State
Smart Transportation
Initiative

Economic Effects of Public Investment in Transportation And Directions for the Future

Prepared for the State Smart Transportation Initiative

With Support from
The Federal Highway Administration and
The Rockefeller Foundation

By the Center for Neighborhood Technology
With James deBettencourt, Ph.D.

2012

Project Steering Committee

Scott Richrath and Kate Dill, Colorado DOT

Peter VanSickle, Kansas DOT

Brian Wall, Pennsylvania DOT

Denise Whiteny-Dahlke, Oregon DOT

John Wilson and Matthew Shands, Minnesota DOT

Daniella Bremmer and Rachel Knutson, Washington DOT

Table of Contents

Economic Effects of Public Investment in Transportation

And Directions for the Future

Executive Summary

The post-2007-2009 recession has been marked by a strong interest among policy makers at all levels in understanding how investment in public infrastructure may affect both short- and long-term economic outcomes. Transportation as a catalyst for economic development is well documented, but how might that change if the U.S. is transitioning to a "new economy" that is knowledge-based and fueled by technological improvements? Furthermore, what if improving manufacturing indicators that may signal a more incremental economic transition prevail? Regardless of the economy's evolution, it is important to understand the relationship between transportation investments and economic results as we have experienced it, and what measures and tools are available to enhance that understanding at the state and local level, where the future economy is being shaped.

This report examines current economic analysis practices in state Departments of Transportation (DOTs) through examples in nine state transportation agencies and an extensive literature review. For additional understanding of the methods in practice, we also incorporated information obtained at selected metropolitan planning organizations (MPOs). The increased interest and demand for better economic results from transportation encouraged the State Smart Transportation Initiative (SSTI) to look for ways to help states improve their ability to predict and measure the economic impacts of transportation policies and investments. In carrying out this research, the key questions addressed include:

1. What is economic development and how does it relate to transportation?
2. What is motivating state DOTs to measure economic performance?
3. What emphasis is placed on economic benefit of transportation investments? How is economic potential factored in to systems planning, project development, and project selection among the state DOTs and other transportation agencies? Do any States require the maximization of economic benefits from transportation or other infrastructure investments?
4. Is a distinction made between new economic activity and simply redistributing it from one area to another, one state to another?
5. How are States accounting for the economic effects of transportation investments? What models and tools exist or can be created to help achieve a better understanding of the relationship between transportation and economics, and thereby improve the results of transportation investment?

6. What are the barriers to adopting effective measures and analytical techniques and models among transportation agencies? What are the relative costs and time involved in collection and analysis.

For the purposes of this study, the research team has defined economic development and economic analysis in broad terms that encompass the full range of potential impacts that may occur from transportation investment. The definitions below are intended to include the potential environmental, social, and economic effects of the identified policy, program, project, or service.

> *Economic Development:* A transparent process or planned action that results in the retention and creation of sustainable jobs, wealth, and the improvement of quality of life.
>
> *Economic Analysis:* Techniques that encompass, but are not limited to, the analysis of the more microeconomic aggregate economic measures relating to regional product, income and employment. Monetary, fiscal, financial, and other impacts that can and cannot be monetized may be included in the analysis, as is relevant.

The Agencies

State DOTs are increasingly motivated to understand the economic impact of investments due to three primary factors:

1. Their interest in a greater return on investment after a prolonged recession and slow recovery;
2. The interest of the public in getting a high return on invested tax dollars; and
3. By state political leadership motivated by such hard realities, including a continuing interest in good, long-term jobs.

But they are not equally funded, structured, or motivated to take on the challenges of complex economic analyses. The agencies reflect the ambitions, goals, and assets of their citizens and geography. Generally, DOTs are directed toward planning and funding highways and bridges because highways receive more transportation funding from state and federal government than any other mode. In FY 2005, for example, the Federal Highway Administration (FHWA) of the US Department of Transportation (USDOT) provided over $31 billion for highway, road, and bridge planning and capital improvements, while states invested approximately $101 billion[1]. Comparable figures for transit are from 2007 when the Federal Transit Administration (FTA) of USDOT provided some $10.7 billion to states and regional transit agencies and states provided $13.3 billion[2]. Most states provide limited planning and grant

[1] *Highway Statistics* provides data for two types of funding, which are the latest dates both are available: 1. State disbursements for all highways found at http://www.fhwa.dot.gov/policy/ohim/hs04/pdf/sf21.pdf
And, 2. Total federal highway allocations found at http://www.fhwa.dot.gov/policy/ohim/hs04/pdf/fa4.pdf

[2] American Association of State Highway and Transportation Officials (AASHTO), *Survey of State Funding for Public Transportation* (AASHTO: Washington DC, 2008) Report found at

programs for other modes such as rail and aviation and pass through federal funding for these modes and for transit. Several DOTs are full multimodal operational and capital development organizations that may even include ports. Six are the operators of major transit systems and 44 of them provide some level of funding to transit. The expenditures, however, are highly concentrated. In FY 2009, 10 states contributed over $11 billion to transit operations and capital improvements of a total of over $13 billion. With these very substantial differences in funding and responsibility, it is understandable that we found the approach to economic analysis, the modes considered in the analysis, and the degree of interest in economic development is not uniform among the state DOTs. It follows that resources devoted to this type of analysis, including the experience, skills, and training of the staff also vary.

Consideration of Economic Impacts/Benefits

In considering types of economic benefits, there are two generic types in the transportation planning process. First, there are primarily direct user benefits that are attributable to active use of the transportation system being proposed or evaluated, and sometimes included are directly associated changes in consumer welfare affected by changes in service accessibility. Second, there are also aggregate economic activity benefits related to changes in output, productivity, and employment that are affected by the introduction of a specific system or improvement in the transportation system or infrastructure. The latter incorporates what are known as indirect benefits of the jobs and productivity and the induced benefits of the second round of spending that comes from the wages and revenue being spent on additional goods and services.

Based on the research, these types of benefits/impacts are divided into four categories:

- System Performance
- Benefit-Cost & Cost Effectiveness
- Regional Economic Development
- Livability

The following graphic summarizes the types of impacts within the four categories of benefits from transportation investment and services and shows how comprehensive analysis builds from a traditional focus on direct user costs and benefits to wider impacts on the regional economy and community quality of life.

http://scopt.transportation.org/Documents/Survey%20of%20State%20Funding%20for%20Public%20Transportation%20-%20FY%202007.pdf

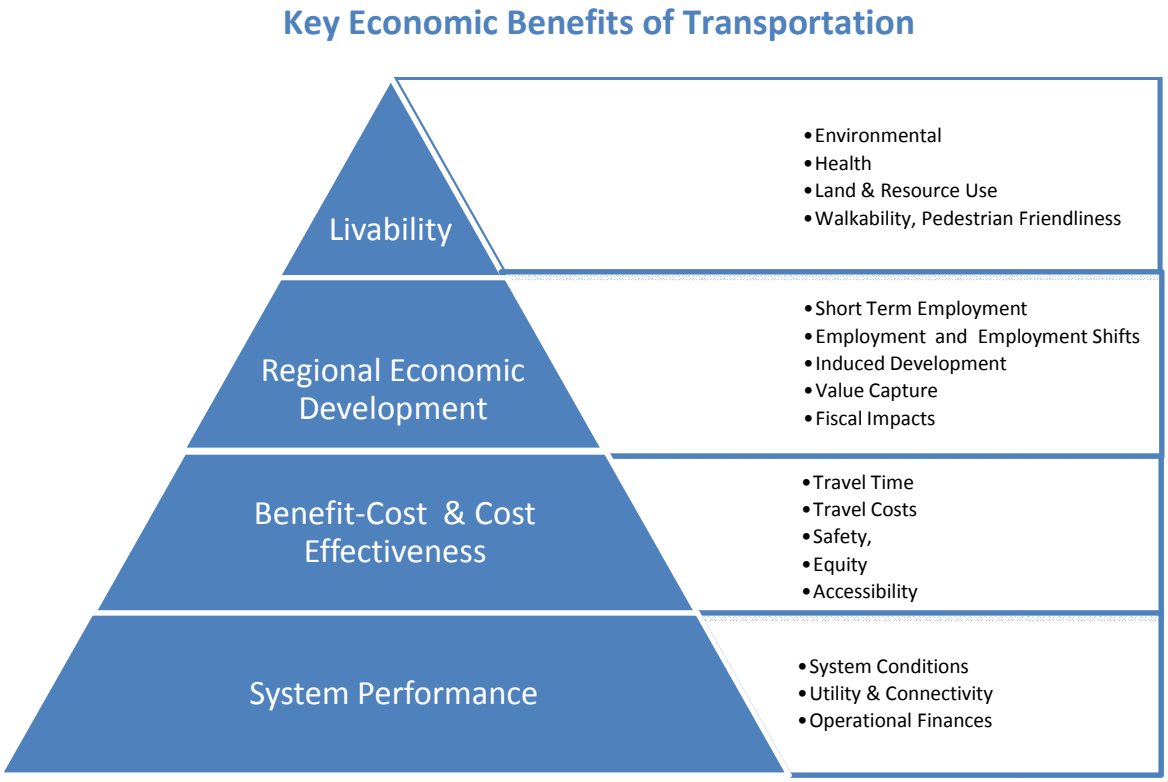

Figure I: The Building Blocks of Comprehensive Transportation-Economic Analysis

Additionally, the research has identified six types of information, tools, and models that are relevant to this discussion. These categories include:

- **Primary Data:** Data and information without interpretation applied to them.
- **Purpose-Focused:** Data and modeled results that focus on specific transportation questions.
- **Traffic Engineering and Performance Based:** Models and capacity manual tools in use in transportation agencies are included in these approaches.
- **Travel Demand:** Models and tools that project or measure travel and its causes and effects.
- **Regional Economic Activity:** Analytical tools used to predict the regional economic impacts of transportation investments including changes in:
    - Employment, industry activity, and economic demand;
    - Fiscal impacts such as property values;
    - Household and business costs and affordability; and
    - Livability impacts such as environment and health, land consumption, and walkability.

- **Community of Practice:** Analytical tools that derive from real-world experience and implementation, such as compilations of case studies of completed projects or a body of research or data on a particular area of inquiry.

A matrix or Scorecard showing the relationship between a broad range of benefits/impacts and types of data and tools available was developed from this research and is provided at http://www.ssti.us/2012/05/economic-effects-of-transportation-investments/

This Scorecard shows how different types of data and tools can be used to provide insight into the nature and extent of the selected benefits/impacts in the four categories. Neither the impacts nor the tools represent an exhaustive list, rather they were selected for because they reflect current practice and/or are recommended for consideration. While both the data and the tools have been improving, particularly with the wider use and availability of GIS applications, there are still important gaps in our understanding of economic impacts, especially in predicting impacts. These gaps are indicated by the blank cells in the matrix and tend to cluster in the regional economic development and community effects benefit/impact areas. Continuing research and tool development in these areas is needed.

The literature and the study's interviews in nine states found that state DOTs have adopted economic goals, but have been slower to adopt related performance measures. Depending upon the agency, this circumstance is a result of a lack of appropriate data, concern for identifying the best measures to reflect the agency goals, lack of staff familiarity with the requirements of economic analysis, and the issues of funding and leadership cited above. Where such analysis has become a priority, it still requires time to select the best few and to acquire the data and report out the results. To get the process going, many agencies have started with freight measures to reflect the concern with improving business conditions.

There are examples of more states being interested in economic modeling, than in times past, but no conclusions can be drawn as to how many states have actually adopted models and are using them in the various stages of planning. The literature indicates that the majority of states rely on consultants as well as metropolitan planning organizations (MPOs) and sister state agencies to meet their needs for economic analysis, including modeling. Cost was not cited as a barrier to using proprietary models in our interviews, but concern over relying on a "black box" was stated. Additionally, not all states have the type of transportation data that is required for inputs to the models.

Regarding net economic gain, rather than just redistribution of jobs and other economic activity from one location to another, the states generally have demonstrated an awareness of the issue and many have put in place procedures to ensure that projects provide net jobs and economic benefit to the state. This is especially when they are part of an incentive program for private investment. There is not much evidence, however, of states avoiding funding for projects that lead to a redistribution of economic activity between states. As to redistribution between localities or within regions, the tools are often not sensitive to such changes primarily due to data that are reported at the county or metropolitan level in the analysis, rather than at a smaller scale such as TAZ or Census block group. Such higher level data

often mask the activity occurring in the immediate project area by looking only at county or state results.

Conclusions

1. **Economic benefits should be viewed comprehensively** rather than considering just the direct user benefits, which have been the traditional focus of economic valuation of transportation investment. Such a limited focus will ignore many potential benefits that are important to an increasingly wary public who are seeking good return on their tax dollars.

2. Transportation agencies **show increased interest in reaping economic benefits**, and in demonstrating those benefits to the public, but have been slow to adopt measures of progress toward goals. In part this results from a professional concern with providing reliable measures supported by quality data that will stand up to scrutiny and provide a sound basis for decision-making. The increased interest is due in part to the emergence of highly competitive, multi-modal grant and loan programs at USDOT that require economic return, such as the Transportation Infrastructure Generating Economic Recovery (TIGER) program and the Transportation Infrastructure Finance and Innovation Act (TIFIA).

3. **State analysis is often focused on user benefits and the business effects of transportation** and thus looking to improve the key areas of manufacturing, logistics and goods movement**.** This emphasis is both desirable and understandable where the economic policy also is focused on manufacturing and logistics, and as a strategy to encourage exporting industry. This approach, however, is not broad enough to recognize the importance of services including medical services, of educational facilities, of retail, and of housing in today's economy. The economies of whole regions are now being fueled by major medical or university complexes and the agglomerative benefits that accrue to these activities. Another example is tourism. Many state transportation plans recognize the importance of tourism to their economies – Wisconsin and Washington both show it as one of the top three industries- but put their attention elsewhere in considering economic benefits. It often does not address the important effects these investments may have on households and on the cost of living at the household level.

4. **Only a small percentage of federally funded projects are evaluated** and fewer for their economic benefit. This leaves a gap in reliable information of actual impacts of transportation investments, which is needed for policy analysis, for developing reliable measures, and for informing funding decisions.

5. **Data and Tools are improving, but gaps remain** that require improved analytic techniques to predict and manage, particularly in emerging issues and practices areas of:

    - The geographic unit of analysis;

- The role of local fiscal impacts such as property values and sales taxes in supporting investment;
- The positive and negative impacts of induced development from investment;
- The impact of agglomerative benefits and how and when they occur; and
- The continued importance of community of practice – collaboration and evaluation.

6. The **benefit to analysis of more refined geographic levels** in the urban setting is clear, especially in considering economic distress, shifts in economic activity, or agglomerative benefits. Purchases of data and of the models that use the data should strongly consider this more refined level of analysis.

7. **Combining, managing and comparing the results from different impact estimation techniques is becoming the hallmark** of some of the newer visualization toolsets for transportation planners. And yet, when looking at the full (comprehensive) benefits and costs of transportation investments, no single tool or model is available to model or assess all such impacts – nor is it necessarily realistic, given the variety of conditions, projects, and goals of individual states.

Recommendations

1. All transportation agencies should conduct economic analysis of transportation **that looks at all the possible impacts** – and therefore benefits - of the types of investments made. While double counting should be avoided if tallying up the results in a cost benefit assessment, analyzing and laying out the various effects on users, non-users, and the community provides a much better understanding of the positive and negative impacts to taxpayers as a whole, and to the long-term effects that make the difference between temporary advantage and sustainable results.

2. **Economic evaluations of a percentage of the billions invested in projects each year should be conducted.** Evaluations of a selection of state transportation projects each year would greatly enhance planners and decision-maker's understanding of how best to increase economic development from transportation investment and of the value of the investment. This documentation would provide much needed information for individual economic analyses such as understanding likely induced traffic and related indirect economic and land use effects of projects. These evaluations would need to use common standards and be conducted over a timeframe that would capture the immediate effects (within 3 years) and again at 5-10 years – recognizing that good quality, sustainable development often evolves over decades.

3. Such analysis should be **conducted by independent third parties and put in an accessible format and web location**. There should be a compilation of the results from each state and a regular review and dissemination of the results, perhaps through a joint NCHRP-TCRP panel. A strong model for this would be the on-going program evaluation element that is part of every one of California's energy efficiency programs. Putting aside .5% of federal funding and matching state share alone (estimated at $48 billion per year) would yield some $240 million. Not an unreasonable amount to be allocated

among 50 states, the District of Columbia, Puerto Rico and direct federal projects to determine what types of projects and circumstances return the highest value.

Attractive, Well-Maintained Transportation Facilities are Important to Long-term Economic Productivity and to Livability

Philadelphia Skyline with Fairmont Park. From: State Smart Transportation Initiative, *SSTI Review of PennDOT's Smart Transportation Program, 2011.*

Chapter I. Transportation and Economic Development: Why the Interest?

Throughout America's history, economic expansion has been facilitated by major transportation investments: the Erie Canal, the Transcontinental Railway, the Intracoastal Waterway, the Air Traffic Control System, and the Interstate Highway. All have played essential roles in supporting the mobility of the population and goods upon which we depend, and have contributed to the economic growth of the Nation.

