

Infrastructure investment: *The supply chain connection*

Government decision makers rarely consider the impact of infrastructure investments on supply chains. But they should: Failing to do so will stifle a nation's economic competitiveness.

BECAUSE OF ITS IMPORTANCE in maintaining and improving economic competitiveness, transportation infrastructure has become a frequent subject of discussion around the world. In the United States, for instance, those discussions reflect concerns about whether the country has the necessary infrastructure to compete with expanding economies like China and India. Another concern is whether the transportation infrastructure can handle international trade growth—a major issue considering that the value of exports and imports as a percentage of gross domestic product (GDP) has nearly doubled since 1990. Rising logistics costs are yet another worry. After years of decline, transportation and logistics costs as a percentage of GDP increased from 8.6 percent in 2003 to 9.9 percent in 2006. Many researchers believe that inadequate infrastructure and the resulting congestion are partly to blame for that cost increase.

The economic implications of these trends were such a concern that in 2005 the United States Congress created the National Surface Transportation Policy and Revenue Study Commission to evaluate transportation conditions and the funding of infrastructure maintenance and improvements. The commission finished its work on July 7, 2008. One of its findings was that recent investment levels are not sufficient to meet the rising demand for trade and goods movement within the U.S. freight system.

We contend that this underinvestment in transportation infrastructure is due in part to a failure to consider the supply chain benefits of infrastructure investments.¹ Recent research and analysis have shown that governments and policy makers typically do not account for the economic stimulus provided by supply chain benefits when they evaluate large-scale infrastructure investments. This is unfortunate because they are overlooking an opportunity to provide a significant boost to the economy. Our research has shown that an investment in freight transportation infrastructure that reduces direct transportation costs by 10 percent will result in supply chain improvements that will help companies reduce their operating costs by 1 percent. By failing to take into account such potential supply chain benefits, governments are basing their investment decisions on inaccurate cost-benefit calculations. As a result, many projects that should be funded do not receive the support that they deserve.

This paper, however, will not show how to measure the supply chain benefits of a generic transportation investment (for example, the benefit per US \$100 million of investment), nor does it prescribe which transportation mode or project to invest in. Rather, this article will first explain how businesses reconfigure their supply chains in response to transportation infrastructure improvements that increase efficiency and reduce shipping costs, and then will use the experience of the

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United States to argue that governments should target, measure, and consider supply chain benefits when deciding whether or not to fund an infrastructure project.

Good infrastructure benefits shippers

When new transportation infrastructure is built, companies take advantage of the new capacity by adjusting their logistics processes and supply chains to improve service and reduce costs. In the short term, they change purchasing and operations behavior. In the longer term, they make input substitutions and reconfigure production processes to take advantage of transportation system improvements. For example, new transportation connectors, gateways, and intermodal links allow shippers to source from more distant suppliers at a lower cost; to reduce transportation costs by forming “hub and spoke” networks that connect multiple distribution points through central operating hubs; and to reduce inventory by switching from bulk shipments to smaller, more frequent orders.

Here are some other ways shippers benefit from adjusting their supply chains in response to more efficient transportation systems:

Lower sourcing costs. Companies want to source from a more diverse base of lower-cost suppliers because it increases their margins. Often this involves offshore sourcing, a strategy that requires managing logistics and transportation over long distances. The lower transportation and logistics costs achieved through efficient freight flows can make it economically rewarding for companies to source from overseas suppliers. High transportation and logistics costs, caused in part by inadequate infrastructure (and the resulting congestion), can make it uneconomical for shippers to do so.

Lower transport costs and an efficient transportation network also help shippers source from fewer locations. Because it is more affordable to ship longer distances from each facility, they are able to reduce the number of plants they operate and thereby increase their return on assets.

Reduced fleet, warehousing, and inventory costs. Infrastructure improvements increase a transportation system’s capacity and reduce or eliminate congestion,

thus improving the system’s reliability. This, in turn, reduces variability in transit times, making it possible to predict on-time performance with greater accuracy. As a result, shippers need fewer vehicles to maintain service levels on congested roadways and can downsize their fleets.

