized bottlenecks • Lengthening railway sidings • Developing parallel lanes, tracks, or terminal slots • Increasing the number or length of runways
Productivity	• Operating longer-combination vehicles or larger vessels • Lengthening trains
Reliability and density	• Enhancing turn-outs and emergency pull-outs • Implementing controls for vehicle separation, design, and channelization • Using information services to reduce vehicle interactions, to plan routing, and to avoid congestion and incidents • Improving incident management techniques
Integration and consolidation	• Improving/streamlining logistics services • Improving efficiency of cross-modal transfers • Ensuring interoperability of technology applications • Developing shared use corridors

Evaluating Projects of Differing Scales

The size, scope, and timeline of freight investment projects can vary considerably. In the past, freight projects have been completed by stakeholders working independently and on an "as-needed" basis – for example, railroads have traditionally prioritized investments and fully funded their most pressing capital projects and rolling stock purchases as their revenue streams allowed. However, the increased prevalence of new institutional

arrangements and strategies, such as multistate coalitions and public-private partnerships, has created new opportunities to engage multiple stakeholders on projects of varying scope, timeline, and cost. Projects such as the Alameda Corridor, although a rail infrastructure project, was able to bring other public and private partners into coordination with the railroads to plan and finance a large infrastructure project with benefits to numerous stakeholders.

We have categorized freight investments in three different scales, described below and in Table ES.4.

1. **Site and local.** Projects that involve a single site/facility or infrastructure element, or otherwise benefit freight mobility on a localized scale;

2. **Statewide and regional.** Projects that involve statewide or regional operations or infrastructure, or benefit freight mobility on a statewide or multicounty scale; and

3. **Multistate or national.** Projects that involve infrastructure or operations that span several states or the nation, or that benefit regional or national freight mobility.

Table ES.4 Project Scales and Sample Project Types

Project Scale	Sample Projects Typical for Stakeholder Type
Site and local	• Roadway enhancement projects • Enhanced signals or use of Intelligent Transportation System (ITS) • Site access enhancements or operational improvements • Warehouse/development center site development • Terminal expansion at nonstrategic land, air, or marine ports • Class I classification yard improvements
Statewide and regional	• Statewide or regional ITS projects • Bottleneck alleviation projects • Bridge safety or capacity enhancement projects
Multistate or national	• Trade corridor improvement projects • Projects to enhance capacity or throughput at strategic land, air, or marine ports that serve as key national entry points • Class I railroad double tracking projects

Accounting for Different Costs, Benefits, and Impacts

The types of benefits received by different stakeholder groups have also been discussed in a number of previous studies and research efforts. However, many of these previous efforts tended to focus only on a handful of stakeholder and project types, typically public-sector transportation planning agencies (DOTs, MPOs) or a singular carrier mode (such as benefits from Class I and shortline freight railroads). It is important to identify benefits that are of concern to the broader set of freight stakeholders, including infrastructure developers, investment bankers, industrial site selection analysts, supply chain professionals, and others. In general, the types of benefits that are meaningful to these freight stakeholders can be summarized in two categories: cost factors, and benefit and other impact factors.

1. **Cost factors** include:

    a. **Facility capital costs,** which tend to be dictated by site location and design, as well as the partners involved in the planning process;

    b. **Facility maintenance costs,** or the ongoing costs of maintaining a facility to ensure safe operations and upkeep; and

    c. **Operating costs,** such as labor costs, fuel costs, equipment costs, and the time lost to congestion or to the breakdown of efficient supply chains.

2. **Benefit and impact factors** include:

    a. **Capacity,** which includes alleviating the impact of highway and rail system bottlenecks, as well as the throughput attainable on any transportation infrastructure or facility access point;

    b. **Productivity,** or the ability to operate a supply chain from start to finish with maximum efficiency;

    c. **Loss and damage**, or maximizing the safety and security of freight operations and movements to minimize loss to the shipper, carrier, or community;

    d. **Scheduling/reliability**, or the ability to have predictable and timely delivery of goods allows for streamlined inventories, less disruption in the manufacturing or supply process, and a more efficient supply chain;

    e. **Tax revenue,** such as that received by new industrial land development, distribution center, or other freight-intensive land uses;

    f. **Wider economic development,** such as **i**ncreased jobs that result from a distribution center, transload, or intermodal facility, as well as multiplier effects to regional economies;

    g. **Safety,** or minimizing of impacts of freight land uses on neighboring communities, and the safe operation of freight vehicles and facilities; and

    h. **Environmental quality,** such as mitigation of air or water quality impacts, reduction of truck vehicle miles traveled (VMT), and noise or vibration reduction.