Today the opportunities for such big effects on the economy have diminished as most of the National transportation systems are established – we no longer need to create an aviation industry or an interstate highway system. Nor will we reap the large benefits from the initial connections they provided between producers and markets. We can expect that new transportation priorities will reflect the need: for making the missing connections between these systems; for extensions of passenger rail and other systems to support expected population growth; and for better connections with local transportation and within communities. These new and more complex priorities will continue to make transportation investment important to the Nation's economy, but also make identifying and ensuring a good return for society from transportation investments much more difficult.

New Urban Freeway Under Construction

Since the 2008 recession, the deep concern with the country's economic health has stimulated government interest at all levels in the role of infrastructure investments in spurring economic development. This interest was further enhanced among transportation agencies in 2009 when U.S. Department of Transportation (USDOT) established a new grant program emphasizing economic competitiveness and cost-benefit analysis as factors in the selection of projects for funding. The Transportation Infrastructure Generating Economic Recovery (TIGER) program[3] challenged state

[3] The TIFIA loan and credit support program also has stimulated an interest in better methods for assessing economic benefits. The program, which was established by Congress for USDOT administration in 1998, also asks for economic analyses. Only a

Departments of Transportation (DOTs), transit agencies, local governments and private sector interests (with public sponsors), to compete for the funding to support highway, transit, rail and intermodal investments. This multi-modal grant program, open to all levels of government, was a big change from the modal programs largely run through formula distribution, without competition.

And compete they have. In the first three grant rounds, USDOT received multiple applications from every state and the District of Columbia totaling 3,226 proposals with a cost of $90.1 billion, greatly overwhelming the $2.6 billion available.[4] Another round of grant funding is approved for FY 2012.

At the time of the initial TIGER grant offering, some state DOTs and other transportation agencies expressed misgivings about being prepared to conduct the necessary economic analyses: both economic impact and cost-benefit analysis.[5] For many transportation agencies, experience with formal economic analysis has been limited to meeting federal environmental requirements for documenting potential social and economic effects of proposed transportation projects. Such statements are often prepared by consultants and may not play a significant role in the project decision-making of the agency or in building economic analysis capacity or understanding among staff. As late as 2008, state DOTs had not regularly used regional economic models in their planning and programming activities[6].

A U.S. General Accounting Office (GAO) evaluation of the TIGER grants substantiated the skittishness among the agencies during the first round of grants:

> ". . . a final challenge in TIGER was that many applications evaluated by the Economic Analysis Team were deemed to not have useful analyses of expected project benefits and costs. . . . DOT officials thought the limited usefulness of applicants' economic analyses was largely a consequence of applicants lacking familiarity with how to properly conduct such analyses."[7]

In response to the experience with the first round of TIGER grants, the DOT increased information and guidance on cost-benefit analysis for the second round of grants, including training seminars explaining

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relatively few states applied for the program before 2009. Most years the $122 million a year in funding was not all obligated. In 2009, the number of applications jumped, and in 2011 more than $14 billion in funding was requested.

[4] Unfortunately, most ARRA projects have not been completed or not completed long enough to establish a clear track record of accomplishment. What we do know is that initial reports of jobs gained show twice as many job months per $billion for transit as for highways. This experience was documented in the report: "What We Learned from the Stimulus", by the Center for Neighborhood Technology, Smart Growth America, and U.S. PIRG (2010), which is found at: http://www.cnt.org/repository/What%20We%20Learned.ARRA-jobs-report.pdf The GAO also has reviewed the ARRA projects, but primarily from the perspective of adequate reporting of costs and construction jobs realized

[5] According to a discussion of transportation benefits by Glenn Weisbrod et al in a 2008 report, analysts should distinguish economic development impacts from other benefits that are used in benefit cost analysis (CBA). (See GlennWeisbrod, Teresa Lynch, and Michael Meyer, *Extending Monetary Values to Broader Performance and Impact Measures: Applications for Transportation and Lessons from Other Fields* (Boston, MA: EDR Group, 2008) *Note that this report treats the terms CBA and benefit cost analysis (BCA) as the same.*

[6] Weisbrod et al, 2008, p.15-16.

[7] United States Government Accountability Office *Surface Transportation: Competitive Grant Programs Could Benefit from Increased Performance Focus and Better Documentation of Key Decisions*(Washington, DC: GAO, 20011) http://www.gao.gov/new.items/d11234.pdf

the difference between cost-benefit and other types of economic analysis. This guidance was further revised for the TIGER III and IV grant rounds.

At the state level, legislatures have shown their interest in achieving economic results from transportation by requiring new performance reports from state DOTs and funding new economic development programs in the agencies. In Washington, for example, in 2010 the legislature added a sixth goal of "economic vitality" to the required annual report on agency performance. Since 2008, states have re-energized transportation planning processes to make economic development a key criterion for planning, and in some states economic analysis has become an explicit part of project selection. North Carolina DOT and Kansas DOT, for example, are now using the results of regional input-output models as significant factors in selecting highway projects. States with new grant programs focused on economic development results include: Colorado, Minnesota, and Pennsylvania. Kansas DOT's existing economic program was expanded from highway improvements only to all modes in 2010 and redirected to focus on faster delivery and clearer evaluation of economic benefits.

Chapter II. Project Scope and Approach

The increased interest and demand for better economic results from transportation encouraged the State Smart Transportation Institute (SSTI) to look for ways to help states improve their ability to predict and measure the economic impacts of transportation policies and investments. In carrying out this research, the key questions posed include:

1. What is economic development and how does it relate to transportation?
2. What is motivating state DOTs to measure economic performance?
3. What emphasis is placed on economic benefit of transportation investments? How is economic potential factored in to systems planning, project development, and project selection among the state DOTs and other transportation agencies? Do any States require the maximization of economic benefits from transportation or other infrastructure investments?
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6. What are the barriers to adopting effective measures and analytical techniques and models among transportation agencies? What are the relative costs and time involved in collection and analysis.

An extensive literature search and interviews with nine state Departments of Transportation (DOT) formed the basis for the research. Please see more on the study methodology in Appendix B.

Chapter III. Defining Economic Development.

Defining economic development in the early stages of research was important to identifying the most appropriate performance metrics. This determination was a key task of the literature review.

The literature is somewhat thin on what the term means and often contradictory. In fact, a history of the term shows that it took hundreds of years to evolve.[8] Today, the literature reveals that the term is used to describe both broad economic change and specific physical development of a place. Professional planners and economic development agencies often use the term very narrowly, encompassing only specific urban development projects, such as industrial development near an airport. The international community applies the term in reference to efforts to elevate the global development status of a poor country, and this definition is also used domestically for describing planned improvement of disadvantaged communities through providing services or physical development.

Looking more broadly, the International Economic Development Council acknowledges the difficulty of establishing a static definition:

> "No single definition incorporates all of the different strands of economic development. Typically economic development can be described in terms of objectives. These are most commonly viewed as the creation of jobs and wealth, and the improvement of quality of life. Economic development can also be described as a process that influences growth and restructuring of an economy to enhance the economic well-being of a community."[9]

Both the broad and narrow uses of the term imply a planned action, such as a new interchange or a new transit line would require, as opposed to economic change that is random or through natural or unexpected forces. Economic development goals also can be achieved by improving a service, such as education, or through other innovations, rather than through physical development.

A task force working under then Illinois Governor Pat Quinn's Recovery Commission in 2009 defined economic development in a similar vein, and emphasized the planned nature of the activity:

> "Economic development is a deliberate planned action that results in a measured increase in the total production of goods and services that may be attributed to an investment in additional labor or capital or to a prolonged period of economic productivity.
>
> Output indicators for economic development include, without being limited to: employment rates; asset utilization; wage levels; area cost-of-living and cost-of-doing-business; capital access; and area economic reputation.

[8] Arndt H.W., *Economic Development and Cultural Change*, (Chicago: University of Chicago Press, Vol. 29, No. 3, Apr., 1981), pp. 457-466. http://www.jstor.org/stable/1153704

[9] From the website of the International Economic Development Council (IEDC**):** "What is Economic Development? See **http://www.iedconline.org/hotlinks/whtecodev.html**

> Economic development as a process consists of such efforts to recognize assets and opportunities that may be hidden, scattered, poorly understood and/or poorly utilized, which then utilize collective resources that result in transparency, alignment and coordination, greater understanding and motivation to invest, and a more sustainable use of scarce capital resources.[10]"

The study team also found strong conviction that the United States is transitioning to a new economic order in the wake of the 2008 recession. While there is no end to the future visions espoused for the economy in recent literature, Bruce Katz of the Brookings Institution, summarizing the recent views of leading economists, pointed out that the new economy is one that, "[M]ust be *opportunity rich* as well as export oriented, low carbon, and innovation fueled." [11] As Katz explained it, the new economy will require us to compete in a truly global market place where, "[O]ther countries are making seismic and ultimately transformative investments in renewable energy, in modern ports, in high speed rail, in metropolitan transit."

This changing economic landscape supports taking a broader view in trying to define both economic development and the performance metrics to predict and measure it. Such a position also reflects the mission of SSTI and could be instructive in supporting member actions to achieve that mission:

> "To promote "smart transportation" (ST) practices that advance environmental sustainability and equitable economic development, while maintaining high standards of governmental efficiency and transparency."

Thus, the team defined **economic development** for the purposes of this research as:

> A transparent process or planned action that results in the retention and creation of sustainable jobs, wealth, and the improvement of quality of life.

Such a definition can be applied to the transportation sector and used at the national, state, regional, or local levels to reflect the goals and assets of the sponsor. This definition implies incorporation of all of the direct, indirect and induced economic impacts on the community affected.

For purposes of this study, the term economic analysis is also used in a broad sense: It encompasses, but is not limited to, the more microeconomic in nature analysis of aggregate economic measure relating to

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[10] Available at: http://www2.illinois.gov/economy/documents/economic%20recovery%20commission%20report.pdf
Adopted from:

1. National Academy of Sciences, *Research on the Relationship Between Economic Development and Transportation Investment*; Transportation Research Board Project NCHRP 2-19, February 1996
2. Albert O. Hirschmann, *The Strategy of Economic Development*, Harvard Press, 1958
3. Scott Bernstein, *The Hidden Assets of Cities and Regions*, E. Michigan University, 1997. Found at: http://www.cnt.org/hidden-assets/end.html

David Lewis, *NCHRP 342: Primer on Transportation, Productivity and Economic Development* (Washington, DC: TRB, 1991), http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_342.pdf

[11] Speech of Bruce Katz, Vice President and Director, Metropolitan Policy Program at the 'The Next American Economy' Conference, Palo Alto, California (February, 2010) available at: http://www.brookings.edu/speeches/2010/0203_nextecon_katz.aspx

regional product, income and employment. Monetary, fiscal, financial, and other impacts that can and cannot be monetized may be included, as is relevant.

Chapter IV. The Role of Transportation in Economic Development

The "new economy" is likely to need transportation as a broad underpinning, as well as a spur to specific economic development outcomes – as did the "old" economy – but not necessarily in the same way or to the same degree. The literature shows relative agreement that transportation continues to be an important support for the economy and a contributor to economic growth. However, numerous conditions and circumstances affect the relationship and one cannot expect all projects to produce a net economic benefit. Some projects are more likely to just shift activity and jobs around. These changes affect the role of economic analysis in transportation planning, making it more important to insure a positive return to value. They also put a spotlight on the indicators and methods used to measure economic impact.

Transportation as One Factor

Now, more than ever, transportation projects are competing for limited public dollars, and must clearly demonstrate their contribution to the economy. In a recent publication, the Treasury Department and the Council of Economic Advisors[12] (CEA) described the economic benefits of infrastructure investments as broad and important, but also made the point that not all infrastructure investments may be worthy on an economic basis:

> "Many studies have found evidence of large private sector productivity gains from public infrastructure investments, in many cases with higher returns than private capital investment. Research has shown that well designed infrastructure investments can raise economic growth, productivity, and land values, while also providing significant positive spillovers to areas such as economic development, energy efficiency, public health and manufacturing.
>
> Not all infrastructure projects are worth the investment. Investing rationally in infrastructure is critically important, as is providing opportunities for the private sector to invest in public infrastructure. . . ."

In the case of transportation infrastructure, the CEA report identifies four major benefits of transportation investment, with first three being distinguished as important for addressing the economic ills after the 2008 recession:

- "Well-designed infrastructure investments have long term economic benefits;
- Infrastructure investment tend to benefit the middle class;[13]

[12] Department of the Treasury and the Council of Economic Advisors, *An Economic Analysis of Infrastructure Investment*, (Washington, DC: October 2010) pp. 1 and 2.

[13] Treasury and the CEA, 2010. Later in the report, in describing the advantages of an Infrastructure Bank, the authors point out that "61 percent of the jobs directly created by investing in infrastructure would be in the construction sector, 12 percent would be in the manufacturing sector, and 7 percent would be in retail trade, for a total of 80 percent in these three sectors. Nearly 90 percent of the jobs in the three sectors most affected by infrastructure spending would be middle class jobs, defined as those paying between the 25th and 75th percentile of the national distribution of wages." p. 4.

- There is currently a high level of underutilized resources that can be used to improve and expand our infrastructure; and
- There is strong demand by the public and businesses for additional transportation infrastructure investments"

One way to look at transportation's contribution to economic development is trying to answer the question: What are businesses looking for when they want to locate a new business activity, expand, or relocate? An August 2008 Transportation Research Board report summarizes the results of extensive interviews with "non-transportation" interests such as commercial real estate experts, manufacturing interests, economic development professionals, chambers of commerce, and labor market specialists. An annual survey of site selection executives provided in the report includes 25 criteria for locating a new business or industry, of which only 5 are transportation-related measures: highway accessibility, proximity to suppliers, proximity to major markets, accessibility to major airport, railroad service, and waterway or ocean port accessibility.[14] The top four of the 25 are the following: state and local Incentives, labor costs, availability of skilled labor, and highway accessibility. Quality of life factors were ranked separately and described as increasingly important.

State DOTs, especially those who felt the recession first, are paying increasing attention to what creates value for the economy and what does not. In considering the most recent Oregon DOT long range plan and the economic effects of new investments, the authors of a resource paper for the plan observed that transportation is just one of several factors that shape economic opportunity:

> "As the maturity of our transportation system grows, there are fewer opportunities to unleash significant economic development by widening roadways, dredging channels, expanding airports, or building new transit corridors. Furthermore, transportation projects in and of themselves are almost never the sole impetus for economic development. Industrial location experts almost always cite quantity and quality of the labor force, quality of life, proximity to markets, and access to raw materials as more critical determinants of a region's attractiveness. These complicating factors, fewer opportunities and critical bundling of non-transportation improvements, create a complex process for transportation planners trying to respond to project stakeholders and advocates who may see transportation funding as one of the few remaining resources to address economic development." [15]

Marlon Boarnet reviewed the extensive literature on the subject in a 1997 article[16] and concluded that the evidence suggests that most recent highway projects "contribute{s} little to state or national productivity." He found that changes in economic activity were largely attributable to redistribution of

[14] Transportation Research Board, *Transportation Implications of Emerging Economic Development Trends*, (Washington, DC, RRD 327, 2008) p.13. The importance of labor availability was noted as partly due to low unemployment for skilled labor at the time.

[15] Oregon Department of Transportation, *Background Paper: Transportation and Economic* Growth, (Salem, OR: Oregon Department of Transportation, 2004) http://www.oregon.gov/ODOT/TD/TP/docs/otpPubs/EconPolRev.pdf. Also see: Marlon Boarnet, *Highways and Economic Productivity: Interpreting Recent Evidence* (Journal of Planning Literature, Vol. 11, No.4, 1997), pp.476-486.

[16] Marlon Boarnet, *Highways and Economic Productivity: Interpreting Recent Evidence* (Journal of Planning Literature, Vol. 11, No.4, 1997)

growth near highways that would otherwise have occurred in other locations or could be the result of prior highway projects due to the long time lags in households and firms moving to more optimum locations. Nevertheless, he found that improvements in the efficiency of the existing system would have productivity impacts and that much of the benefit of highway construction is localized economic impacts. He suggests that more careful project evaluation would help avoid "unwise" projects and that the method of funding should reflect where the benefits occur.

Measuring Performance for Sustainable Development

In 2009, the Bi-Partisan Policy Center's National Transportation Policy Project (NTPP) called for a new performance-based Federal transportation program in its report, *Performance Driven: A New Vision for U.S. Transportation Policy*. The report underscored a decline in the quality of the national transportation system due to a loss of purpose and direction of national policy, resulting in potentially, "[S]ubstantial costs to our collective prosperity, security, environment, and quality of life". The authors cited the need for change, in part due to new challenges: "There is also a growing awareness that our approach to transportation must be responsive to a new set of 21st century challenges, from staying competitive in an increasingly globalized economy, to addressing urgent concerns about energy security and climate change."[17]

The Pew Center on the States and the Rockefeller Foundation in a 2011 report pointed out that states spent some $131 billion on surface transportation in 2010,"[B]ut many cannot answer critical questions about what returns this investment is generating". The report, *Measuring Transportation Investments: the Road to Results,* gave a positive nod to just 13 states shown to be using a process of goals, performance measures and data relevant to policy making and "to ensure a strong return for taxpayers".