Improved reliability also allows shippers to consolidate warehouses that had been holding inventory to buffer against the congestion-related unreliability of inbound shipments. Moreover, when line-haul transportation flows freely (and therefore predictably), shippers can replace traditional warehouses with effi-



cient cross-dock operations that keep inventory in transit instead of putting it in storage.

With better transit time visibility—that is, information about where shipments and vehicles are located and when they will arrive at their destinations—shippers can safely postpone final assembly or configuration. This production strategy allows them to not only decrease inventory but also increase customer satisfaction (and sales) by providing a broader product mix with shorter lead times.

Increased revenue. Perhaps the biggest—albeit indirect—supply chain benefit of a transportation infrastructure project is the potential enhancement of revenues through the adoption of new business models. Shippers can take the savings they realize as a result of infrastructure improvements and reinvest in more competitive pricing. Infrastructure improvements can also help companies reach a broader market, facilitating increased sales. Alternatively, they may decide to offer higher service levels (shorter order-to-delivery lead times) instead of, or in addition to, pocketing the savings.

It is not easy to quantify the relationship between infrastructure investment and increased revenues for shippers. There is no question, however, that such investments improve supply chain efficiency. When one considers that some of the most successful companies are those that use their supply chains as competi-

tive weapons—Zara, Wal-Mart, Dell Computer, and Amazon.com are just some that come to mind—it seems likely that investing in transportation infrastructure will provide economic benefits, including sales growth, for the companies using that infrastructure.

Quantifying the benefits

Now that we have a sense of the types of supply chain benefits that can result from infrastructure improvements, we can quantify the impact of some of those benefits.

When the consulting and research firms Boston Strategies International (then Boston Logistics Group), Cambridge Systematics, and the Economic Development Research Group collaborated on a comprehensive economic study, *Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects*, for the United States Department of Transportation in 2006, they concluded that the supply chain benefits of an infrastructure investment that reduces direct transport costs by 10 percent has the potential to reduce a company’s operating cost by an *additional* 0.5 percent. This estimate was based on a sample of a wide variety of industries.²

Since that report was published, however, a number of significant changes have pushed transportation and logistics costs even higher. We estimate that increases in the price of fuel have raised U.S. companies’ trans-

[FIGURE 1] SUPPLY CHAIN BENEFITS OF FREIGHT TRANSPORTATION INVESTMENTS

Infrastructure Benefit	Supply Chain Impact	Supply Chain Benefit Expressed as % of Operating Costs
10% transport cost reduction	Lower material cost by substituting farther, cheaper sources	0.11%
	Consolidate plants due to extended reach	0.24%
	Switch modes and reduce shipment size, decreasing inventory	0.11%
		<hr/> 0.46%
10% capacity increase	Reduce safety stock	0.08%
	Rationalize fleet and warehouse assets	0.06%
		<hr/> 0.14%
10% better in-transit visibility	Gain postponement benefits (cost side only)	0.4%
		<hr/> 0.4%
Secondary effects (Revenue benefits)	Increase service levels	Not quantified
	Convert cost savings to price reductions	Not quantified
	Implement on-demand supply chains	Not quantified
		<hr/> 1.00%

[SOURCE: BOSTON STRATEGIES INTERNATIONAL UPDATE OF TABLE A.1 IN *GUIDE TO QUANTIFYING THE ECONOMIC IMPACTS OF FEDERAL INVESTMENTS IN LARGE-SCALE FREIGHT TRANSPORTATION PROJECTS*.]

portation costs from roughly 5 percent to about 6 percent of their total expenditures. Meanwhile, safety stocks increased from 20 percent to 25 percent of inventory as a result of more offshoring, which made it necessary for companies to carry more buffer stock. However, labor-cost inflation in China has cut into the savings that drew companies to source there. In our estimation, the cumulative effects of these and other relevant changes have increased the potential supply chain benefit of the scenario described above to 1.0 percent of operating costs. Note that this savings does *not* account for the additional revenue that can be derived from improved transportation infrastructure by allowing shippers and carriers to increase service levels, convert cost savings into price reductions, and build on-demand supply chains.