Although some benefits, such as safety, are likely considered by all freight stakeholders, it is certainly the case that each stakeholder group will be primarily interested in just a few benefits or impacts. The scale of the benefits or impacts received by a particular freight investment strategy will likely be the determining factors as to whether a freight stakeholder chooses to participate in a freight investment strategy or not. As shown in Table ES.5 below, the primary considerations for most freight stakeholder types can be summarized by between two to four benefits. For example, though a service provider likely considers a wide range of variables when determining their participation in a freight investment project, the ultimate decision generally is determined by the underlying impact on operating costs and system capacity.

Table ES.5 Stakeholder Types and Benefits

Benefit Category	Type of Beneficiary			
	Asset Provider	**Service Carrier**	**End User**	**Other Interest**
Cost Factors				
Facility Capital Costs	●	○	○	○
Facility Maintenance Costs	●	○	○	○
Operating Costs	●	●	○	○
Benefit and Other Impact Factors				
Capacity (includes bottleneck congestion)	●	●	○	◑
Loss and Damage	○	◑	●	○
Scheduling and Reliability	○	●	●	○
Business Productivity	○	○	●	○
Tax Revenue	○	○	○	●
Wider Economic Developments	○	○	◑	●
Safety	◑	◑	◑	●
Environmental Quality, Sustainability, or Energy Use	◑	◑	◑	●

Key:

Less Important ○ → ◑ → ● More Important

Understanding the primary benefits felt by each stakeholder groups has several practical applications. First, by understanding "who benefits" from a freight improvement project,

it is easier to assign responsibility for a project at a level that is proportionate to the benefit received. This is very useful when entering into a project where several different stakeholder types, including carriers, public agencies, and communities, are involved in project planning, approval, and financing. In addition, understanding the benefits received by user groups can help to highlight those situations where they may be a compelling public interest in supporting freight network improvements.

Understanding both Public and Private Decision-Making Processes

Differences in the types of benefits considered by different stakeholders necessarily lead to different types of freight investment decision processes. The decision-making process employed by public-sector stakeholders is much more "democratic," and focuses on building consensus on a wide range of issues. In many situations, the number of stakeholders with a vote at the table is quite large; the multiple objectives (and impacts) of a proposed freight investment may often be muddled; the funding sources and mechanisms are numerous and complex; and the final decision to move forward or not with any given proposal rarely rests with a single agency or decision-maker. This complex process has many positive aspects; for example, it has given more people a voice in what happens in their communities, and is more "fail safe" than the early days of publicly-funded transportation investments. At the same time, this highly participatory process often drags out the timeframe for planning and implementation of any significant improvements, and may ultimately kill a project or program through "death by a thousand cuts."

The private-sector process is much more narrowly focused on projects that relate directly to business goals and objectives. The process is much less inclusive, and stakeholders and decision-makers are brought into the process only to address specific issues (e.g., permits, approvals) or to provide specific areas of support (e.g., funding, incentives). As opposed to the public process, the final decision to move forward or not with any given proposal often rests with a single decision-maker or collection of senior executives.

In addition, different stakeholders assess benefits at different points in the process. The public-sector process typically consists of five key steps:

1. **Needs identification.** When system needs and deficiencies are identified and potential approaches are identified;

2. **Plan development.** When transportation vision, goals, and strategies are documented;

3. **Project programming.** When the process of actually implementing transportation improvement projects begins;

4. **Project development.** When more detailed design and a more formal assessment of the necessary permitting and approval activities occurs; and

5. **Project implementation.** When final approval is obtained, detailed construction plans are developed, and right-of-way (if necessary) and construction permits are acquired.