Todd Litman, executive director of the Victoria Transport Policy Institute sees great variability in outcomes from transportation. He views economic development as linked to transportation through efficient use of resources including user and non-user costs:

"*Economic Development* refers to progress toward a community's economic goals, such as increases in economic productivity, employment, and business activity. Transportation facility investments and subsidies are often justified with the claims that they will stimulate economic development. Various techniques can be used to measure the economic development impacts of a particular transport policy or project. Although most economic activities require transportation, not every transport improvement increases economic development. Policies that violate market principles (such as underpricing and distortive taxes) and inefficient investments (roads or railroads that are not cost effective) can increase mobility but reduce overall economic development. Transport policies tend to increase economic development if they:

[17] Bi-Partisan Policy Center, *Performance Driven: A New Vision for U.S. Transportation Policy*, (Washington DC: Bipartisan Policy Center, 2009)

- Increase and improve cost-effective transportation options,
- Result in more cost effective transportation facility and service investments,
- Increase transport system efficiency (reduce total costs or increase total benefits),
- Create more efficient pricing by making prices more accurately reflect marginal costs,
- Create more neutral public policies (such as less distortive tax policies),
- Reduce resource costs, such as the amount of fuel consumed per unit of transportand the amount of land devoted to transport facilities." [18]

In considering transportation investment sustainability, Litman argues for a broad assessment of all impacts having value (not just monetary), "[I]ncluding nonmarket, indirect and long-term impacts in other regions and to future generations." Litman concludes that such an analysis requires, "[S]pecial efforts to evaluate difficult to measure impacts."[19] This type of analysis goes beyond traditional user-oriented impacts of travel time (delay or savings), safety benefits, and system costs and revenues, which are the most common measures employed by transportation agencies.

Incentivizing to What Purpose

The issue of publicly provided incentives is a controversial one at all levels of government. That state and local governments use new transportation investments to lure economic development to their territory is hardly news. In any given year, roughly half of state DOTs have such programs[20]. Some are broadly seeking jobs with quality wages and capital investment, others are more narrowly focused on industrial development and the related jobs. Wisconsin, for example, seeks to increase jobs in export industries to ensure a positive cash return to the state.

However they are structured, the key issue is whether these incentives result in net economic gain or are only encouraging economic shifts from one state to another, from one region to another, and even within regions. Various studies have recognized "economic shifts" from one region to another from transportation investments - whether incentives are offered to firms or not. Firms move to improve competitive advantage of better accessibility to markets, ports, etc. As noted earlier, Boarnet found that some of the benefit of recent highway projects was due to redistribution of growth in a given area or between areas.

The important thing in measuring economic performance is to make a clear distinction "between such relocations and actual net increases in local economic activity that result from business arrivals or expansions"[21]. Weisbrod points out[22] that such shifts may be a benefit for the receiving region, but these

[18] Todd Litman, *Transportation Cost and Benefit Analysis Techniques, Estimates and Implications*[Second Edition] Victoria, BC: VTPI, 2009) http://www.vtpi.org/tca/tca03.pdf

[19] Litman (2009) pp. 3-4.

[20] Glen Weisbrod and Manisha Gupta, *Overview of State Economic Development Highway Programs (Washington, DC: FHWA 2003)*

[21] David Forkenbrock and Glen Weisbrod, *NCHRP Report 456: Guidebook for Assessing the Social and Economic Effects of Transportation Projects* (Washington DC: TRB, 2001)

positive regional economic impacts do not count as a benefit from a national perspective (or also state, depending on what is meant by ”region”). He acknowledges that such shifts also may have social value when they benefit an economically distressed community. It should also be noted that concentrating jobs in locations that reduce the need for travel and therefore VMT is a long-term advantage for the region.

Some of the transportation and economic development (TED) programs reviewed as part of this research incorporate safeguards to avoid providing incentives for projects that are just moving jobs around the state or region. For example, Oregon DOT requires firms to certify that projected jobs are new to the state. Other states require documentation of new jobs and require reports from 2 to 5 years post-project completion. Not all states require documentation, and the interstate issue is largely unaddressed by the programs.

Conclusion

In short, the literature makes clear that the relationship between transportation and economic development is complex and varying, depending on the environment in which the investment is made, prevailing market conditions, and the goals of the sponsor. There is also increasing recognition that simply supplying transportation is no longer enough to attract development, and other factors require equal consideration. Application of new performance measures and analytical tools is needed to get the relationship right when planning transportation investments . . . and especially when incentivizing the development.

[22] Weisbrod 2007, p.16.

Chapter V. Federal Requirements for Assessing Economic Impact

State DOTs consider economic effects to meet both their state goals and federal requirements, many of which have been in effect for decades.

Federal Planning and EIS Requirements

At the federal level, planning requirements for highways and transit underscore the need to consider economic vitality by requiring a comprehensive, statewide transportation planning process that provides for consideration and implementation of projects, strategies, and services that will—"support the economic vitality of the United States, the States, nonmetropolitan areas, and metropolitan areas, especially by enabling global competitiveness, productivity, and efficiency". At the metropolitan level, a planning framework including seven factors requires MPOs to: "support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency". These factors were adopted in 1998 and replaced 15 factors in the 1991 legislation, which incorporated several economic considerations, but lacked a clear requirement to do economic analysis.

Since the passage of Intermodal Surface Transportation Efficiency Act of 1991, states, MPOs, transit agencies and other public and private interests have been bound in a joint process to plan for the long range development of the transportation systems of regions and the state. Project planning and development of highways and transit follow on separate paths in most states and regions. Project planning is more specific to the mode, although transportation agencies are encouraged to plan for multimodal investments, such as those that improve connections between and among the modes of transportation.

Several related laws direct social and economic considerations in transportation planning. These include:

- Title VI of the Civil Rights Act of 1964
- Federal Aid Highway Act of 1970
- National Environmental Policy Act of 1970 (NEPA)
- Executive Order 12898 in 1994 on environmental justice

Compliance with these laws, especially NEPA, often serves as the introduction to economic analysis for state DOT staff and the rules apply to all types of transportation projects. The Council on Environmental Quality (CEQ) rules makes consideration of the economic setting and the potential economic impact of individual projects a clear requirement of the process.

> "It is worth stressing that Section 1508.8 of the Council on Environmental Quality (CEQ) regulations for implementing NEPA states that effects to be taken into account include "ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health" (CEQ 1986). Thus, social and economic effects are given the same standing in the CEQ regulations as other effects on the human environment, even though Section

1508.14 states that "economic or social effects are not intended by themselves to require preparation of an environmental impact assessment."[23]

How much the information developed in the environmental process is used in decision making is unclear. It should be noted, however, that the Environmental Impact Statements (EIS) process has sparked a continuing history of legal action on whether or not land use and economic effects – in particular indirect effects of induced development - were adequately considered. Contrary to the earlier discussion citing studies that cast doubt on the economic effects of highway projects, plaintiffs have had some success arguing that the phenomena of induced development is a real possibility.

Wildlife Underpass for Deer in Florida

American Association of State Highway and Transportation Officials, *Best Practices in Environmental Stewardship Competition,* Florida DOT as National Winner for Program Category, 2003.

In response to the legal problems, the American Association of State Highway Officials (AASHTO) in conjunction with the Transportation Research Board (TRB) commissioned a report in 2007 to provide states with specific guidance on how to do such assessments.[24] Regardless of the motivation, the preparation of these analyses does provide an experience with economic analysis and measures within both the state DOTs and metropolitan planning agencies.

Federal Highway and Transit Project Planning

While transit and highway planning requirements follow joint systems planning and procedures as well as environmental processes, the fact is that planning for projects of all modes of transportation reflects specific modal requirements. The primary reason for this situation is the very different history of public funding for each mode, both at the state and federal levels, with transit, aviation, and ports having been a local and state function and highway development having been primarily a state responsibility with

[23] Forkenbrock and Weisbrod 2001

[24] Uri Avins, Robert Cervero, Terry Moore, Christopher Dorney, *Forecasting Indirect Land Use Effects of Transportation Projects* NCHRP Project 25-25, Task 22 (Washington, DC: Transportation Research Board, 2007)

significant federal assistance. Section 145 of Title 23 of the U.S. Code (highway title) makes the role of states clear: “The provisions of this chapter provide for a federally assisted State program.”

The individual modal history is reflected in federal legislative requirements and, importantly, funding arrangements. For example, funding from the Federal-Aid Highway Program (FAHP) is allocated primarily by formula to the states, with directed sub-allocation of a small portion to larger metropolitan areas. Federal Transit Program (FTP) funding, however, is a hybrid of formula allocation and discretionary (competitive). The two primary transit programs are the Urbanized Area Formula program and the Capital Investment Grant program, which is part formula and part discretionary (for the new fixed guideway or New Starts program). The New Starts represents about 30% of FTP funding, but competition for funding brings a lot of attention to the program from state and local interests.

The basic requirements for approval of FAHP are laid out in Sections 106 and 109 of Title 23. Approval is based on acceptable plans, specifications, and estimates that accommodate future traffic needs and provide for “safety, durability, and economy of maintenance” as well as “conform to the particular needs of each locality.[25] While federal approval for Interstate Highway projects require the road to be at least four lanes and meet the traffic needs for at least 20 years. Highway projects over $25 million in cost and bridge projects over $20 million require value engineering analysis intended to reduce the cost of the project or time involved. Such bridge projects also require a life cycle cost analysis. Major highways over $500 million in cost also require a project management plan and a financial plan. No separate economic impact analysis is required in addition to the NEPA requirement, but additional analysis may be performed.

By contrast, New Starts discretionary transit grants have very specific requirements to receive grant approval, and they are far more extensive than highway projects of a similar size and cost. Congress has mandated extensive requirements for New Starts, but only added economic impact analyses in 2005. There is also a threshold requirement for analysis of possible alternatives, in addition to the analysis of alternatives in the NEPA process. (Projects under $25 million meet lesser requirements.)

[25] 23 U.S.C 106 (a) and (b)

Redevelopment of Parking Lots at the Fruitvale Transit Station in Oakland, California in the 1990's Transformed the Isolated Station into a Vibrant, Economically Productive Community

Documented cost effectiveness of projects play a large role in the requirements for the Secretary to approve funding for New Starts[26], which span 11 factors. The Secretary further is directed to consider such unique requirements as "the reliability of the forecasting methods used to estimate costs and utilization made by the recipient and the contractors to the recipient; and (F) the cost of suburban sprawl…"[27]

New Starts appears to be part of a trend where Congress is increasingly concerned about economic effects. Since the late 1990's and especially since 2008, new federal grant and loan programs have emphasized economic considerations and required economic analysis by the states and other applicants. Two loan/credit enhancement programs -- the Transportation Infrastructure Finance and Innovation Act (TIFIA) and the Railroad Rehabilitation and Improvement Financing (RRIF) -- were created

[26] 49 U.S.C. 5309 (b), (c), and (d)

[27] See SAFETEA-LU Section 3011, which amends Section 5309 (d)(2) on Major Capital Projects over $75 million at: http://thomas.loc.gov/cgibin/cpquery/?&dbname=cp109&sid=cp109qP8dz&refer=&r_n=hr203.109&item=&&&sel=TOC_717048& The factors listed come after approval of requirements such as environmental documentation, which apply to all types of transportation projects.

by the Transportation Efficiency Act for the 21st Century (TEA-21) in 1998 and have economic development purposes, at least in part. Their applications are competitive and require economic justifications.[28] The nature of the grant is discretionary (competitive) versus formula allocation and appears to determine the extent of requirements and whether economic matters are factors in grant approval.

A third group of transportation programs is the economic stimulus grants provided through US DOT. The basic stimulus grants from the American Recovery & Reinvestment Act of 2009 (ARRA) did not have economic analysis requirements to receive the funds, but did have rigorous (and duplicative) reporting requirements concerning jobs and other economic indicators. (ARRA transportation funding is primarily spent or obligated and no new round of such funding is authorized.) While these funds were vital to many state DOTs to maintain construction programs and services, the program that stimulated state DOT interest in economic analysis and measures is the companion program, Transportation Infrastructure Generating Economic Recovery (TIGER), administered by US DOT. TIGER is the first competitive program where funds are available to all surface transportation modes, including connections to air, rail, and water ports. TIGER applications require both economic impact analysis and cost benefit analysis (CBA),.and is highly competitive as 35 times more funding has been requested in three funding rounds than available ($90.1B as compared to $2.6B available). The program is approved for an additional round in 2012.

During interviews, DOT staff in several states described being challenged to respond to the solicitations and feeling unprepared to conduct the economic analysis. Staff also described being overwhelmed by requests for analytic support because others in the agency did not have the technical background to respond to the information requirements. A March 2011 report of the US GAO[29] confirms that applicants were challenged in providing useful cost benefit analysis, and that the US DOT took steps to increase information on analytic techniques and training of potential applicants before TIGER II and again before TIGER III.

In addition to TIGER, the Federal Railroad Administration was responsible for awarding $8 billion in funding for High Speed Passenger Rail projects. According to another GAO report[30] FRA used its standard criteria for evaluation (such as in the RRIF program), which includes cost benefit analysis. FRA applicants

[28] Neither TIFIA nor RRIF were very competitive for the first decade of their availability. Beginning in 2009, TIFIA has become over-subscribed, going from applications for less than the available $122 million/year in 2008 to over $14 billion requested in 2011. While demand for the RRIF has remained relatively stable. Only $1.6 billion of a total of $35 billion authorized being approved since the program began. The TIFIA program is currently guided by 8 selection criteria, the first of which "(i) The extent to which the project is nationally or regionally significant, in terms of generating economic benefits, supporting international commerce, or otherwise enhancing the national transportation system."

[29] United States Government Accountability Office, *Funding Used for Transportation Infrastructure Projects, but Some Requirements Proved Challenging*, (Washington DC: GOA, 2011) p. 29 and Appendix A.

[30] United States Government Accountability Office, *Recording Clearer Reasons for Awards Decisions Would Improve Otherwise Good Grantmaking Practices, (Washington,DC:* GAO-11-283, Apr 11, 2011)

were more likely to be familiar with the techniques because of the long-standing requirement and no problems with the quality of the cost benefit analysis were cited in the report.

Conclusions

The prospect of competitive grant programs continuing – in contrast to formula allocations of funding to states – has clearly increased interest in improving agency ability to predict and measure economic results – at least within this study sample. And, in turn, the situation has increased interest in understandable measures and analytical tools and techniques. While requirements for economic analysis could be included as a standard for formula grant allocation, such requirements for approval currently apply only to discretionary, competitive grants and loans.

Chapter VI. How Are States Considering the Economic Effects of Transportation Investments?

States play a vital role in economic outcomes. Legislatures and governors largely determine how much of a role state DOTs play in formal economic development efforts by providing directives in four areas:

1. Reporting (to legislature and public) on economic measures such as jobs sustained by departmental programs;
2. Setting economic goals for planning;
3. Requiring economic factors in project selection; and
4. Funding programs targeted to economic development.

Political Leadership

Since the 2008 recession, state political leaders have shown varying degrees of interest in transportation agencies producing economic results. These actions can be seen in all four areas. In 2008, Governor Sebelius of Kansas appointed a task force that adopted the goal to "align transportation to better support the Kansas economy." In 2008, Ohio Governor Ted Strickland, took a different tack to link transportation and economic outcomes by including three goals in the performance agreement of the state DOT Secretary, one of which was this measure: "Link transportation investment to economic development and curbing sprawl".

The leaders of Pennsylvania and New Jersey took the unusual step of joining their planning efforts to develop common guidance meant to strengthen communities environmentally and economically at a time of reduced revenues and deteriorating infrastructure. The joint effort produced new design guidelines, *Smart Transportation Guidebook*[31], to improve the design, placement, and positive impact of local projects.

Legislatures have enacted economic vitality goals for transportation planning in Colorado, Washington and Oregon since 2009. In Oregon that directive came as part of a comprehensive requirement for adopting Least Cost Planning in all activities of the Department.

Other direct ways to ensure economic outcomes are to propose allocating funds by economic criteria or to fund new transportation programs that are intended to produce economic results. In 2010, the Kansas legislature enacted a $10 million annual program directed toward economic development. The Minnesota legislature also approved a one year program in 2010 and approved another in 2011, tying highway investments to economic outcomes. In Pennsylvania, the legislature at the Governor's request, established a multimodal, smart growth grant program for local governments that included economic improvement as one of six criteria, including economic competitiveness. Called the Pennsylvania Community Transportation Initiative (PICTI), PennDOT is completing the second round of multimodal grant awards to local communities and MPOs.

[31] Pennsylvania and New Jersey Departments of Transportation, Smart Transportation Guidebook, 2008

These requirements are often more directives and are not legally binding requirements to take particular actions. In contrast since 1987, Wisconsin DOT has been required by legislative act to use economic impact as a factor in the selection of major highway projects. The DOT is giving 40% weight to economic impact when considering and comparing major projects for funding.

Another of the exceptions to what is a very flexible planning and funding environment is California's Sustainable Communities and Climate Protection Act of 2008 (SB 375). The law requires setting regional targets for transportation emissions reduction and sticking with them. The law ties regional transportation planning to land use and housing planning. As part of doing this, a Regional Targets Advisory Committee was created to examine transportation modeling and data and make recommendations for the implementation of the law through state creation of regional greenhouse gas (GHG) reduction targets.[32] That process is now complete, and regions are submitting "Sustainable Community Strategies" (SCS) to the state to show how they will meet those targets. The state must analyze the regional modeling and certify that each SCSs will enable its region to actually meet its GHG target.[33]

State DOT Management and Staff Skills

The variety of economic activities and analysis methods require different skill sets and capabilities than in other planning and management roles in the DOTs. In interviews with state agencies we found economic analysis units with a team of economists and in other states, no one specifically hired as an economist. (Although credentialed economists do work under other job titles and in other capacities.) Organizationally, the economic function and the performance measurement responsibility is often found in a central staff office, such as the director's office, or planning or programming divisions. One performance manager, who described being in all these organizational units and others over a 20 year history, is now part of the auditor's office. Whether these organizational and personnel decisions reflect a priority by the agency or the myriad of circumstances surrounding organizational structure and personnel management is not known. The fact is that there are wide differences among the agencies interviewed in the degree of experience and skill levels in economic analysis and performance measurement. These circumstances can be expected to influence the degree to which the different activities are undertaken in the agency.