Figure 1 breaks down this revised estimate by type of infrastructure improvement and its resulting supply chain benefits. In this analysis, the hypothetical infrastructure investment reduced transportation costs by 10 percent. If a company responded to this improvement by optimizing its supply chain (through such steps as switching to more distant but lower-cost suppliers, consolidating plants, using cheaper transportation modes, and reducing shipment size), we believe that it could see an additional 0.5-percent reduction in operating costs. This estimation is based on Boston Strategies International's strategic sourcing survey of 182 companies in 13 service and product industries, its analyses of low-cost country sourcing economics, and a major consumer goods company's actual experience with plant consolidation. A transportation infrastructure investment that reduced transportation costs by a higher or lower percentage would yield higher or lower benefits.

Furthermore, if that infrastructure improvement increased capacity by 10 percent, we believe that the resulting fleet and warehouse rationalization and reduction in safety stock would amount to a 0.1-percent reduction in operating cost. This estimate is based on Boston Strategies' analysis of the inventory of 29 companies in six different types of supply chains and inventory and fleet benchmarks from its analyses of four companies' logistics networks; data from published sources such as CSCMP's annual *State of Logistics* study; and fleet data collected by the American Trucking Associations.

Finally, if that infrastructure improvement increased in-transit visibility by 10 percent, and the company takes advantage of this to implement postponement, it will be able to reduce operating costs by

at least 0.2 percent. This reduction in operating costs is based on reductions in stockouts experienced at retailers such as Wal-Mart and consumer packaged-goods suppliers such as Procter & Gamble.

While the aforementioned examples are from the United States, the same principles apply to major economies worldwide, especially large countries and economic areas where shippers can take advantage of hub-and-spoke infrastructure to design more economically efficient supply chains.

Why are supply chain benefits ignored?

Despite these demonstrated benefits, government transportation officials and their consultants rarely account for short-term and long-term supply chain effects in their financial evaluations of freight transportation investments. There are two main reasons why this is so.

First, whereas the infrastructure priority following World War II was to construct highways, today's freight movements are substantially different. Typically, freight travel involves longer distances than passenger travel, and thus it involves more governmental jurisdictions in infrastructure decisions.

Furthermore, private sector stakeholders own many key rail and marine assets, and these companies do not have standard procedures for participating in the public funding and authorization process. In addition, many freight movements today are multimodal, and infrastructure decisions for this type of traffic require deeper transportation experience and more complex analytics than had ever been needed for passenger traffic infrastructure.

Second, decision makers don't always have the time to consider every aspect of every potential infrastructure project, especially the smaller ones. Evaluations are complicated because there are many types of costs, benefits, and impacts involved. For example, there are at least eight major types of potential consequences of infrastructure projects:

1. Environmental impacts
2. Safety and security benefits
3. Public operating and capital expense benefits
4. Direct user or carrier benefits
5. Direct shipper benefits (which include access to terminals and possibly more efficient modes of transportation that could save time and cost)
6. Economic impact (jobs, industry and market growth)
7. Supply chain benefits
8. International economic benefits (through sup-