Within this process, public-sector stakeholders (e.g., infrastructure providers [state DOTs] and impacted parties) typically begin developing a detailed understanding of potential investment benefits only within the project programming and project development stages. However, with the exception of a handful of states, this benefit assessment occurs *after* a proposed project has entered the pipeline, and is generally used to decide among competing investments (both freight related and non-freight related) to build support for an investment or suite of investments among impacted parties, and/or to allocate costs and benefits across different stakeholder types.

Among private-sector freight stakeholders (e.g., railroads, shippers, and industrial site developers), potential investment benefits are assessed as a *first* step in the process. Railroads, for example, immediately assess a project's potential impact on operations and revenue, and calculate net present value (NPV) of potential investments very early in the process. Similarly, one of the only factors a financial investor or concessionaire will consider within the decision-making process is financial returns, typically via "due diligence" studies that involve third-party confirmation of market demand and revenue assumptions.

This mismatch on when benefits are assessed within the decision-making process can make it difficult for all types of investment stakeholders to focus attention on freight investments that might have benefits for all parties.

Assessing Risk

Risk assessment has long been a critical component of private-sector investment decision-making. Monitoring safety, regulatory compliance, and emissions is important because the costs associated with risk experience can be very high, and sizable loss can be devastating to smaller firms. Risk management metrics also have a role in customer satisfaction, potential market development, and market access. All of the functions in this category can have a direct cost – insurance, employee safety and retention, financial penalties and down time, etc. On the public-sector side, risk management techniques are typically included in asset management strategies for pavements, bridges, and other investments. Rarely are risk management techniques employed as part of the investment decision-making activities of these agencies, including freight investments.

However, risk assessment has taken on more importance among public-sector agencies given recent interest in utilizing public-private partnerships or shared asset activities. The emphasis placed on financial evaluation is typical for private-sector projects, but the degree of analysis devoted to risk assessment stands out, and (according to players in this market) exceeds that to which the public sector is accustomed. Public-Private Partnerships provide a route to funding and operating a project by accessing private-sector funds and support. It is a partnership that is marked with differences, however, as the public sector is responsible for promoting projects for the good of its constituents, and the private-sector functions and operates based on its bottom line. Financially, they have evolved separately and rely on different sources of funds. For the private sector to

participate, the public-sector agency should have established policies, processes, and frameworks that facilitate a partnership.