Many of the state DOTs rely on other agencies for analytic support. Washington, Kansas, Minnesota, Missouri, and Colorado report relying on economic development agencies to advise on analytical standards and to review applications for economically related grants. In Minnesota, the funding provided to MNDOT for a new TED program was supplemented in its second year by the state economic development agency, enabling a broader category of projects than the highway interchanges that the legislature had allowed for the program.

[32] Regional Targets Advisory Committee, "Recommendations of the Regional Targets Advisory Committee (RTAC) Pursuant to Senate Bill 375," September 2009, http://www.arb.ca.gov/cc/sb375/rtac/report/092909/finalreport.pdf

[33] California Air Resources Board, "Description of Methodology for ARB Staff Review of Greenhouse Gas Reductions from Sustainable Communities Strategies (SCS) Pursuant to SB 375," July 2011, http://www.arb.ca.gov/cc/sb375/scs_review_methodology.pdf.

In Washington, the Governor's Office of Financial Management (OFM) is responsible for the annual performance report, which includes measures for six legislatively directed transportation goals, including economic vitality. The two agencies work together to determine the appropriate measures and the DOT provide much of the data. However, OFM staff is familiar with the economic model, IMPLAN, and use it in revenue forecasting for the DOT. The DOT and OFM are working closely on the development of freight measures.

Approximately half of the state DOTs interviewed reported they relied on MPOs for urban traffic analysis – an important factor as all the economic models require output from the traffic models for such measures as travel time savings and other traffic conditions. A survey by the General Accountability Office[34] revealed that just over half of the state DOTs (52 including the District of Columbia and Puerto Rico) had their own traffic models. It is interesting to note that the joint guidebook developed by New Jersey and Pennsylvania was unusual as a two state effort, but they contracted with an MPO that serves areas of both states in the Philadelphia region, the Delaware Valley Regional Planning Commission, to oversee contracting for the guidebook. The resulting, Smart Transportation Guidebook, is a tribute to an unusual collaboration of states and MPOs.

State DOT Practices Vary Widely

The growing federal requirement to consider economic effects at the state and metropolitan levels is clear, but generally it is not a requirement to act. As a result, the manner and degree to which the agencies take consideration of economic vitality to heart in their planning processes vary widely. The emphasis that states place on economic outcomes appears to determine the degree to which DOTs adopt actions and measures to implement goals. The study team found that state DOTs use economic performance measures for one or more of these purposes for:

- Reporting publicly on website "dashboards" or annual reports to the legislature and public;
- Setting goals to frame issues in long range plans, for evaluating alternatives often as part of environmental documentation;
- Assessment of individual projects, including information for federal grant applications; and,
- To a much lesser degree, as a factor in programming and project selection for funding.

Leadership is another factor in whether an agency includes economic considerations in planning and ultimately selecting projects. Several interviewees pointed out that over the last 20 years the emphasis on economic factors within a given agency waxes and wanes based on the interests of governors and of agency management. Generally, the team found high staff interest in more regular use of performance measures that better inform their efforts to achieve economic results and to demonstrate the benefits of different types of investment.

[34] U.S. Government Accountability Office, *Statewide Transportation Planning: Opportunities Exist to Transition to Performance-Based Planning and Federal Oversight,* (Washington, DC: GOA, 2010) http://www.gao.gov/new.items/d1177.pdf

Several interviewees described the need to use performance measures to help illustrate the economic benefits of transportation to the public. DOT staff report that a project's economic benefits are a strong selling point with local officials and the public and are looking for better ways to measure benefits, as well as to explain them[35].

DOT Staff Are Looking for Better Ways to Measure Benefits and to Explain Them to the Public in Meetings and Other Outreach Activities.

Numerous studies support goal setting as a necessary first step in establishing a performance management system.[36] While establishing economic goals is prevalent among the DOTs, fewer have identified performance measures for the goals. In interviews with DOT staff, it was pointed out that getting and maintaining data for some of the economic measures is harder when the data needed is not regularly collected, as is highway condition data mandated by the Federal Highway Administration. A number of staff expressed a strong interest in tracking economic data over time. In the limited funding situation most states are experiencing, however, staff are being careful not to rely on measures that require data that may be hard to collect regularly, difficult to obtain initially, or costly to analyze.

Similarly, a survey by the Transportation and Climate Initiative[37]of staff of both state environmental and transportation agencies on agency efforts to measure performance in sustainability, revealed that measures of economic prosperity were among the most desired to acquire, but also perceived to be the hardest to implement. The other eight categories of measures were transport options and levels of

[35] Picture is from a community planning session at Blue Island Illinois on Cargo-Oriented Development sponsored by the Center for Neighborhood Technology.
[36] Cambridge Systematics, Inc., et al., *Performance-Based Planning: A State-of-the-Practice Summary* (Washington, DC: TRB, 2010),
[37] The TCI is a coalition of 12 state environmental and transportation agencies in the Northeast and Mid-Atlantic regions , hosted by the Georgetown University Climate Center at: http://www.georgetownclimate.org/transportation

service, Infrastructure condition, energy intensity, air quality and emissions, land development and conservation, transportation accessibility and affordability, public health and safety, and equity and environmental justice.

Finding the appropriate data is often a stumbling block. This gap may occur because it is difficult or costly to acquire the data or because the data may involve data sets and analytical disciplines that are not familiar to the individuals involved or to the agencies generally - or both. Other factors appear to include adequate staff time, computer resources, and software programs for analysis.

The bright spot in analytical capability is the adaptation of GIS and GPS to transportation planning, which has made location specific analysis much easier to conduct. While most transportation professionals now have experience with the mapping and visualization capabilities of GIS, either as producers or consumers of that information, using GIS as a tool in economic impact analysis may be unfamiliar. A recent TRB report [38] for a conference on the use of Census data, documents many new analytical techniques combining socio-economic data from Census with GIS capabilities. The Census Transportation Planning Package (CTPP) and the Longitudinal Employer-Household Dynamics (LEHD) datasets allow for geospatial assessment of transportation and employment aspects of census data in an unprecedented way. Today's computer software packages include tools that allow for multivariate statistical analysis across data layers. The increased granularity of this kind of analysis enables deeper understanding of the relationships between variables as well as place-based diversity and trends.

GIS analytical tools, combined with geospatial tagged data, such as from accident reports or GPS travel information, give transportation professionals more information about their practice than has ever been available in the past. It can explain complex relationships that help planners understand what is going on at a specific place, making place-based planning a reality. Real-world benefits of this technology can be significant. For example, Florida DOT was one of the first to map all environmentally sensitive areas in a state, making potential impacts from alternative highway locations much easier to understand and speeding up the environmental review. Providing a picture of a problem or a solution through mapping makes the planner's task much easier in explaining complex issues to the public and to decision makers.

The availability of GPS data for real-time traffic information enables fast response to traffic incidents by travelers, emergency personnel, and traffic managers and also provides invaluable information over time for transportation planning and investment. Private providers of this information aggregate traffic-related information from vehicles equipped with GPS and other sources, such as mobile devices, to provide both accurate real-time and historical traffic information. One of those providers, INRIX, also

[38] Transportation Research Board, *Uses of Census Data in Transportation (Washington, DC: TRB, prepared for conference on Using Census Data for Transportation, October 2011)*

issues an annual report that combines traffic information with certain economic data to correlate traffic trends with economic trends[39].

Public Reporting

A review of dashboards and annual performance reports in the nine states included in the research show that these reports include only a few system or organizational measures and most do not explicitly include economic performance. Those states that do include an economic measure, usually report on changes in travel time or speed, measures of freight traffic, and certain measures of accessibility. These same measures may be reported under other categories such as system capacity or condition, rather than as "economic". As an example, Kansas does not specifically report on economic impact on the dashboard, but does measure access to several modes of transportation, as well as travel speed.

Development of performance metrics, dashboards and analytical tools can be funded from the FHWA state planning and research funding, which is a take down from the major funding programs. Some Federal Transit Administration (FTA) funding also is provided for state level activity. The vast majority of funding for MPOs for all purposes is from the metropolitan planning set aside, also a take-down from major highway and transit programs.

As part of this study, nine state long range plans were reviewed for economic goals and measures. In this sample, an economic goal is not only common to the plan, but often is a strong theme of the planning process. This indicates a high level of interest in the issue – as well as the federal planning factors. In several cases, there is no specific economic goal, but the goal of economic improvement is found incorporated in several goals or objectives. Minnesota for example, has no explicit economic goal, but several plan policies have economic objectives and indicators, such as cost of goods movement in freight corridors and number of lock and dam delays.

The chart below summarizes what we found in nine states in terms of public reporting of economic measures and treatment of the issue in state long range planning. As indicated, adoption of explicit goals is very common and is consistent with federal requirements. What happens after goal setting varies a great deal state to state.

[39] A May 22, 2012 press release from the firm, INRIX, shows how traffic data is being used with basic economic performance data to link congestion, fuel prices, and economic conditions. See: "Traffic Congestion Plummets Worldwide: INRIX Traffic Scorecard Reports 30 Percent Drop in Traffic Across the U.S." found at: **http://www.inrix.com/pressrelease.asp?ID=156**

Table VI. 1. Economic Performance Measures Regularly Reported by State DOTs

State	Dashboard or Performance Tracking[40]	Long Range Plan Measures	Notes
Colorado	*Annual Performance Report, FY10*, includes measures in four areas, but not economic.	No economic goal among the 15 for the LRP, *Moving Colorado*. The DOT conducted economic benefits study for 2008 LRP, *2035 Statewide Transportation Plan*, showing $60 billion in benefits from $48B in investment.	A 2011 amendment to the Plan added the new legislative requirements and and economic goal: "Targeting infrastructure investment . . . to support economic vitality of the state and region", and a separate goal for efficient freight.
Iowa	No Dashboard, but an *Annual Performance Report,* with 5 core functions, not including economic. Some measures for other functions are economic measures, such as one with wages created by their TED program, RISE: "Average annual combined wage rate of RISE-supported jobs as compared to average county wage rates."	IDOT in process of developing new LRP; Considering multi-modal performance measures for the plan that include such economic measures as: % of total employment within 1/4 mile of fixed route transit; and % of track miles able to handle 286,000 pound rail cars.	See Performance Plan 2011 and link to Strategic Plan at: http://www.dom.state.ia.us/planning_performance/files/plans/performance/2011/FY11Transportation%20Performance%20Plan2.pdf
Kansas	Dashboard and performance tracking of new investment program, T-Works, includes measures for access to transit, air, and rail service	New LRP includes a goal to "Align Transportation to Better Support the Kansas Economy". Actions described do not include performance measures, but look to improve programming and coordination and create new economic development grant program.	T-Works is a 10 year, $8 Billion program, includes a multi-modal E.D. grant program, which uses economic modeling to select projects. Among the criteria for the program is the measure: jobs with wages that meet or exceed median income for state. An economic distress indicator at the county level is used.
Minnesota	Annual performance report since 2008 and scorecard. No explicit economic PMs, but includes measures of intermodal connectivity within and external to state that provide indicators of economic activity over time.	The Statewide LRP has no explicit economic goal, but several policies have clear economic ties and PMs and indicators such as: national and global freight connections, lock and dam delays, cost of goods movement in freight corridors, and changes in transit ridership.	Policy Plan paired with Investment Plan in 2009. See performance measurement details at: http://www.dot.state.mn.us/planning/stateplan/Final%20Plan%20Documents/Policy%20Plan/PDF/AppendixD.pdf
North Carolina	Has Executive Measures for 2011, no explicit economic goal, but several efficiency measures are economy related, such as travel time index of surveyed interstates and rail service customer satisfaction.	Statewide plan, 2040 Plan, is under development for completion in 2012. New plan includes economic goal with explicit jobs objectives. Prior plan (2004) also included economic goal.	NC DOT is conducting their long range planning and programming with a multi-modal framework that includes projects from the regional TIPs as well as the state projects.

[40] For measures included in annual performance reports for plans, see *2011 Data and Measures Synthesis*, found on: http://www.ampo.org/assets/1005_2010dataandmeasuresynthes.pdf but originated by a coalition of state agencies known as the Midwest Transportation Knowledge Network: http://members.mtkn.org/measures/2011

State	Dashboard or Performance Tracking[41]	Long Range Plan Measures	Notes
Oregon	Has Dashboard with the goals of Mobility and Economy in one category. Measures include: Travel Delay/Capita; Special Transit Rides; Total Rail Riders; Intercity or Rail Service to Communities Over 2500 pop.; and Percent Commuting Alone During Peak Hours. Under category of Stewardship, the Dashboard includes another measure, which meets both Stewardship and Mobility/ Economic Vitality goals: # of jobs sustained as a result of construction expenditures	*The Oregon Transportation Plan*, adopted in 2006, includes Economic Vitality as one of 7 Plan goals; performance measures are included in the modal and transportation system plans that are considered part of the OTP.	Dashboard:http://www.oregon.gov/ODOT/CS/PERFORMANCE/2010Dashboard.swf http://www.oregon.gov/ODOT/TD/TP/ortransplanupdate.shtml Numerous economic background papers were developed for the OTP. http://www.oregon.gov/ODOT/TD/TP/otpPubs.shtml#Economic_and_Financial_Information ODOT has an extensive history with Least Cost Planning (LCP), and in 2009 the legislature defined it and directed the ODOT to establish an LCP process. This effort is underway. http://www.oregon.gov/ODOT/TD/TP/LCP.shtml
Pennsyl-vania	Dashboard relates to construction management only.	State LRP, *Pennsylvania Mobility Plan*, has 5 goals and 15 objectives, including "Direct resources to support economic and community development", with 4 indicators and 6 action items that are tracked at least annually.	The LRP is at www.pamobilityplan.com and the progress report is at: ftp://ftp.dot.state.pa.us/public/pdf/PennPlanMoves/statewidegoalsandobjectives.pdf
Washing-ton	The *Gray Notebook* is a comprehensive accountability program that includes many economic measures and reports. 5 goals, with related measures were tracked since 2001, legislature added economic vitality as 6th goal in 2010. Gray Notebook at: http://www.wsdot.wa.gov/accountability/GrayNotebook.pdf	State long range plan measures are incorporated in *Gray Notebook*. "Economic Vitality—Improve freight movement and support economic sectors that rely on the transportation system, such as agriculture, tourism, and manufacturing" – is one of 6 goals of 2007-2026 Long Rang Plan, as well.	Although Economic Vitality was addressed in the last LRP, the WSDOT has not yet decided on specific measures for this area. A number of truck freight and truck-intermodal measures are being tested. Governor initiative, Connecting Washington, to develop a 10 year investment strategy calls for rigorous performance management and metrics.
Wisconsin	Dashboard is under development, but no explicit economic measures are included in proposal. Goals tracked: Mobility, Accountability, Safety, Service Quality, and Preservation.	"Responding to local, regional, national and international economic trends to maintain state economic competitiveness" is one of goals of Wisconsin's LRP, *Wisconsin 2030*; the need for tracking implementation of the plan is discussed, but PMs are to be developed outside of the Plan itself.	The LRP can be found at: http://www.dot.state.wi.us/projects/state/connections2030.htm

[41] For measures included in annual performance reports for plans, see *2011 Data and Measures Synthesis*, found on: http://www.ampo.org/assets/1005_2010dataandmeasuresynthes.pdf but originated by a coalition of state agencies known as the Midwest Transportation Knowledge Network: http://members.mtkn.org/measures/2011

Cambridge Systematics conducted a survey of state DOTs use of measures and targets in 2009 and found similar results to our interviews. The survey identified only six states that had adopted economic measures among 23 states responding. One state had adopted measures and indicators. A number of these states used freight measures only. The research from which the chart below was derived concluded that "economic development and environmental stewardship remain important strategic goal areas that lack meaningful or well-developed measures at most DOTs. While the extent to which state DOTs consider livability, energy efficiency, climate change, and other economic and environmental factors in planning and policy decisions have grown in recent years, there is no uniformity among state transportation agencies for measuring and quantifying improvements in these areas."[42]

State DOT Use of Measures and Targets by Goal Area[43]
(Among 23 Respondents)

Goal Area	Measures Only	Measures and Targets	Neither
Preservation	3	19	1
Freight/Economics	6	1	16
Safety	4	19	0
Congestion	8	10	5
System Operations	7	9	7
Environment	5	7	11

In 2008, the American Association of Highway and Transportation Organizations (AASHTO) Standing Committee on Performance Measurement (SCOPM) formed nine technical task forces to use the collective expertise and resources of the state DOT staffs to support performance driven management. One of these groups is devoted to Economic Development and Freight. In framing the Committee's work, six national goals were recommended for which measures are being tested:

1. Preservation and Renewal
2. Interstate Commerce
3. Safety
4. Congestion Reduction and Connectivity
5. Systems Operation
6. Environment

For the purposes of this research, the Interstate Commerce goal is the most directly relevant and, in this case, the measure is defined in terms of goods movement:

[42] Cambridge Systematics, Inc., et al., *Performance-Based Planning: A State-of-the-Practice Summary* (Washington, DC: TRB, 2010), http://planning.transportation.org/Documents/NationalForum/DR1_National%C2%A0Forum%C2%A0State-of-the-Practice%C2%A0Report.pdf

[43] Cambridge Systematics, Inc., et al, *Performance-Based Management: State-of-the-Practice White Paper* (Minneapolis, Minnesota: University of Minnesota Center for Transportation Studies May 2009)

> "**Interstate Commerce**: Supporting America's global competitiveness, growth in productivity, economic development, and national defense through an improved multi-modal freight system."