[FIGURE 2] CONSIDERATION OF BENEFITS IN FOUR PROPOSED FREIGHT PROJECTS

	California: Inland Empire Rail Shuttle	Chicago: CREATE	Vancouver: Major Commercial Transportation System (MCTS)	New York: Cross-Harbor Tunnel
Impact on public operating and capital expense	Reduction in pavement wear Fuel tax revenue	Highway investment averted	Not quantified	Economic impact of operating and capital expense Reduction in pavement wear
Direct impact on carriers	Savings for rail operators	Savings for rail operators	Improvement in ability of the system to maintain capacity to meet projected demand (trains, carloads, and value of goods) using the rail system	Reduction in costs for existing freight rail carriers and reduction in congestion for remaining trucks
Direct economic impact on shippers and passengers	Not quantified	Mitigation of congestion in future growth of highway passenger traffic Time savings for rail commuters and for motorists at crossings	Reduction in road system delay associated with excess vehicle miles and hours traveled for commercial vehicle operations, commuting, and overall highway network efficiency in the region	Travel time and reliability benefits of diversion from truck to rail
Impact on supply chains	Not quantified	Inventory reduction savings (national assessment only)	Not quantified	Not quantified
Economic impact	Not quantified	Regional construction stimulus National growth and productivity	Ability to avoid losses of gateway port economic activity) that would otherwise occur Ability of the Vancouver region, British Columbia province, and Western Canada to maintain its economic vitality and importance	Business attraction/retention due to greatly enhanced freight rail service and a new intermodal yard Economic impacts to the region and nation
Impact on international trade	Not quantified	Not quantified	Not quantified	Not quantified
Impact on the environment	Reduction in air and noise pollution	Value of emission reductions due to reduced train and motor vehicle idling	Not quantified	Value of emission reductions from diversion from truck to rail
Impact on safety	Reduction in accidents	Savings tied to accident reduction at crossings and less congested highways	Reduction in accidents	Fewer highway accidents
Total economic benefit	\$23 million	Almost \$500 million in public benefits; 1,000 jobs and \$50 million payroll	\$1.5 billion in high-impact scenario, benefit/cost ratio of 1.6	\$0.6 billion personal income nationally and 29,000 jobs in New York metro area by 2025 in double-tunnel system

[SOURCE: HDR DECISION ECONOMICS SUMMARY OF CASE STUDIES PRESENTED IN *GUIDE TO QUANTIFYING THE ECONOMIC IMPACTS OF FEDERAL INVESTMENTS IN LARGE-SCALE FREIGHT TRANSPORTATION PROJECTS*.]

port of international trade)

While public officials commonly address some of the benefits and impacts on this list in their cost/benefit analyses, they usually do not consider all of them. In our experience, they most often consider a project's impact on the environment, safety, public operating and capital expense budgets, and direct benefits for users, carriers, and shippers. The economic impact, in terms of job creation or loss, is sometimes considered, especially in large-scale investments where multiple constituencies or stakeholders are affected.

However, our research has found that supply chain benefits and international trade benefits are most often omitted from any type of analysis, resulting in an incomplete assessment of a project's benefits. This is evident in Figure 2, which summarizes which factors were considered and which were not in a sample of recent freight project evaluations in North America. Chicago's CREATE project, a consortium of public and private parties working to develop streamlined intermodal connections and through-traffic patterns in Chicago, was the only one of the four that examined extended supply chain benefits.

Case example: Baltimore rail project

The Baltimore Freight Rail Bypass investment project illustrates how the inclusion of supply chain benefits in an infrastructure cost/benefit analysis can yield a result that would be more likely to lead to funding. This project involved the commitment of about US \$3 billion for new tunnels beneath the city of Baltimore, Maryland, USA; alternate alignments that would bypass the city to resolve congestion that led to repeated train delays; and upgrades to the condition of tracks and tunnels. There are multiple stakeholders; track is shared by freight and passenger rail and is owned by several companies.

Figure 3 calculates the anticipated benefits and

costs of the project when including different benefit categories and perspectives. The first column only considers benefits to the state of Maryland, while the other columns include national benefits that take into account all trip origins and destinations, whether inside or outside of the state. The US \$270 million benefit for freight rail operators represents the direct operational cost savings (in labor, fuel, and so forth) that would result from less travel time through the current bottleneck. The shipper benefits represent the savings to shippers and receivers who would ship via rail (with lower per-ton-mile shipping rates) rather than by truck due to the increased capacity. The Amtrak (U.S. national rail service) benefits relate to faster travel times for passengers because of a drastic reduction in shared-track conflicts with freight trains. The highway benefits result from reduced truck traffic on state and interstate highways because rail would carry a larger share of future freight volumes. These benefits would come from a reduction in accidents, vehicle emissions, and pavement damage, and slightly improved traffic conditions for the remaining highway users.

Finally, the supply chain benefits were estimated using the parameters in Figure 1 regarding the relationship between reduced transportation costs and supply chain benefits for private industry. The supply chain benefits were based on the direct freight-related cost savings and were customized based on the industry and commodity mix of the multistate region where most freight trips start or end. These include:

- Lower sourcing costs;
- Lower fleet, warehousing, and safety stock costs because of increased reliability;
- Lower inventory due to smaller shipments and the postponement of final configuration; and
- Increased revenue from adopting new business models.