A Framework for Addressing these Challenges

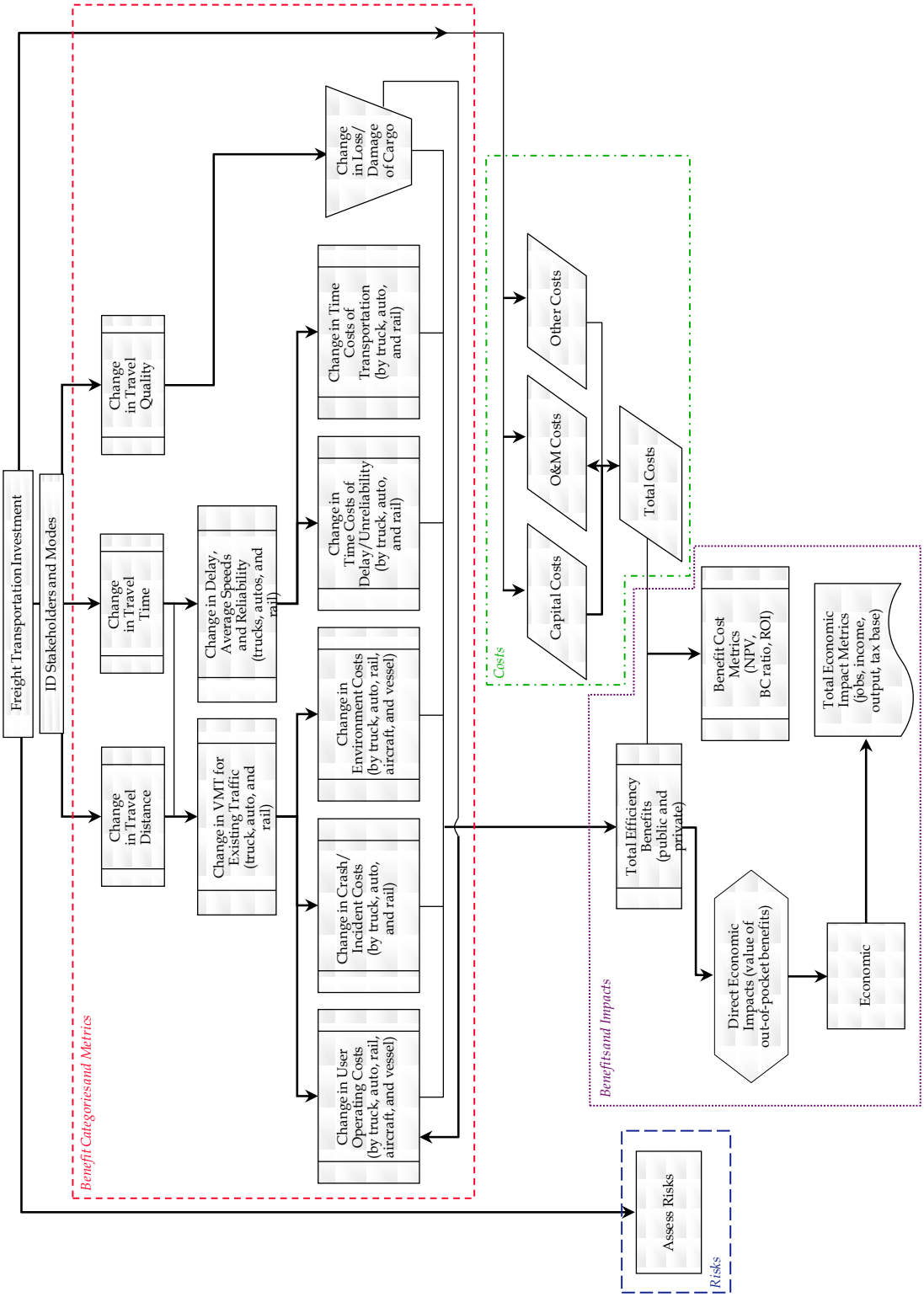
The Freight Evaluation Framework, shown below in Figure ES.1, addresses the challenges described above by providing a common approach to evaluating freight investments. The Framework allows stakeholders to evaluate the potential benefits of highway, rail, seaport, and intermodal connector projects on an "apples-to-apples" using existing data and analytical tools and in a manner that is consistent with existing decision-making processes of different stakeholders.

The Framework consists of four key elements, described below:

1. **Identify benefit categories and metrics**. As described earlier, different stakeholders value different potential benefits. While there are a few measures, such as transportation cost savings, crash reductions, emission reductions, and pavement/ track conditions, which are important across a wide array of stakeholders, others, such as maintenance savings and asset velocity, will be relevant to a smaller set. It is these unique benefits, however, that are likely to drive that stakeholder's decision on whether or not to participate in the investment. The Framework recognizes this and reflects the impact or benefit categories that are likely to be most important to different freight stakeholders in determining whether the project is beneficial from that group's perspective.

2. **Calculate project costs**. The costs of a constructed facility or implemented technology to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components. The magnitude of each of these cost components depends on the nature, size, and location of the project, as well as the owning organization (i.e., public or private).

Figure ES.1 Freight Evaluation Framework



3. **Calculate benefits and impacts**. The Framework addresses benefits and impacts proceeds in two parallel tracks: benefit/cost analysis (BCA) and economic impact analysis (EIA). Benefit/cost analysis identifies the benefits of investing (as compared with not investing), and compares these to the project costs. Economic impact analysis, in contrast, compares the overall economic growth (for example, employment, income, and output) in the specified study region with or without investing. For the purpose of both BCA and EIA, all costs and benefits are measured over the project life cycle to capture the timing of costs and benefits. Then the NPV of the costs and benefits are calculated using the appropriate discount rate.