The literature shows goods movement indicators predominate in the economic performance measures currently in use by states, and this emphasis was also found in the interviews. An emphasis on freight is likely due to the clear linkage between transportation and the cost of goods movement and to the fact that useful goods movement measures are directly derived from transportation activity, for which data is often collected by the agencies. The SCOPM adopted two measures from their work on the Economic Development and Freight goal and both were highway based freight measures, and derived from management data frequently collected by State DOTs:

- **Speed/travel time on significant freight corridors (SFC)**
- **Reliability on SFCs**

Considering national transportation conditions, the 2009 report of the Bi-Partisan Policy Center[44] decried the lack of performance planning and tracking among state DOTs. The Center cited the need to establish clear goals, but then pointed out that goal setting was only a first step:

> "More difficult but absolutely essential to the actual implementation of a new approach is defining performance metrics that can be used to measure progress toward federal policy goals."

The report identified measures for the goal: Economic Growth, which could be "fair and free of bias toward any particular mode or region". The measures recommended include two measures for metropolitan accessibility (access to jobs and labor and access to non-work activities) and two measures of national connectivity (network utility and corridor congestion). The authors acknowledge that due to the complexity of measuring economic growth, these and other measures will not produce a "definitive result", pointing out that imperfect measures are "preferable to ignoring economic benefit altogether."

Selected Agency Experiences: Washington, North Carolina, and Oregon DOTs

Washington DOT (WSDOT) is one of several agencies included in the interviews for the report, which has an extensive history with performance measurement and an on-going program that has been in place over a decade. The Gray Notebook, as the effort is known, reports on many facets of transportation management and construction. By legislative directive, the program is oriented around 6 goals. The 6th goal of "economic vitality" was not added until 2009.

[44] Bi-Partisan Policy Center (2009) See initial reference on page 8 and see the report's Appendix C describing network connectivity metrics.

Similar to other states, the staff has started the process of measuring economic vitality with freight transport, specifically truck freight and truck intermodal. Among the challenges is defining truck freight economic corridors. While volume of freight on a given road is a key criterion, other factors such as critical industry or location of an important facility require consideration as well. Additionally, some corridors have to meet other criteria, including commuter arterials and scenic byways. Another issue cited by the program manager is getting quality data. With many of the freight delay problems being in urban areas, the BTS commodity flow data is not suitable because data is needed at a smaller geographic level than the state, which is the level of BTS data. To overcome this problem, the WSDOT has turned to a private provider of GPS data.[45] The program now includes global positioning systems (GPS) data from over 6,000 participating trucks. This data has been instrumental in identifying bottlenecks and pointing to the need for operational improvements such as signal timings, as well as helping establish practicality of the performance measures.

With the attention to detail and quality of data that is characteristic of the Gray Notebook, the freight measure analysis is extremely comprehensive. The analysis matrix includes over 100 measures in three operating environments: Global Gateway; Urban Goods Movement; and Rural Economy, each of which includes measures reflecting eight types of impact/benefit measures. The measure types considered include: reduction in cost; improved travel time reliability; safety; economic vitality; environmental impacts; resiliency; and other. The measures are further assessed by five evaluation criteria: consistency with federal; consistency with state criteria; importance to freight system users; importance to public; and direct correlation to state's economic vitality.

In each of the operating environments there are at least 20 measures for economic vitality with multiple measures for jobs and productivity. For example, the following jobs measures are included in each category:

- Improves job creation and expansion:
- Number of long-term jobs and wages
- In high-unemployment area
- Number of manufacturing or other high-wage jobs not requiring advanced degrees
- In high-poverty area
- Number of short-term jobs
- Average wage of jobs
- Number of transportation and warehousing jobs

The ranking of measures was done by a broad-based technical committee of public and private sector representatives including, state and local officials, industry associations, trucking interests, railroads, labor unions, planning organizations and the clean air agency. The process is expected to be completed in mid-2013. The matrix is found at Appendix E.

[45] Edward McCormack and Wenjuan Zhao, *GPS Truck Data Performance Measures Program in Washington State*-(Seattle,WA: Washington State Transportation Center,2011))

The North Carolina Department of Transportation (NCDOT) has adopted a strategic prioritization process[46] for its Statewide Transportation Improvement (STIP) projects for the years 2018 to 2022. Prioritization 2.0, as the second generation of the effort is known, includes ratings based on project benefit/cost analysis and economic competitiveness for the first time.

Economic competitiveness is based on the increase in productivity the transportation project is anticipated to provide. The economic competitiveness measure is generated by using travel time savings and project construction cost values in combination with the Transportation Economic Development Impact System (TREDIS) economic modeling software package.

North Carolina licensed TREDIS after a systematic evaluation of available software that included outside stakeholders and NCDOT staff. The TREDIS software was found to be affordable—the license for the state is under $25,000 per year; user friendly—the software walks the user through a decision tree for a given analysis; and TREDIS was able to take on the analysis NCDOT needed—calculating project economic value added in each of the state's 14 transportation divisions based on travel time savings. TREDIS can provide economic value results to a zip code level, NCDOT choose however to derive this at a county level and to compare projects within their respective "regions" (in this case a region is equal to a state highway division, which is six to eight counties).

NCDOT spent a substantial amount of staff time preparing data to use in the TREDIS analysis due to a decision to improve its input data—travel time savings by project. Economic value added was defined as the delta between travel time savings before and after the project.

The NCDOT is using the term Economic Competitiveness vs. Economic Development, since contingent development is NOT being used in the analysis - that is land development that might occur as a result of the project. Contingent development is often based on many other factors outside of the project including land use, zoning, and the location of water and sewer lines.

Economic Competitiveness is used in scoring highway projects on the Statewide and Regional tiers where new lanes or new capacity are being added. Statewide tier projects essentially include the Interstates and major US Route-numbered highways and Regional tier projects essentially include the remaining US Route-numbered highways and NC-numbered highways. Economic competitiveness is 10% of the total score for Statewide tier projects and 5% for Regional tier projects.

The additional analysis has been well received by decision-makers, as clearly laying out criteria has improved the transparency of the project decision process. It has also changed the order in which projects are funded—with those that score well accelerated and lower scorers pushed further down the 10 year pipeline. Overall, NCDOT finds that the existing economic modeling software tools are up to the task of helping state DOTs add economic measures to decision-making and doing so improves the process.

[46] Sources for the North Carolina discussion: Alpesh Patel, North Carolina Department of Transportation, Strategic Planning Office, personal interview February 1, 2012 and April 23, 2012; and North Carolina Department of Transportation, "NCDOT—Prioritization 2.0," March 2011, http://www.ncdot.gov/download/performance/Prioritization2March2011.pdf

An instructive **example of linking goals to measures comes from the Oregon DOT**, which is considering the goal of economic vitality through the lens of Least Cost Planning (LCP). In 2009, the DOT was directed by the legislature[47] to develop a LCP process. LCP originated in the utility industry and a number of transportation agencies, including the ODOT, tried to adapt LCP to transportation during the 1990s. In the *TDM Encyclopedia*[48], Todd Litman describes *Least-Cost Planning* as integrated planning and:

> "[A]n approach to resource planning that:
>
> - Considers demand management solutions equally with strategies to increase capacity.
> - Considers all significant impacts (costs and benefits), including non-market impacts.
> - Involves the public in developing and evaluating alternatives."

In directing the new effort, the legislature defined LCP for ODOT as follows:

> "Least cost planning means a process for comparing direct and indirect costs of demand and supply options to meet transportation goals, policies or both, where the intent of the process is to identify the most cost-effective mix of options. The Department of Transportation shall, in consultation with local governments and metropolitan planning organizations, develop a least-cost planning model for use as a decision-making tool in the development of plans and projects at both the state and regional level."

The agency is in the process of building on that earlier knowledge and adapting it to the new legal definition and to today's challenges, including the reality of funding constraints. The project has identified four broad categories of measures for the principle of Economic Vitality and is testing a series of measures for future adoption and implementation. The framework[49] is follows:

Oregon Least Cost Planning: Economic Vitality Goal

Measure Category 1 : *Economic Impacts of Spending for Construction, Operations and Maintenance*
What it Does: Reflects changes to the state, regional or local economy as a result of transportation expenditures.
Impacts and Measures: Impacts include short-term impacts of capital spending (e.g., design and construction of a new commuter rail line) and the longer term effects of annually recurring expenditures (e.g., labor costs associated with the operation of commuter trains, track maintenance). Direct, indirect and induced impacts are typically estimated. They may be expressed in terms of jobs, output, income, and/or tax revenue. These in turn may be expressed in gross or net terms (gross includes transfer from other sectors, whereas net includes only net new value to the state economy).
Measure Category 2: *Economic Impacts of More Efficient Transportation Services*
What it Does: Changes to the state, regional or local economy resulting from improvements in the

[47] Oregon Department of Transportation, *Update on Oregon's Least Cost Planning Project: Next Generation Planning Tool* (Salem, OR: Oregon Department of Transportation, 2004) http://www.oregon.gov/ODOT/TD/TP/otpPubs/EconPolRev.pdf
[48] Victoria Policy Institute, *TDM Encyclopedia,* (Victoria, VC, Canada: VTPI, 2011) http://www.vtpi.org/tdm/tdm21.htm
[49] The Framework was provided by Denise Whitney-Dahlke, transportation economist, ODOT, in an email on January 6, 2011.

performance of the transportation system
Impacts and Measures: Affects the user through changes to such factors/conditions as travel time saving, improved access, and reduced shipping costs.
Measure Category 3: *Structural Economic Effects of More Efficient Transportation Services*
What it Does: Changes to the state, regional or local economy resulting from a transportation plan/project/action, and arising specifically, but indirectly, from improvements in transportation efficiency over a given geographic area
Impacts and Measures: Examples would be economic development at either end of an expanded freight corridor, and improved labor productivity resulting from reduced commuting times.
Measure Category 4: *Local Economic Development and Revitalization Effects*
What it Does: Is a subset of the above three general indicators, and focuses on economic impacts in selected communities (e.g., Economically Distressed Areas).
Impacts and Measures: Impacts can be seen in both economic and real estate metrics. Examples include: employment, property value, number of construction permits.

The Gap Between Setting Goals and Funding Projects

In the last decade, the Government Accountability Office (GAO) has conducted several studies concerning the use of performance measures and economic analysis tools in state and local transportation decision making. These studies have found that decision-making in transportation project selection often relies on informal information and factors.

GAO's 2005 study concluded that state DOTs and transit agencies: "often did not use formal economic analyses to systematically examine the potential benefits and costs. Even when economic analyses are performed, the results are not necessarily the most important factor considered in investment decision making. Rather, our survey responses indicate that a number of factors, such as public support or the availability of funding, shape transportation investment decisions."[50]

In 2010, GAO[51] looked at transportation decision-making again, but with a focus on the planning practices of state DOTs and rural planning organizations, including the use of performance measurement and targets. In this study, the GAO found that "to develop required short-range plans— state transportation improvement programs (STIP) — states assess needs and determine funding allocations. However, in selecting projects, states assigned greater importance to factors such as political and public support than to economic analysis of project benefits and costs. While the majority of surveyed RPOs reported being satisfied that their rural needs were considered, some RPOs reported less satisfaction with their role in allocating funds for rural areas."

[50] United States Government Accountability Office, *Highway and Transit Investments: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results* (Washington, DC: GAO, 2004).

[51] United States Government Accountability Office, *Statewide Transportation Planning: Opportunities Exist to Transition to Performance Based Planning and Federal Oversight* (Washington, DC: GAO, 2010).

Three agencies interviewed for this study reported having used economic benefit as a specific factor in deciding among projects within the last funding cycle for a major program. For these states: Kansas, North Carolina and Wisconsin, the results of the economic analysis were given 25, 10, and 40 points, respectively, out of 100. Pennsylvania also uses an economic model in considering projects, but does not give a specific weight to economic considerations in the final selection.

In the case of Kansas, TREDIS modeling was used in the identification of highway projects for the new long range plan's program of projects, known as T-Works. The two other factors used were 50% engineering needs, including safety and capacity, and 25% local consultation results.

North Carolina's use of TREDIS to rank major highway projects as to their "economic competitiveness" was discussed earlier in this chapter, but several points are worth making here. Major projects include two tiers: Statewide tier, which are essentially the Interstates and Regional tier, which are primarily the US Route-numbered highways. Economic competitiveness is 10% of the total score for Statewide tier projects and 5% for Regional tier projects. It is important to note that the projects are not ranked across the state, but within each of the 14 agency districts, each of which is several counties. The concern with competing across the state is that the economic results are strongly influenced by the economic circumstances of the district. For example a large highway project has a greater impact on regions that are not as economically robust because the activity stands out so much more than when economic growth is stimulated by many causes in a growing urban region.

Wisconsin used the agency's in-house capability, building on years of corridor and network analysis, along with some support from proprietary models – primarily REMI Policy Insight and IMPLAN. The methodology used by WisDOT economists emphasizes investments that will support industry that exports out of the state, to encourage new dollars coming in to the state. Wisconsin is required by statute to use economic potential as a factor in selecting major highway projects, but the degree of emphasis – in this case 40% –is determined by the staff. REMI Policy Insight and IMPLAN are described later in this chapter.

Additionally, for almost a decade, the Minnesota DOT has required cost benefit analysis as part of a cost effectiveness standard for projects that require an environmental impact statement (EIS), environmental assessment (EA), or an Environmental Assessment Worksheet (EAW). The EAW is a state requirement triggered by certain capacity increases on the trunk highway system, such as a new road or additional lanes one or more miles in length; a new interchange on an existing limited-access highway, or an access consolidation or closure of 2 miles or more in length. New transit ways and any transit project seeking federal or state capital funds, as well as major airport improvements and capital investments for facilities over $10 million also require an EAW. These cost benefit analyses (CBA) generally occur about the same time as the environmental analysis and are meant to gauge how well each alternative considered for the project meets stated performance objectives. Business impacts along with social, environmental and community goals must be considered for most of the capacity projects and for all projects if they do not have a cost-benefit rating of at least 1. Projects that do not rate a CBA of 1 or meet separate best value criteria are subject to review and approval by a separate Transportation Program Committee.

We also found several states that have used measures of neighborhood or even household impact in considering economic trends. Iowa used the Housing +Transportation Affordability Index[52] to assess the percentage of affordable metropolitan areas in the state compared to six nearby states and the United States as a whole as part of a review of economic trends. Minnesota and Kansas have developed their own economic distress indices rather than use national indices.

Although it may have occurred in the past, we did not find instances of **multimodal ranking of projects**, except within the smaller transportation and economic development programs (referred to as TEDs). For many reasons, these programs can be seen as opportunities for innovation, as well as a source of data for what works and what does not in terms of stimulating economic development.

TEDs – Local Economic Development Stimuli

The TEDs are state transportation grant and loan programs designed to foster economic development by supporting local units of government and sometimes private sector companies. According to a Federal Highway Administration study in 2003[53], of 50 states contacted, 39 said they had some type of special highway fund/program targeted to economic development. These range in size from less than $5 million annually to $50 million. Many states also have rail and aviation programs.

For the purposes of this study, what is interesting about these programs is that most have clear performance indicators that serve as criteria for project selection, many have programs to track these measures, and a number also track whether these are net new jobs. Wisconsin is one of the programs with regular audits, and the agency requires payback of funds if jobs credited to the grant are not realized in years 3 and 7. Some states target industries which have been shown to be beneficial to the state and to support other state industries.

Typically, the measures applied include:

- Number of short term jobs, and number of permanent jobs
- Average wage (often with credit for being higher than median wage for county)
- Amount of capital invested
- Type of industry supported
- State cost per job
- $ Invested in Distressed Communities (usually measured at county level)

In an effort to secure and accelerate private investment, some states have adopted quick turnaround provisions for the TEDs. One such state is Kansas. In 2009, the DOT revamped their highway and economic development program, creating a multi-modal grant program with clear economic objectives

[52] The H+T Index is a tool of the Center for Neighborhood Technology to assess the combined costs of the two largest household costs – housing and transportation - for the typical household at the block group level. It can be found at: http://htaindex.cnt.org/

[53] Glen Weisbrod and Manisha Gupta, *Overview of State Economic Development Highway Programs* (Washington, DC: FHWA 2003)

and analysis requirements. The program was expanded from $5 million annually to a $10 million and structured to be able to respond within 45 days to "immediate opportunity" projects to bring new employers to the state. Priority is given to projects that: create immediate opportunity to bring new employers or facilities to the state, locate in disadvantaged communities, make capital investment, and create or retain jobs in sectors that have been determined to be important to the Kansas economy: manufacturing, agriculture and food production, and warehousing. Retail, housing development, and service jobs generally are not eligible.