[FIGURE 3] RAIL FREIGHT CASE STUDY RESULTS (IN US\$ MILLIONS)

Benefit	Maryland Benefits Only (No Supply Chain Benefits Included)	National Benefit (Excluding Full Highway User Benefits and Supply Chain Benefits)	Total National Benefits
Freight rail operators	\$270	\$270	\$270
Shipper costs	1,052	1,656	1,656
Amtrak (U.S. national rail service)	176	626	626
Highway	565		874
Supply chain			1,303
Total benefits	2,063	2,552	4,729
Total costs	3,046	3,046	3,046
Benefit/cost ratio	0.7	0.8	1.6

[SOURCE: EXCERPT FROM FIGURE 8.4 IN *GUIDE TO QUANTIFYING THE ECONOMIC IMPACTS OF FEDERAL INVESTMENTS IN LARGE-SCALE FREIGHT TRANSPORTATION PROJECTS*.]

If one counts only the benefits to the state of Maryland, the benefit/cost ratio was shown to be 0.7, meaning that costs exceed benefits when limiting the analysis to affected trips with origins and destinations in Maryland. By including national benefits that accrued to shippers outside of Maryland (including Amtrak but excluding highway user and supply chain benefits), the benefit/cost ratio rose to 0.8. The inclusion of both supply chain and national highway user benefits increased the benefit/cost ratio to 1.6—in other words, the projected benefits exceeded the cost of the project. Assuming the forecasts of benefits are reasonably accurate, these projections present a strong case for investment in and support of this project.

Nationwide implications

Based on case study analyses conducted for the *Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects*, we can estimate that omitting supply chain benefits in an infrastructure project analysis may cause government planners to undervalue the potential benefits of freight transportation investments by

up to 37 percent. This is demonstrated in Figure 4, which is drawn from an analysis of supply chain benefits in relation to the freight rail project in Baltimore. In this example, there were \$62 million of supply chain benefits in the 2006 study and \$278 million of total benefits. After updating the coefficients to reflect changes in costs since 2006, the projected supply chain benefits for the project today would be \$126 million and \$342 million, respectively.³ Assuming for the moment that approximately half of potential investment projects are similar to the case examined for this research, and that 10 percent to 15 percent of the projects that currently are rejected would be accepted if planners accounted for those additional supply chain benefits, we estimate that on average, 13 percent more projects would be approved if planners did consider those benefits.

The implication is that the United States may have been underinvesting by 1.9 percent annually (see Figure 5) since roughly 1985, when supply chain management gained currency as a management movement and companies began actively managing their supply chains to best leverage transportation investments and efficiencies. Based on actual federal and state capital expenditures for all transportation modes in 2004, an additional \$4 billion would be spent annually.⁴ Retrospectively, the cumulative value of a 1.9-percent underinvestment for 23 years would have resulted in 156 percent more capital expenditure than actually occurred during that period.

What should happen now?

In our opinion, government agencies that are responsible for transportation investment decisions should change the way they evaluate major freight projects to incorporate estimates of supply chain benefits for private industry. This will help to ensure that essential freight transportation infrastructure projects are funded and that businesses and the national economy receive these critical supply chain benefits. We believe that government agencies involved in infrastructure investment should:

- Identify and review high-profile investments that are especially likely to generate supply chain benefits. Taking a step in that direction, the National Surface Transportation Policy and Revenue Commission recommended the creation of a program of investment in a

[FIGURE 4] INCREMENTAL PROJECTS THAT WOULD BE FUNDED IF SUPPLY CHAIN BENEFITS WERE CONSIDERED

Parameter	Value (Percent or US\$ millions)
Supply chain benefits	\$126
Total benefits	\$342
Supply chain benefit as percent of total benefits	37%
Second-order benefits, including supply chain	\$301
Total benefits	\$404
Total second-order benefits as percent of of total benefits	74%
Percent of cases like Baltimore	50%
Percent of cases that are within 31 percent of having a net positive net present value	20%
Percent of cases that are within 72 percent of having a net positive net present value	30%
Percent additional projects that would be approved—low estimate	10%
Percent additional projects that would be approved—high estimate	15%
Percent additional projects that would be approved—average	13%

[SOURCE: BOSTON STRATEGIES INTERNATIONAL AND HDR DECISION ECONOMICS]

report called “Freight Transportation: A Program to Enhance U.S. Global Competitiveness.” In that report, the commission recommended a substantial national commitment to transportation investment of “at least \$225 billion annually from all sources for the next 50 years.”