4. **Assess risks**. The incorporation of risk into the Framework represents a significant enhancement to the freight investment analysis tools, methods, and processes that have been developed as part of previous research efforts. Risk in the context of a freight investment refers to downside outcomes due to uncertainty. From a financial perspective, investors or bondholders may experience weaker than anticipated returns on their investment. Weak returns can be the result of weaker-than-expected demand for a facility's services, or higher-than-expected capital or operating costs, or a combination of the two. From the public's perspective, the project may not yield its anticipated benefits in the form of congestion mitigation or job creation.

The NCFRP-05 Project Report provides more detail on the specific structure and use of the Framework in each of these key areas.

■ Existing Data and Analytical Tools

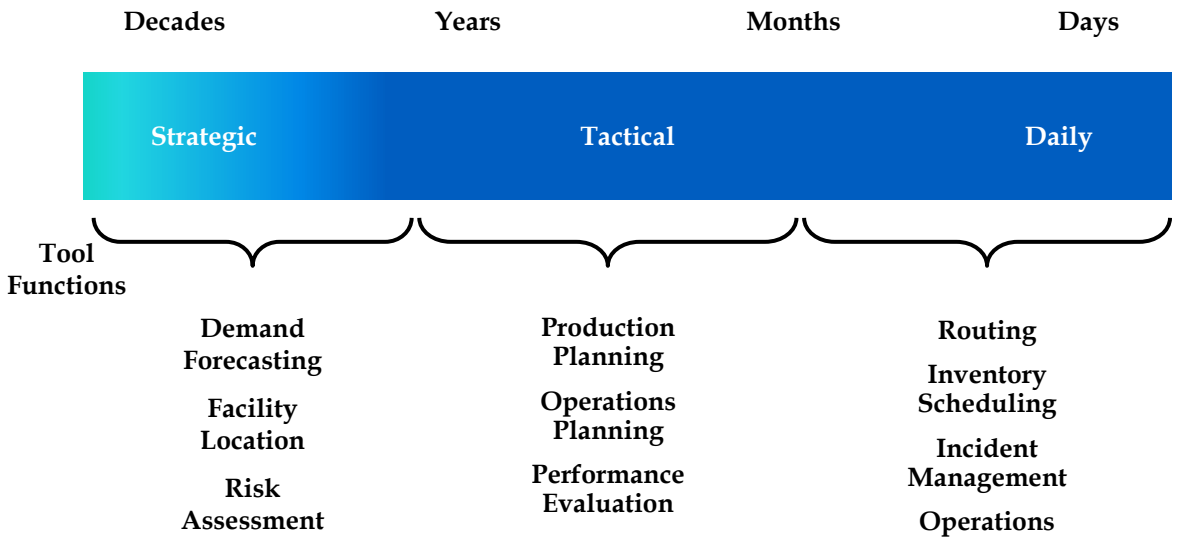
The Freight Evaluation Framework was developed to utilize the wide array of analysis tools currently employed by different freight stakeholders. These tools provide different functions at different points in time, as shown in Figure ES.2 and described below.[1]

- **Strategic Planning Tools.** These include tools used to assess long-term needs and deficiencies impacting the transportation system and the life-cycle costs of operating and maintaining transportation infrastructure (for asset providers); and longer-term market analyses, production, and site selection alternatives (for service providers and end users).

- **Carrier Cost and Performance Analysis Tools.** These operational analysis tools, which estimate the operational performance and cost of freight carrier operations under alternative scenarios to represent the impact of transportation projects, programs, or policies, are primarily used by freight infrastructure providers and carriers.

[1] A detailed description of these analysis tools is provided in the NCFRP-05 Project Report.

Figure ES.2 Benefit Assessment Spectrum



- **Shipper Cost and Performance Models.** These tools estimate the cost and time characteristics of alternative freight mode and service options; and are intended to represent the total logistics time, cost, and safety/reliability tradeoffs available for a shipment so that optimal shipping decisions can be made. These tools are primarily used by end users (i.e., the businesses that generate outgoing freight or the consignees who receive the freight and ultimately pay the shipper cost).

- **Transportation System Efficiency Models**. These tools, often defined as "benefit-cost analysis" systems, are intended to evaluate the benefit and cost streams over a specified period of analysis to determine whether a proposed investment will yield benefits in excess of its cost.