Another state with an "immediate opportunity" provision is Oregon. The legislature established the program in 2005 at $50 million to support non-highway modes. Due to financial constraints, the program was recently cut back to $20 million per year. Like Kansas, the program criteria favor investment in certain business types. Oregon's program has an explicit goal to lower cost of Oregon businesses. Oregon requires certification of any job supported by the program being new to the state..

Minnesota's TED program was initially funded in 2010 as a pilot program for only one year to demonstrate the economic results from investments on the state's trunk highway system and the local road system. The popularity of the program led the legislature to support the local grant program for a second year (a 2012 solicitation is cuurently in progress) at the $20 million level for trunk highways and an additional $5 million that could be spent on transportation improvements on the local road network. The TED program is a multi-agency initiative using both MnDOT and Department of Employment and Economic Development (DEED) resources.

The emphasis of the program is on transportation improvements that will support industries that provide high wage or "wealth creating" jobs. The target industries include: manufacturing, technology, warehouse and distribution, R&D, agricultural processing, bioscience, medical, and tourism/recreation. Support for industrial park development or mixed use multimodal development also are favored. Project selection favors those projects that can be delivered as early as possible. Additional criteria include the ability to secure private contribution of construction costs, improved accessibility to businesses, impact on transportation mobility and safety, net new job creation in the state, and job retention.

Generally, we found that TED program applications provide clear measures to evaluate the success of the project. A systematic review of a cross section of state TED-funded projects should yield valuable information in understanding: the return on investment from the incentives; the types of projects and circumstances that produce positive returns; and impacts of projects on the local community.

Appendix C includes a chart showing key measures used by selected states in administering TED programs.

Conclusion

State DOTs are clearly making efforts to include economic considerations in planning processes, but the degree to which these efforts are formalized in plans, goals, measures, and improvement programs varies widely. Surveys and research by federal agencies such as GAO, think tanks, and national professional organizations show that goals are often not backed up by measures of progress toward

those goals. And that freight mobility measures predominate among the measures in use. Such measures are important, but are not “the whole elephant”. Moreover freight corridors are often priorities for other uses, including as several states reported, routes such as scenic byways, considered important for the tourist economy. Such circumstances require a balancing of goals and related measures. TED programs provide another means for agencies to seek economic results and to require accountability in return for funding.

The interest in assessing economic performance appears to have grown recently among many state governments, at least in part due to emphasis of the stimulus programs on economic effects, including the competitive US DOT program, TIGER. What we found in our nine agency sample is that most use economic benefit information informally as part of the framework or discussion in the selection of projects. Not surprisingly, some said that the degree to which the result of formal analysis was an explicit consideration varied over the years within individual agencies. In other words, things change as management changes.

Chapter VII. Evaluating Transportation Investments and Benefits.

The benefits and impacts of transportation investments are manifold, and, as such, their evaluation has become a complicated task. Originally framed in terms of simple benefits due to travel time and cost savings, evaluation criteria now can include multiple dimensions, measures, and areas of concern, in order to provide a comprehensive framework for valuing the proposed investment(s).

The initial framework that considered simple consumer surplus measures of travel time and travel cost savings has evolved to include in the economic evaluation many different measures of economic activity. This expansion points attention at regional economic impacts and benefits – describing how overall economic activity is expected to change in response to transportation investments. Now we consider not just system condition and benefit-cost (or cost effectiveness), but bolster that analysis with broader economic impact assessments. Finally, there is increasing concern with preserving and enhancing the local communities as valuable elements in the social and economic fabric of a larger region.

As tools and methods have expanded to include a greater array of economic benefits and economic activity, the need for a more detailed and comprehensive geographic focus also has become clear. Jobs, housing, walkability, economic distress and other measures of value and accessibility are best treated as localized measures. As a result, we now often need to understand benefits and impacts at the finest geographic levels, whereas typically analysis has been at the county or state level.

This comprehensive approach to evaluating transportation investments and benefits is depicted in the figure below as building blocks, where system user benefits are measured and used as the foundation for a continuum of benefits and impacts. This chart shows key evaluative dimensions – the building blocks - for each of the principle areas of concern – system performance, cost benefit/cost effectiveness, regional economic development, and community effects.

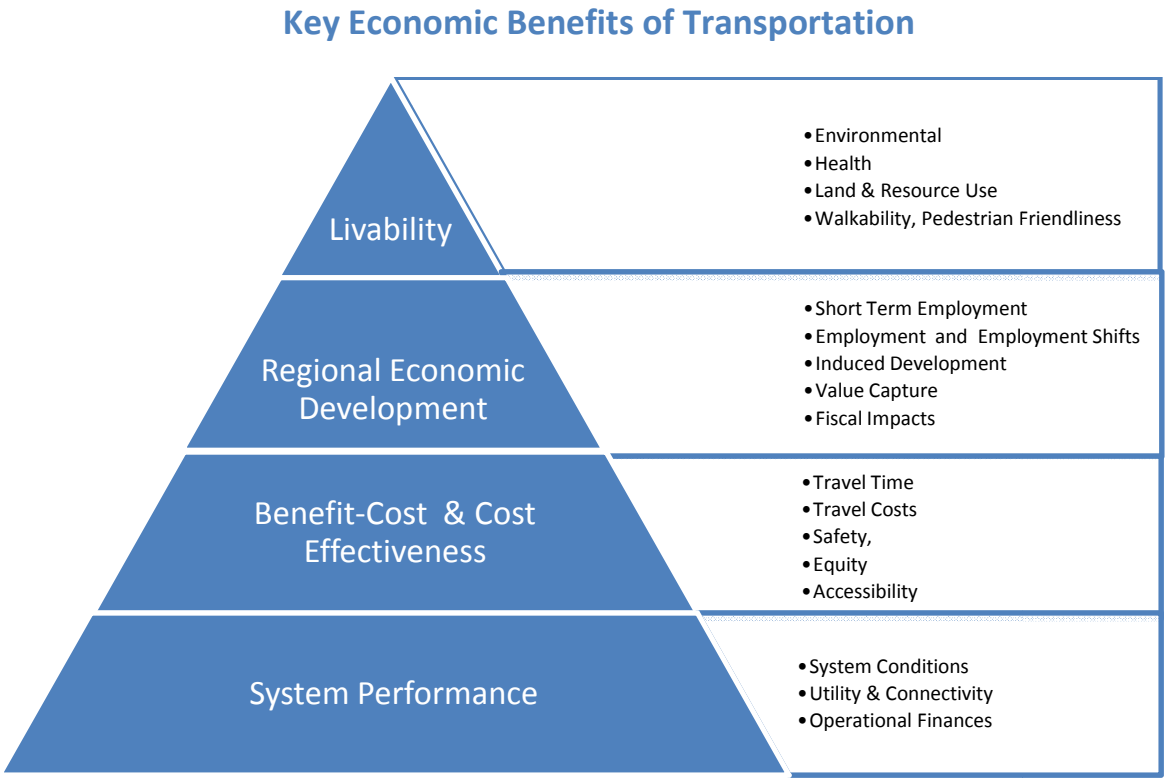


Figure VI.1: The Building Blocks of Comprehensive Transportation-Economic Analysis

The material that follows provides additional explanation of each of these four transportation investment evaluation domains. Examples of specific tools and approaches relevant within each domain also is provided, as appropriate. Then, this discussion will summarize a consolidated or integrated consideration of both these domains and the categories of tools and methods available to aid in evaluations. This consolidated view provides a type of evaluation management matrix or scorecard, identifying how various tools and methods can help address concerns and aid in discussions about one or more of the four evaluation domains – system performance, benefit-cost, regional economic development, and community effects.

System Condition and Performance – The Value of 'State of Good Repair'

The rationale for a focus on system performance is important due to the role that performance of the system (ultimately dependent on the condition) has to continued economic performance. Generally, infrastructure performance may be taken for granted like the couch in your living room until it wears out and becomes uncomfortable. The significant investments that have been made need to be continually managed, maintained, and kept in a state of good repair, so we can continue to reap the benefits from

these large public assets. Moreover, economic gains may be realized by improvements in the efficiency of the existing system.[54]

Responding to this need for resource stewardship, new tools for system performance management have been developed and are in use across the country. Tight state budgets, limits on federal support, and a backlog in maintenance and repair of existing infrastructure drive current interests in monitoring and understanding system performance. This need for maintenance and upgrades is an important part of the equation in allocating funding among competing concerns.

There is a strong, direct link between infrastructure conditions and utility of the transportation infrastructure to a community. Deteriorating conditions limit this utility and restrict the connectivity provided by the transportation infrastructure. Poorly managed and maintained systems and services often cost more to correct or rebuild than if they were more reasonably maintained and managed, and they also exact an economic cost on users and on the community.

This makes maintaining a state of good repair, including adoption and financing of operational and efficiency improvements, a significant concern. A variety of tools and techniques have been advanced over the years to support this area of concern, starting with techniques from traffic engineering practice where system characteristics are linked to capacity and value as network elements and as predictors of maintenance needs and the useful life of system elements.

The Highway Performance Monitoring System (HPMS) has been developed to reflect this need for tracking highway network quality nationally, and it relates system quality to performance and maintenance issues. The HPMS was established over 30 years ago to provide up-to-date and continuing information on the extent, condition, performance, use and operating characteristics of U.S. highways. The data are collected and reported by the state DOTs to the Federal Highway Administration (FHWA).

Analytical systems such as the **Highway Economics Requirements System – State (HERS-ST)** rely upon performance data from sources such as HPMS and travel modeling results to help define, rank, and prioritize investments in system maintenance and development across a state. Another type of tool potentially of value in this area for project ranking based on performance impacts, benefit-cost results, and economic impacts is the **Transportation, Economic & Land Use System (TELUS).** TELUS was designed for FHWA to support the development of transportation improvement plans (TIP) at the MPO and state level. The model includes an economic input-output model that can be used in ranking projects. TELUS was developed with the help of an MPO users committee and is in active use in 60 MPOs, but only one state DOT, although 34 state DOTs have registered users[55]

[54] Marlon Boarnet, *Highways and Economic Productivity: Interpreting Recent Evidence* (Journal of Planning Literature, Vol. 11, No.4, 1997)

[55] FHWA Website accessed on 4-20-12: http://www.fhwa.dot.gov/research/deployment/telus.cfm

Evaluating Different Types of Economic Effects: User Benefits and Activity Impacts

The types of tools mentioned above, such as HPMS, HERS-ST, and even TELUS bring to the fore the issue of evaluating all of the economic effects of system Investments, and the complexity involved in the choice of the specific economic analysis tools and the approaches to use for such assessments.

There is a substantial body of literature concerning transportation economic analysis, much of it focused on correctly differentiating end-user cost-benefit analysis from regional economic development or economic impact analysis. As discussed by a number of authors, and even addressed within federal funding guidelines, both approaches are of value to decision-makers to make sure the various benefits and impacts are identified. But care must be taken to insure that no double counting of benefits occurs; doing so could significantly bias project assessments.

Each framework has a number of distinguishing characteristics, and so they are generally considered as separate types of evaluations. This discussion will separate these two analysis approaches in later material. To help explain this separation, some of the key distinguishing characteristics are briefly summarized below.

Benefit-Cost and Cost-Effectiveness Analysis: Valuing User Benefits

Cost-Benefit Analysis (CBA) and Cost Effectiveness Analysis requires comprehensive specification of project costs, including the proposed project initial expenses, ongoing operations and maintenance expenses, and asset residual value at end of the project analysis period. The offsetting benefits or effects primarily focus on the consumers or users affected by the services and/or facilities, and in costs-benefit analyses are usually assessed using the notion of the 'consumer surplus'.

User benefits have principally been defined in terms of the travel time and travel cost savings associated with a specific project or investment. These benefits can accrue to households, and they can accrue to businesses, and specific analysis procedures have been developed to monetize or value effects such as travel time savings. These benefits are key values included in a standard benefit-cost analysis, and offsetting these benefits are the net project costs.

In addition to the basic travel time and travel cost savings, project benefits can also include other measurable impacts that can be monetized. Among these may be found safety benefits, equity benefits, and employment accessibility impacts. The inclusion of any specific benefit category in a benefit-cost analysis depends upon the use of a suitable measurement and monetization strategy.

Safety benefits – if measured as the reductions in accidents and the social costs imposed by these accidents – is widely included in many analyses. Social equity and accessibility benefits can also be included in so far as they represent savings in the social costs to support unemployed and underemployed, or as they reduce the expected expenditures and effort associated with journeys to work, for example. These benefits (or impacts) can also be seen as impacting other categories of benefits such as community effects, but they can only be counted once. As these are traditionally counted with transportation user benefits, we have included them here.

Weisbrod[56] points out the limitations of traditional cost benefit analysis due to limited consideration of social effects, including "lack of sensitivity to wealth differentials, distributional impacts on vulnerable groups and intergenerational impacts." He further points out that only using "narrow user benefit measures" one will miss non-user impacts on business productivity and competitiveness and "distort project selection."

The CBA measures are needed, but for these reasons, it is important to consider additional benefits and impacts in terms of economic development and community effects.

Regional Economic Development (or Economic Impact Analysis)

Regional Economic Development (or Economic Impact Analysis) requires the ability to estimate basic economic values of interest, as well as changes to these values created by the transportation investments. Measures used include regional aggregate economic activity, commodity flows, employment and household income or earnings. Impacts are estimated incremental activity levels based on the application of economic impact multipliers or a regional economic model. Importantly, the area of interest in the analysis is often only the region containing the subject project(s), and cross-border or out-of-area impacts aren't often considered.

This current two-level approach to economic benefits and their calculation was well-described in both TCRP Report 35 and by Forkenbrock and Weisbrod in their 2001 guidebook. Since these discussions, the approaches and techniques have been refined further and strategies have been developed to apply these concepts in an ever expanding evaluation context. There are also a variety of more current, useful discussions about transportation economic analysis[57] that may be among the more informative of recent efforts at describing current understanding of economic analysis approaches in transportation planning.

For example, Weisbrod[58] discusses the use of the multiple-user and non-user economic benefit measures and related evaluation techniques with respect to a ranking and project selection process in Kansas that demonstrates how alternative ranking factors can affect outcomes. While the specific metrics and evaluation approaches may vary state to state, there are a common set of benefit estimation techniques now in general use within transportation planning and project evaluation efforts.

So, from the above, there are two types of economic effects to be considered in the transportation planning process. First, there are primarily direct user benefits that are attributable to active use of the transportation system elements being proposed or evaluated, and sometimes included are directly associated changes in consumer welfare affected by changes in service accessibility. Second, there are

[56] Glenn Weisbrod, *Incorporating Economic Impact Metrics in Transportation Project Ranking and Selection Processes* (Washington, DC: Paper presented to TRB Annual Meeting, 2011) http://www.edrgroup.com/library/multi-modal/metrics-ranking.html

[52] Glen Weisbrod and Arlee Reno, *Economic Impact of Public Transportation Investment* (Washington, DC: APTA, 2009), http://www.apta.com/resources/reportsandpublications/Documents/economic_impact_of_public_transportation_investment.pdf and,

Glenn Weisbrod, *Incorporating Economic Impact Metrics in Transportation Project Ranking and Selection Processes* (Washington, DC: Paper presented to TRB Annual Meeting, 2011)

[58] Ibid.

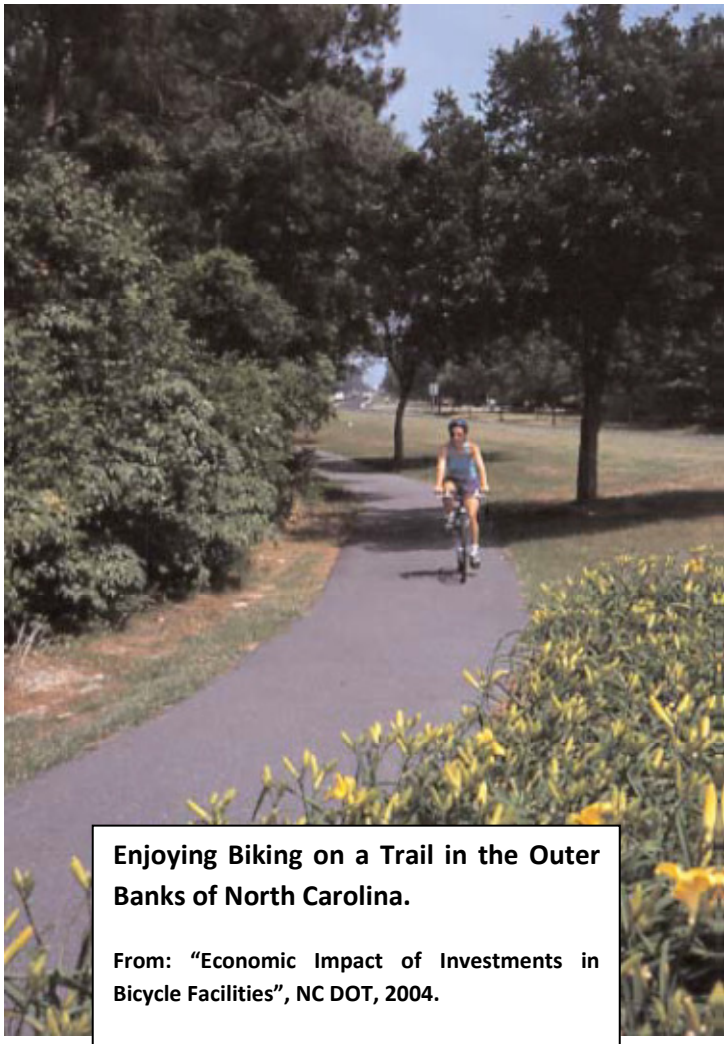
also aggregate economic activity benefits related to changes in output, productivity, and employment that are affected by the introduction of a specific system or improvement in the transportation system or infrastructure.