- Apply the benefit-calculation method proposed in *Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects*. As that report indicated, the magnitude of the supply chain benefits of freight projects will vary depending on the mix of industries for the shippers and receivers that are affected by the improvement.

- Develop methodologies for sharing the costs and benefits among jurisdictions (local, state, federal) and the public and private sectors. This includes funding the research needed to establish a framework for splitting the costs and benefits among affected parties, as well as identifying the multipliers for different regions and types of investments. This last step will require a subordinate but critical piece of research: An acceptable method for quantifying the international trade benefits of large-scale infrastructure projects will be essential to equitably allocating supply chain costs and benefits.

These are not concerns for government alone; other stakeholders must get involved if infrastructure funding is to be accelerated. Governments, carriers, and shippers all need to play an active role in assuring that the right projects get approved and the costs and benefits are equitably distributed.

Carriers and shippers, for instance, should use industry associations to provide input to the government on how to prioritize, evaluate, and approach costs and benefits when dealing with public-private partnerships. Academics should teach about public-private partnerships in their finance and supply chain courses, and they should pursue grants for research in this area.

The issue of shared benefits and costs will not go away. It will increase in depth and breadth as the volume of international trade increases and the need for an increasing number of larger trade and transportation gateways expands. Supply chain benefits are at the center of that issue, and when government decision makers acknowledge their existence and their value to the economy, they will have taken the first step toward developing an important new approach to investment in and management of transportation infrastructure. △

[FIGURE 5] HYPOTHETICAL IMPACT ON THE U.S. TRANSPORTATION BUDGET

Variable	Value (Percent or US\$ millions)
Transportation capital expenditures, 2004 (US\$ billions)	\$213
Percent additional projects that would be funded	13%
Percent of budget for capital projects (vs. operating expenses)	47%
Average years duration of capital projects	3
Implied additional yearly budget (US\$ millions)	\$4,141
Percent additional annual transportation funding	1.9%
CUMULATIVE UNDERINVESTMENT	
Percent underinvestment per year	1.9%
Number of years of underinvestment (from 1985 to 2008)	23
Cumulative underinvestment percent	156%

[SOURCE: BOSTON STRATEGIES INTERNATIONAL ANALYSIS OF DATA FROM THE U.S. CONGRESSIONAL BUDGET OFFICE, THE U.S. OFFICE OF MANAGEMENT AND BUDGET, THE U.S. DEPARTMENT OF TRANSPORTATION, AND THE AMERICAN ASSOCIATION OF RAILROADS]

Endnotes:

1. The total value of transportation investments (and the revenue sources used to fund them) in the United States is determined within a complex set of factors that includes political and public priorities, gas taxes, the federal Highway Trust Fund, and other effects (safety, congestion, environmental) of transportation.

2. *Guide to Quantifying the Economic Impacts of Federal Investments in Large-Scale Freight Transportation Projects*, 2006. This report is available to the public at www.dot.gov/freight/guide061018/guide.pdf. The information used in this article is credited to Cambridge Systematics and Boston Strategies International (formerly Boston Logistics Group).

3. The 2006 study estimated supply chain benefits of \$61.9 million and total benefits of \$278 million. The estimated supply chain benefits increased by 118 percent since 2006 due to increases in fuel costs, Chinese labor costs, and other relevant costs.

4. Assumes that the average project budget is expended over a three-year time horizon, and that the transportation budget consists of 47 percent capital expenditure and 53 percent operating and maintenance expenditure, which was the case with the U.S. federal highway budget in 2006.

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