- **Economic Development Impact Models**. These tools estimate impacts of transportation projects on income and jobs in the economy, and are primarily used by public-sector (local, regional, or state) transportation agencies to explicitly consider business productivity and economic development impacts that are not represented by transportation system efficiency tools.

- **Financial Impact Accounting Tools**. These tools, typically used by those that have a direct stake in the cost of a project, provide estimates on how the proposal will affect outgoing cost streams, incoming revenue streams, cash flow, borrowing or bond requirements, net profit or loss over time, upside/downside risk, and rate of return.

- **Risk Assessment Tools.** These tools assist private-sector asset providers and end users in understanding and quantifying critical areas of uncertainty related to making investment decisions.

These tools have varying degrees of importance to different stakeholders, as shown in Table ES.6.

Table ES.6 Importance of Analysis Tools to Freight Investment Stakeholders

Stakeholder Types	Tool Types						
	Strategic Planning	Carrier Cost & Performance	Shipper Cost & Performance	Transportation System Efficiency	Economic Development Impact	Financial Impact	Risk Assessment
Infrastructure Provider	●	●	○	●	●	●	●
Service Provider	●	●	◑	●	○	◑	●
End User	◑	◑	●	◑	○	◑	◑
Impacted Party	○	○	○	◑	◑	○	○

Key:

Less Important → ○ → ◑ → ● More Important

These existing tools make it possible to estimate costs and benefits for a wide range of freight improvement projects within the Freight Evaluation Framework, often well enough to facilitate further discussion between public and private parties. But one of the primary advantages of using the Framework is its ability to allocate those costs and benefits to affected stakeholder groups in a way that can enable further discussion. Figure ES.3 shows an example of how benefits from a freight investment are allocated among different stakeholders.[2]

[2] The NCFRP-05 Project Report provides detailed case studies on how the Freight Evaluation Framework is applied to actual freight investments.

Figure ES.3 Typical Example of a Stakeholder Benefit and Cost Allocation

Benefit metric	Infrastructure Provider	User	Service Provider	Public
Reduced Shipping Cost	--	--	$738,630	--
Reduced Inventory Carrying Cost	--	$468,439	--	--
Travel Time Savings	--	$1,191,735	--	--
Reduced Vehicle Operating Costs	$16,631	--	--	--
Safety Benefits	--	--	--	$209
Emissions Savings	--	--	--	$1,996

■ Summary and Conclusions

The Freight Evaluation Framework has proven to provide a method and process for identifying and evaluating the costs, benefits, and impacts of a wide variety of freight investments. The following sections provide an overview of the most critical conclusions and lessons learned from the research process. The NCFRP-05 Project Report provides more detail on lessons learned and potential next steps.

There are numerous available tools that can be used to assess benefits, costs, and risk of freight investments. What is needed are clear procedures that help analysts and decision-makers integrate these tools and that guide the analysis to ensure consistency from project to project.

This research uncovered a wide variety of investment decision-making techniques and tools that are currently used to assess user benefits, conduct return on investment assessments, and conduct benefit-cost analysis, economic impact analysis, and risk analysis. Yet there is general agreement among both public- and private-sector freight stakeholders that the Freight Evaluation Framework is a very useful way to frame an investment decision analysis. Many analysts find it difficult to wade through the variety of tools and data and determine which are the most appropriate for their particular situation. Many also feel that having a structure that guides the analyst through steps of an analysis would be very useful. Some specific features of the Framework that are particularly useful include:

- The identification of stakeholders and relationships between benefit categories and stakeholders. This helps in allocation of costs among beneficiaries.

- The categorization of benefits and relationships among benefits, project types, and modes. This essentially provides a checklist for the analyst to make sure he/she has considered all appropriate benefit types for a particular project type.

- The ability to conduct multimodal comparisons, as well as to consider cross-modal impacts of projects.

- Incorporation of risk analysis. As described earlier, risk analysis is a critical element of private-sector decision-making, but it is not often explicitly accounted for in public-sector analyses. Incorporating risk analysis also can help compensate for uncertainty introduced as a result of data or methodology weaknesses.