Current policy and economic analysis standards dictate that these two types of effects – the user benefits vs. the market or sector benefits –be considered separately.

Community Effects

A newer area of assessment for transportation investments is community impact, also referred to as livability. The potential for transportation investments to affect the health, environment, land use, and other aspects of community life are well known, but systematically measuring these impacts and assigning them economic value is a more recent practice.

These impacts may be incorporated into cost/benefit analysis or regional economic impact assessments, but they may also be treated as standalone measures. The existing tools and data for transportation economic modeling are least comprehensive in the area of community effects, but some tools are adding livability measures due to increased demand from users and changes in project funding requirements.



Enjoying Biking on a Trail in the Outer Banks of North Carolina.

From: "Economic Impact of Investments in Bicycle Facilities", NC DOT, 2004.

Environmental benefits, such as air quality and greenhouse gas emissions, can be estimated based on changes in travel demand, and methods exist for assigning such impacts economic costs. So, economic impact tools and models that leverage travel demand impacts can add air quality and climate change assessments relatively easily. Air quality impacts may also be translated into health benefits or costs based on links to asthma and cardiovascular disease. Other environmental impact assessments, such as effects on water quality, are not as standardized and, as such, are not included in most of today's tools or models.

Land consumption and resource use intensity are important considerations as communities focus on issues of sustainable development, smart growth, and energy security. The impacts of transportation

investment on land use are a large field of research and the beneficial impact that transportation infrastructure can have on community design is becoming widely understood through efforts such as transit oriented development. Conversely, projects – both highways and transit lines- that divide communities by large swaths of right of way that do not provide for frequent access across the corridor, or that render large areas as unusable for community or commercial purpose disrupt community patterns and personal mobility. They also can present challenges to local fiscal stability, if enough taxable land is removed from the tax roles.

The health benefits of transportation investment and community design are also an area of growing interest, as walkability and pedestrian friendliness improve exercise rates and may reduce obesity. Walkability is seen as a value in its own right, beyond its health benefits. Research is showing more and more the value communities place on walkability, as evidenced by the increased use of Walk Score in real estate listings. Transportation investments must be better evaluated for their full impacts to incorporate livability elements into consideration.

Information and Tools for Economic Analysis

At some point for all analyses, the most widely used and frequently discussed techniques to identify, describe, and assess economic benefits should fall into one of the following groups or modeling and analysis categories:

1. **Primary Data:** In some circumstances, the relevant information available may simply be descriptive data. Geographic information, property characteristics and value, economic activity levels are examples or types of data that are primarily descriptive in nature. In many situations, simple descriptive information, such as the number and location of business based upon analysis of business directory information may answer key economic development questions.

2. **Purpose-Focused**: Beyond the basic information resources, there are a variety of more advanced information systems as well as specialized, targeted datasets and analytical resources. Starting with the well-known CTPP (Census Transportation Planning Package) data, other examples of this category include household surveys and the reports and measures built from these survey results. Another subset of this class includes new affordability and employment accessibility measures such as CNT Housing + Transportation Affordability Index.

TRANSPORTATION AFFORDABILITY

This indicator estimates the transportation costs as a percent of income for the typical regional family (defined using the regional median income, regional average household size, and regional average number of commuters per household) in a given block group. It can be reported as well for the average household earning the national median income or 80% of the regional median income. The indicator is part of the CNT H+T Affordability

3. **Traffic Engineering and Performance Based:** There are different tools and systems available to help assess the system conditions, system needs, and system finances and provide support ongoing infrastructure management needs. Founded on simple concepts relating roadway characteristics and quality to potential volumes, these tools have become ever more sophisticated and draw upon multiple categories of information, some performance based, but more often than not including techniques such as the Highway Economics Requirements System – State (HERS-ST) or the much more tactical approaches found in Intelligent Transportation System supporting tools.

4. **Travel Demand:** User benefit estimation is fundamentally based on travel demand models, even including the somewhat more complex integrated transportation and land use models. This category includes the oftentimes consultant developed and supported 3-step aggregate statewide models and the metropolitan 4-step models. These models often use data from the Census Transportation Planning Package program (CTPP). Or, if a more advanced modeling development effort is warranted, improved use may be made of the more specialized data sources as may be more typically derived from household travel surveys. Changes in travel time, travel costs, and associated monetized impacts are common indicators associated with these types of measures. The newer activity based models, which use the more complicated tour concept, appear to be attractive to a growing number of MPOs; while the earlier generation of input-output, economically driven models have seen more applicability at the state and sub-region levels, as in Oregon and California. The Integrated Transportation, Economic and Land Use Model meets a need long recognized by the transportation planning community: modeling the symbiotic relationship between transportation infrastructure, land use patterns, and economic activity. These latter models are very data intensive and analytically complex.

Integrated Models

There are a number of frameworks or systems that can be used together to define an Integrated Transportation and Land Use Model. But there remains tremendous variability in the final structure of each applied model, as they usually reflect different base regional economic models, policy geographies (e.g. transportation zones, land use zones, metropolitan boundaries, counties, etc.), transportation models, and even local policy emphases.

These types of models are referred to as 'Integrated' because they combine or integrate multiple models, such as a separate economic model with spatial components, land use and land development models, demographic models, even aggregate and disaggregate travel models, along with specific network assignment algorithms. See Appendix D for more information.

5. **Regional Economic Activity:** Benefit estimation based primarily upon multi-regional industry activity or input/output models. These models describe changes in economic activity that can be created by initial transportation investments and ongoing operations and maintenance

expenditures. Most of this modeling is based on industry economic activity data collected by the Bureau of Economic Analysis (BEA), and includes such products as the RIMS II Multi-regional model. Almost all instances of these toolsets include Statistical/Econometric Impact Models**.** These Independently defined models are used to estimate a variety of user and non-user benefit, impact, and performance measures. These types of techniques categorize or functionally describe specific relationships between the characteristics of transportation services and other important activity measures such as travel, personal expenditures, land use, and employment. As mentioned earlier, the IMPLAN model, the TREDIS system with IMPLAN, and the REMI TranSight product are all examples of tools in this category.

MODEL	Description
REMI TranSight	Regional Economic Models Inc. (REMI) is one of the leading public policy economic modeling software firms. REMI Policy Insight is used to analyze regional economic impacts of policy change, such as the impacts of climate change regulations on energy prices and the wider economy. TranSight is a newer model from REMI that focuses specifically on transportation. TranSight allows the use of outputs from transportation demand modeling, such as vehicle miles traveled or vehicle hours traveled, as well as transportation project parameters to estimate the economic impact of projects. REMI TranSight's transportation-specific economic impact modeling use the transportation model and project parameters to estimate impacts of changes in travel on emissions and accidents. TranSight also models shifts in fuel expenditures, related gasoline tax impacts, and other transportation expenses. The economic value of changes in commute time and access are estimated as well. Project costs for construction, operation, and maintenance are provided by the modeler. REMI's regional economic model then uses all of these elements to estimate a suite of impacts including employment, gross regional product, wages, and migration.
TREDIS	TREDIS, the Transportation Economic Development Impact System (http://tredis.com), is an analysis and evaluation software system that can provide both benefit-cost and economic impact assessments for transportation system investments. TREDIS systematizes the calculation of benefit-cost and economic impact measures. It combines economic modeling with the relevant economic benefit and impact calculations, and generates summarizations that can meet various benefit-cost and economic analysis requirements for transportation investment reviews. TREDIS includes a specialized economic impact model referred to as the Dynamic Response, Multi-Regional macroeconomic impact forecasting system as part of the Economic Adjustment Module. According to the software creators, "[T]his incorporates elements of Moody's Analytics® economy.com forecasting and IMPLAN® trade flows within a broader econometric framework."[59] And it is possible to substitute other regional models, such as those based on BEA RIMS II, or REMI.

[59] TREDIS Software Group, "Economic Adjustment Module," accessed January 24, 2012, http://tredis.com/product-info/modules-and-structure/economic-adjustment-module.html

6. **Community of Practice:** Case-based reasoning and experience-based standards, and various related analysis methodologies are sometimes used in estimating benefits of transportation projects. These approaches attempt to characterize projects through comparison with results from similar projects and programs, almost a type of benefits by benchmarking. Repositories where project details and performance can be investigated include the Strategic Highway Research Program (SHARP) T-Pics database, as well as other compilations of case study analyses. such as the transit-related case studies of the Center for Transit-Oriented Development (CTOD). .The breadth of measures can be supported with this approach, and some of the current measures associated with these practice-based methods include increases in tax base, changes in perceived land value, and changes in community value. The collaboration of researchers on an issue or to define simpler methods by combining one or more approaches is another example. For example, combining panel of experts with local knowledge to evaluate the results of analysis or model outcomes.

Combining, managing and comparing the results from these different impact estimation techniques is becoming the hallmark of some of the newer visualization tools for transportation planners. The most capable of these methods integrate geographic information systems (GIS), relational database features, project planning, various mathematical transportation modeling and economic analysis modules. These also include extensive data analysis and reporting features that support the discussion and presentation of various cost-benefit and impact analyses associated with transportation plans and projects.

Consolidated View of Tools Supportive of Identifying Benefits and Impacts

Each of these types of information and tools can be evaluated in terms of how well they support specific transportation investment benefits and impacts described earlier in the chapter. Picking specific examples of the information and tools as representative of the available tools within each of the groupings earlier, it is possible to identify the degree of importance and usefulness each tool has in responding to needs for information to support specific types of evaluations and provide details for specific measures within each evaluation domain. As described at the beginning of the chapter, a detailed matrix or Scorecard showing the relationships between benefits and types of data and tools available for analysis was developed from this research and is provided at http://www.ssti.us/2012/05/economic-effects-of-transportation-investments/

This Scorecard shows how different types of data and tools can be used to provide insight into the nature and extent of the selected benefits/ impacts in the four categories and at what level of geography they are offered. The matrix provides examples of the data and tools and then assesses the utility of the tool for the type of benefit by indicating a 1 (measures an aspect), 2 (measures several aspects or may provide a full measure), or blank, is not relevant or insignificant utility). An example of how to use the matrix can be seen in the comparison of the examples under Purpose Focused Data and the Benefit Cost/Cost Effectiveness category of benefits.

Decision Support Information and Tools	Examples	Benefit-Cost and Cost Effectiveness						
		Travel Time Benefits - Passenger	Travel Time Benefits - Freight	Household Costs	Business Costs	Safety (Accidents, Injuries)	Equity Impacts	Employment Accessibility
Purpose - Focused	CTPP (Census Tranportation Planning Products) Data	2	2	2	2	2	2	2
	Environmental Studies (EIS, Air SIP)						2	
	American Community Survey/Household Surveys	2	2				2	2
	H+T Affordability Index	2	2	2			2	2
	Transit Oriented Database	1		2			2	2
	Washington State Freight Aggregated GPS Data		2		2	1		

While both the data and the tools have been improving, particularly with the wider use and availability of GIS applications, there are still important gaps in our understanding of economic impacts, especially in predicting impacts. These gaps are indicated by the blank cells in the matrix and generally the 1's, and tend to cluster in the regional economic development and community effects areas. Continuing research and tool development in these areas is needed.

Costs and Barriers Bounding Effective and Efficient Analysis

Time and money; all projects seem to need more time and more money. And, seemingly, whatever has held true for the actual projects themselves seems to hold true for attempts to evaluate projects.

These approaches, models, and techniques referred to above don't come without significant costs or complexity. Such information systems require substantial amounts of data, and they can consume significant computing resources. They require knowledgeable, professional staffs, often with consulting support. And, preparing data, analyzing output, reporting and interpreting modeling results also take time. The availability of usable data is a continuing problem requiring considerable staff time and resources. In trying to evaluate impacts on land value, for example, land and building value data is often available at the county level as either sales records or assessed value. The data, however, is not always in a useable form such as a digital format and the format county-by-county may not be consistent, requiring substantial effort to convert it.

Requirements and complexity will vary depending upon the types of planning and analysis tasks being undertaken. And it is likely that a number of concurrent efforts may rely upon similar data, resources models, and staff. Typical activities might involve long range planning, short range improvement plan updating, individual project planning and development, not to mention completion of funding requests and grant applications. Coordination of effort and project management is essential.

But, fundamental to all of these evaluations is the availability of outputs from some type of travel demand model. Some estimate of expected change is necessary in order to begin the evaluation process. Yet, travel demand models, particularly the new generation of advanced models that include integrated models like SWIM2 in Oregon, and the more complicated activity based travel models, may take years and require several million dollars to develop, with similar sums required to continue to operate, maintain and update such models.

The timeliness and accuracy of modeling results, particularly as they relate to benefit estimates has come in question. In fact, there may be no real way to assess the accuracy of modeling results. And even audits of implemented projects and systems may only yield partial validation of project and planning assumptions.

In the end, selecting a modeling approach will be a compromise. A compromise that balances data needed, expected funding and staffing, and perhaps the urgency of the need for some specified results. Selection of an approach becomes a risk-return analysis on its own.

Another consideration for an agency involves how it chooses to evaluate specific plans and projects. There are a couple of evaluation frameworks available, and there is always the ad-hoc approach that relies upon staff to complete project evaluation and assessments as needed for internal reviews and when needed for external funding requests.

Proprietary evaluation systems provide reliable data and analysis frameworks but they also require agency inputs of transportation data. The acquisition cost of these models is generally small compared to the cost of planning the many projects analyzed. TREDIS, for example, under newer pricing may have a base cost of about $18,000 to $25,000 for a basic MPO or State installation. Additional expenses are associated with adding multiple users and locations, and extending the software to other smaller MPOs and partner agencies, for example. There is a need for regular, often annual, updates to licenses, which have a similar cost. REMI TranSight is similarly priced to the TREDIS product based on the number of regions and how regions are constructed.

Sometimes regarded as 'black boxes' the use of these evaluation tools and frameworks could become more prevalent as long as they provide key information for decision-makers, and they limit resources needed to deploy, use, and maintain these systems.

Conclusions

In the end, the combination of improved benefit estimation methodologies and more advanced evaluation frameworks help the statewide and metropolitan agencies respond to ever more complex challenges of the transportation planning process. And, as seen in some of the research consulted, a combination of tools – for example expert panels with the addition of some basic analytical tools – might be the most effective and efficient approach.

But, these tools and techniques should be expected to continue to evolve – partially due to professionals developing a better understanding of how to assess and measure benefits, and partially because it is likely that more issues will be added to the considerable number of topics being addressed within these investment analyses. But, a few key issues need to be called out for consideration and discussion as described in the next Chapter.

Chapter VIII. Emerging Issues and Practice

The research reveals five key emerging issues in the practice of transportation economic analysis that deserve more attention as economic performance becomes a more recognized factor in planning and investment for transportation:

- The importance of the geographic unit of analysis;
- The role of local fiscal impacts such as property values and sales taxes in supporting investment;
- The positive and negative impacts of induced development from investment;
- The impact of agglomerative benefits and how and when they occur; and
- The continued importance of community of practice – collaboration and evaluation.

These factors are largely in the realm of social and economic effects and of fiscal impacts as such impacts may support or impede future investment. They are not new issues. Each has been the subject of inquiry and research for decades, but as more is understood about economic effects and the methods used to assess them, the questions get more complex – and interesting.

> *"The key implication of the diversity of social and economic effects is that it is fruitless to attempt to combine them into a single cumulative index or measure. Each effect must be examined separately using the most suitable method and presented in a comprehensive way."*
>
> Forkenbrock and Weisbrod, 2001

The Scorecard (in matrix form) referred to in Chapter VII shows that some tools and methods provide varying levels of insight into these areas. But the matrix also reveals gaps where more knowledge is needed to guide wise investment. This is especially true when it comes to predicting impacts not just chronicling them. Forkenbrock and Weisbrod made the point in their excellent guidebook on social and economic effects of transportation[60] that such effects need individualized methods for evaluation. Other studies have shown that several methods need to be combined to provide reliable assessments[61]. And as pointed out in the previous chapter, the emerging practice appears to be combining techniques to capture the unique factors that produce real economic results, particularly in the five areas cited.