Allocation of benefits and costs among stakeholders is a critical feature of the Freight Evaluation Framework, but could be enhanced.

Initial tests of the Framework uncovered a number of issues related to how freight stakeholders are engaged throughout the application of the evaluation framework, including:

- **Disaggregating benefits by stakeholder type**. As described earlier, the Evaluation Framework identifies and classifies stakeholders into different groups and then adds a table to assign or allocate the various elements of benefit and cost to specific stakeholder groups. However, in carrying out the analysis, it can become a challenge to effectively assign various classes of benefits to specific stakeholders when there are dynamic interactions among them. Tracking the string of payments among facility developers, owners, and operators can be challenging, and estimating their final allocations may require the type of risk analysis that is included in the Framework.

- **Consistency among stakeholders and benefits**. Maintaining consistency with how stakeholders are identified and how they might benefit from particular projects will add value to the evaluation framework. For instance, the results and findings from a study can look very different depending on the level of detail in which stakeholders are defined and the degree of depth to which their interactions are traced. Both detail and consistency are required to generate useful results.

- **Accounting for sensitivity differences**. Finally, there are potentially large differences in the sensitivity to cost, benefits, and risk among different stakeholder types that are not all captured within the existing evaluation framework. This becomes important if the Framework is used to help rank projects from the perspectives of various stakeholder groups. In some cases, there may be "lexicographic preferences" (i.e., issues of such importance to a particular stakeholder group that they outweigh any and all other possible costs and benefits to that particular agent). In such cases, group preferences may include factors not all captured in the current framework. It may be possible for the framework to be expanded to account for and incorporate these types of preferences. Alternatively, it may be necessary to just note cases where the framework does not (or cannot) encompass other major considerations.

Solutions to existing problems are easier to measure and assess than "new opportunities"

The Evaluation Framework works well when there is a clearly defined problem to be solved. In these cases, there are clearly defined goals for the project, clearly defined benefits that are expected, and clearly defined "success" elements or performance measures. For instance, the Framework is very easy to apply to capacity enhancement projects that are designed to solve a particular problem or issue (e.g., limited double-stack clearance, truck access through local neighborhoods). In these cases, it is straightforward to identify the specific baseline conditions and current costs or disbenefits to be resolved.

Application of the Framework becomes more challenging for projects that are designed to take advantage of new opportunities (e.g., "greenfield" projects). In many cases, the primary benefit of these types of new (not expanded) capacity investments (where there are no existing users) is the ability to accommodate additional traffic. Analytical models used to support the original market justification for such projects were often based on unconstrained forecasts and just assumed that operating conditions would worsen without the capital investment. In the real world, that is often not a realistic assumption. For instance, as congestion rises under a "no build" scenario, a variety of different outcomes may occur, and hence may be represented by an alternative scenario:

- Cases where, without the new investment, businesses will merely stay in place and endure continuing growth of congestion delays and costs;

- Cases where, without the new investment, business activity shifts to other shipping modes, routes, or facilities that can offer a "second best" solution for remaining in place; or

- Cases where, without the new investment, some businesses will simply relocate to some other location where costs are not as high as would occur if they stayed in place.

It is both necessary and possible to define both project scenarios and alternative scenarios to represent the expected changes in freight demand patterns and business responses to them. In addition, the risk analysis method used in these cases shows how alternative assumptions about key factors such as freight demand growth can be explored and represented in a report on benefit-cost findings.

The Framework could benefit from a more consistent approach to identifying the sources of risk and uncertainty that should be incorporated in the analysis.

As described earlier, risk analysis often is focused on the market and cost risks that create the greatest uncertainties, and that could lead to different project outcomes. The market risks may be a result of normal fluctuations (such as business cycles), which may be reasonably predictable, or other random events that are important to consider, but more difficult to predict. Guidance could be developed to help identify the most typical sources of each type of risk and uncertainty for different types of projects. In addition, guidance could be provided for how to account for methodological uncertainty in the analysis. Given the fact that there are a number of key performance attributes of freight investments that are difficult to predict with currently available tools and data, having a

way to assess the level of uncertainty this introduces into investment decisions would be helpful.