[60] Forkenbrock and Weisbrod, 2001.
[61] Reid Ewing, "Highway Induced Development: Research Results for Metropolitan Areas", Transportation Research Record No. 2067, Transportation Research Board, 2008.
[61] Uri Avins, R. Cerverro, T. Moore, and C. Dorney, *Forecasting Indirect Land Use Effects of Transportation Projects*, (Washington, DC: Transportation Research Board, NCHRP 25-25, 2007)

The Importance of Geographic Unit of Analysis

In the last 10 years there has been a significant increase in the sophistication and complexity of transportation and economic models. Many of these – Regional Economic models and Integrated Land Use and Transportation models - use and report much of their data at the county or higher level[62]. Using data at this level of aggregation is appropriate for comparing impacts of national, state level or large sub-state improvements. In rural areas, also there may not be enough economic activity to subdivide the data into units smaller than a county and still have sufficient data for valid analysis. There are four reasons for caution, however, when using the larger scale data to assess potential benefits of individual projects, particularly projects in larger metro regions where economic activity is greater and where induced demand and agglomerative benefits are more likely to occur. These reasons include:

1. **Impacts that are important at a corridor or sub-regional level often are not notable** when measured at a metropolitan region or county level. An example is proposed investments in Oak Park, IL that are expected to produce hundreds of new housing units and commercial spaces, but these increases - that are so important to Oak Park - may be barely noticeable when considered as part of the economic activity of Cook County, as a whole. However, these local economic developments are what add up to growth and economic progress in Cook County.
2. **Policies intended to support distressed communities will miss fairly sizable sub-regional areas** of distress when the unit of measurement is county or larger. The county may be prosperous but sizable communities within it may not be and may not receive benefits of programs targeted on distress, as a result.
3. **For the same reason, shifts of economic activity from one part of the county to** another that may disadvantage one place and advantage another are not discernible when the county is the unit of measurement.
4. **Accessibility is a key determinant of economic benefit to places**. Using accessibility data at the corridor, census tract or census block group level in combination with geographic information systems (GIS) will enable analysts to better identify actual connectivity and access to the specific facility as well as to identify barriers to access of that facility. For example, transit in the median of a highway rarely has the same degree of accessibility or proximity to development and generally produces less local economic development than stations closer to residential and commercial land uses. Data modeled at the county or greater level would not identify these issues or the potential for design to improve access or possibly the agglomerative benefits from the project.

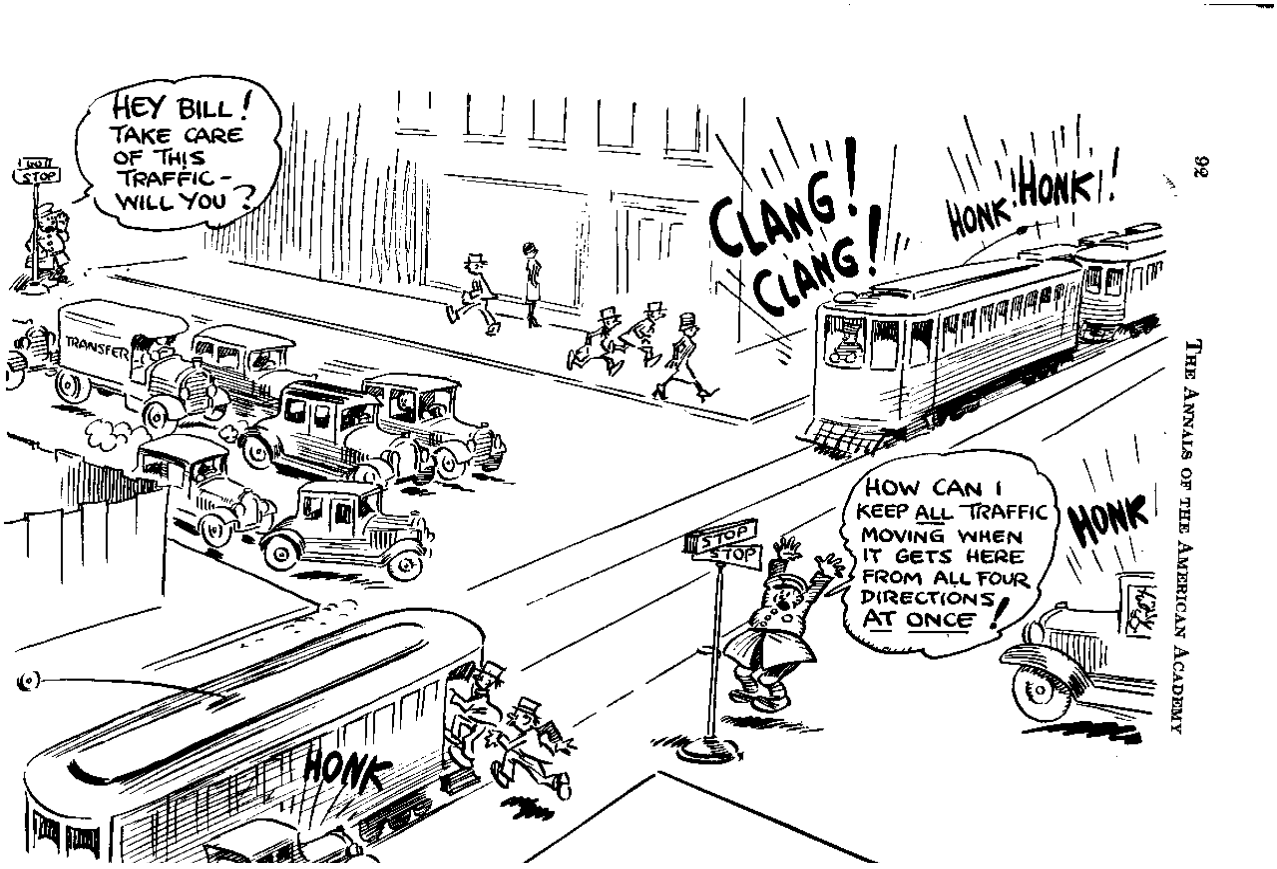
For these reasons, it is important to understand the geographic level of the data and the level at which results will be reported in the various analytical methods and models.

[62] TREDIS with IMPLAN has recently made zip code level data an option. And REMI TranSight and other REMI products can be made available with census tract or TAZ geographies, but no transportation client has requested the smaller scale data.

Finding Value to Capture

Changes in property value often result from transportation investment. This has been observed over and over again for both highway and transit investments[63]. This observation is important because an increasing number of agencies are attempting to use such changes in property value to justify and even finance development, as well as future operations and management.

Forkenbrock and Weisbrod[64] describe property values as derivative effects of other factors. (Presumably, this obtains for other fiscal effects such as sales taxes that may be generated by land use changes.) Thus a change in property value is highly variable depending on the degree of access provided to the transportation system: better access equals higher values generally, but this is mitigated by factors such as noise, traffic, the local economy, community cohesion, land development and regulation, and visual quality. This dependence on a range of other factors, some external to the project and study area, makes good prediction of a change in value also dependent on good analysis of all the relevant direct and indirect effects of the project.



It was a mess, but it was the 100 percent commercial intersection in the 1920's[65]

[63] Forkenbrock and Weisbrod, 2001, p. 6 and 7.
[64] Ibid, p. 160.
[65] "Traffic Control," Burton W. Marsh in *Planning for City Traffic*, Special issue of **Annals of the American Academy of Political and Social Science**, Vol. 133, September 1927, p. 92

Property values tend to vary within a study area due to these factors (all boats do not rise), in particular increased noise, which tends to degrade property values. For example, Forkenbrock and Weisbrod note that properties affected by the noise of the right of way of either transit or highways may be negatively impacted, while areas with good access to the stations and on-ramps, and not directly adjacent to the right of way, may see considerable positive change. The variation in value for residential properties may be reflected in the noise contours included in many environmental impact statements (EIS), and these could be used to help predict changes in value. Such variations may be different for different categories of land use, where commercial properties may not be as sensitive to some factors such as noise, and may benefit more from proximity, which would increase market access, and presumably value, for some types of businesses. Personal esthetic values inevitably become an issue in these matters, as do trends in consumer preferences that may substantially change the desirability of residential property. There is an old saying in real estate that the most valuable urban property is at the corners, and this was borne out in a study of induced development in Texas[66].

GAO[67] also has looked at the question of property values in relation to new transit investments, under the New Starts program. The researchers noted that "property value increases near a project may occur due to option value [of multiple modes] or agglomeration effects, both of which are indirect results of transit investments and not explicitly related to mobility improvements." This means that a key measure of evaluation used by the agency, known as TSUB measure, may not include the total benefits from better access to a dense downtown. GAO cited prior analyses that indicated potential "residual benefit from these indirect effects that is not accounted for in travel time benefits or other direct impacts."[68] This would translate to under-counting benefits in the New Starts competitive grant program.

Some studies show values also may vary over time, and it is important to understand these cycles and to try to collect data on property values from similar projects over time. A review[69] of 17 years of tax assessment records for a highway right of way in the Austin Texas region found high inflation in land values right after right of way purchase, with declines in value subsequently, and with values moving back to higher levels as development began along the corridor. A similar phenomenon was described for corridors undergoing redevelopment in the District of Columbia generally due to announcement of decisions to restore streetcar service. An economist for the Chief Financial Officer of the District government[70], who is responsible for fiscal analysis, pointed to a time factor where property values tend

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[66] K.M. Kockleman, Ben Siethoff, C. Michael Walton, and H.S. Mahmassani, *Research on Relationships Between Transportation Infrastructure and Increases in Vehicle Miles Traveled: The Effects of Highway Capacity Expansion on Land Development,* Final Technical Report for US EPA (Austin, Texas: University of Texas, Center for Transportation Research, 2001) as reported in literature review by Reid Ewing, 2008

[67] United States Government Accountability Office, *Improvements Are Needed to More Fully Assess Predicted Impacts of New Starts Projects* (Washington, DC: GAO, 2005)

[68] See United States Government Accountability Office, *Highway and Transit Investments: Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results*, (Washington, DC: GOA 2008)

[69] Kockelman, et al (2001.)

[70] Interview March 7, 2012 with Yesim Yilmaz, Policy Director, Office of Finance and Revenue, Washington, DC.

to rise rapidly after a project is announced. And, as development tends to lag or happen unevenly over a period of years, the value is likely to vary up or down afterwards, before it stabilizes.

Availability of the data is a challenge to this type of analysis, in part because it is not familiar to many transportation professionals. The experience of the Oregon Department of Transportation (ODOT) in acquiring both property sales data and property assessments[71] is instructive. Staff sought the data to calculate land value in their integrated economic, land use, and transportation model. They found that county level data was available for both in some counties, but public sales data tended to be available only in the more populous counties. ODOT purchased the data for the remaining counties from a private vendor. The quality of the data and its usability were affected to some degree by the varying forms and formats of the data county by county. Nevertheless, they were able to acquire data for most of the model zones and to allow the missing values to be estimated for the remaining zones. The study found that proximity to the CBD of large metro areas was an important factor in positive value changes:

> "The final results of the land cost estimation process behaved in a manner that is generally consistent with the values expected in a land rent model. Land values tended to decrease with distance from the CBD of the largest metropolitan areas. Land extensive uses consumed larger amounts of land area and had lower unit costs for land. Social and economic factors related directly to land prices for single family housing. Rural resource lands that could not be developed for other uses had very low land values as a reflection of the economic value of the return from small areas of land."

Looking at how to predict the changes in value, the excellent guidebook by Forkenbrock and Weisbrod previously referenced suggests several methods, but cautions generally that there are many factors to consider in addition to those cited above, including such real events as economic downturns, changing regional economies, and population changes. Thus, predicting actual parcel values is discouraged. With these cautions, they recommend the following steps in the process to evaluate the possible changes and direction of those changes in values[72] and provide detailed methods for assessment in the guidebook:

1. Identify the associated direct effects and the area in which they will occur:
   - Accessibility
   - Safety
   - Noise
   - Visual quality
   - Community cohesion
   - Business productivity

2. Identify the setting of affected areas in terms of current land use, density, property values and rate of change of values and development:
   - Land use Mix
   - Density
   - Current Value
   - Rates of change in value
   - For commercial competing market locations

[71] Parsons Brinckerhoff, Quade & Douglas, Inc., *Developing Land Market Data for Use in a State Wide Land Use and Transportation Model* (Salem Oregon: Oregon DOT, 1997)
[72] Forkenbrock and Weisbrod (2011) pp. 163 -66

3. Assess each of the effects found in the first step on property values using a variety of methods including market studies, comparable property studies, case studies, and use of regression models to identify the key variables, as described briefly below:

- Some methods of assessing potential changes include the traditional comparison of similar residential properties. In this case, one would assess actual values that occurred from a **comparable project (similar area - demographics, economy, and land** features - and transportation improvement type) and then try to predict direction and order of magnitude values for the proposed project.
- For commercial property, the authors recommend a **market study** of the businesses in the area and the possible changes to market accessibility and hence to potential revenue.
- **Case studies**, including evaluations of completed projects 5 and 10 years or more out, would contribute to understanding the effects particular projects may have on value.
- The authors underscore that one of the more promising techniques[73] is the use of **multiple regression analysis** to isolate the effects of individual factors on property values. An extensive listing of such studies related to transit is in a recent publication of the Center for Transit Oriented Development[74]. The results may be used for order of magnitude estimates. It should be pointed out that none of the studies recommend forecasting actual value due to the variability of impact, exogenous factors, and the difficulty of finding good fits among comparable properties and examples. The following chart provides a summary of the results of a number of regression studies of property value, giving some guidance as to possible ranges of effects. Summaries of similar studies on walkability effects follow as Tables VIII.1 and 2.

Table VIII. 1. Summary of Regression Studies of Property-Value Effects[75]

Study	Transportation factor	Observed effect
Residential property values (observed effects after project completion)		
Grand Rapids, MI (Bagby, 1980)	Change in traffic volume in a residential neighborhood	Property values decreased roughly 2% per additional 100 vehicles per day on residential streets.
Baton Rouge, LA (Hughes and Sirmans, 1992)	Difference in traffic volume on a street	On high-traffic streets, each additional 1,000 vehicles per day reduced property values by 1% in urban areas and 0.5% in suburban areas.
Brisbane, Australia (Williams, 1993)	Proximity to a freeway	Property values increased $1.78 per meter closer to an on-ramp, but decreased $4.48 per meter closer to the freeway (where there was no on-ramp).
Washington State (Palmquist, 1982)	Proximity to a newly constructed highway	Property values increased 15-17% where there was highway access, but properties located nearby decrease 0.2-1.2% per dBA of traffic noise.

[73] Forkenbrock and Weisbrod,(2001,) pp.167-68

[74] Nadine Fogarty, Nancy Eaton, Dena Belzer, and Gloria Ohland, Capturing the Value of Transit (Oakland, CA: Center for Transit-Orientated Development, 2008) pp. 6-9.

[75] Forkenbrock and Weisbrod, 2001, p. 168

San Francisco, CA (Bernick and Carroll, 1991)	Proximity to a rail transit station	Rents increased $0.05 per sq.ft. for each mile closer to a station.
Toronto, Canada (Bajic, 1983)	Proximity to a rail transit station	$5,370 premium for homes close to a station.
Commercial/Office rents (observed effects after project completion)		
Santa Clara, CA(Weinberger, 2000)	Proximity to a light-rail transit station	Rent values increased 3-6% for sites within a mile of a light-rail station.
Atlanta, GA (Bollinger et al., 1996)	Distance from a heavy-rail transit station	Rents increase 4% for sites close to a station.
San Francisco, CA (Landis and Loutzenheiser, 1995)	Distance from a heavy-rail transit station.	No effect in San Francisco or Oakland; elsewhere rents increased 16% for sites up to 3/8 mile from a station.

Table VIII.2. Walkability and the Relationship to Property Values

Study	Transportation Factor	Observed Effect
15 Housing Markets (Cortright, 2009)[76]	Walkability	Residential property values increase $700-$3,000 for each WalkScore point increase in a typical market. Correlation negative in Las Vegas, absent in Bakersfield.
National (Pivo and Fisher, 2011)[77]	Walkability	For each WalkScore point increase, values increased 0.9%--office, 0.9%—retail and 0.1%--apartment. No significant increase for industrial.

Despite the difficulty, being able to more accurately forecast the relative change in property values is getting more attention due to the potential for increased local and state revenues that can be pledged to retire bonds and thus advance a project timeframe. The new revenues enable government to bring the project on line rather than wait for conventional grants or being delayed by General Obligation bond limitations.

[76] Joe Cortright, "How Walkability Raises Home Values in U.S. Cities," (Chicago, IL: CEOs for Cities, 2009) ,p.2.
[77] Gary Pivo, Jeffrey D Fisher . "The Walkability Premium in Commercial Real Estate Investments," Volume 39 Issue 2, (*Real Estate Economics*: 2011), pp. 185-219.

Economic Gain, or Shift from Induced Development?[78]

Economic gain is derived from projects that improve transportation efficiency, productivity, reduce commutes or catalyze other development, especially if that development is in economically distressed communities. Such gains are often been measured as net changes in overall economic activity or demand, changes in household incomes, and changes in employment. Any such positive gains can easily translate into fiscal benefits for governments, agencies, and businesses.

Channeling natural growth or inducing new growth in locations that can be served over the long-term with more efficient transportation services generally produces a net benefit to the community and supports the economy over the longer term. However, when the economic activity resulting from new investment is primarily development and jobs from elsewhere, that is an economic shift or redirection, which produces little net economic return. In an article on highway induced development, Reid Ewing[79] summarizes some 20 highway impact studies over the last 30 years. Many of these studies showed that major investments are more likely to move development around the region than to stimulate positive economic gain. For example, a joint HUD-DOT study of 54 metropolitan areas[80] included in the article found that suburban beltways have little impact on the growth of such areas, but may shift growth within the metro area.

Predicting the indirect effects of projects that cause these shifts has been the subject of disagreement among transportation agencies and with the public for decades. The issue usually comes to the fore around controversial projects where the amount and type of development induced by the investment is at the heart of the disagreement over the project. A comprehensive guidebook (NCHRP 25-25) on the subject[81] in 2007 found that, despite numerous guidance documents by states and research organizations, the practice of predicting these effects was "a largely ad-hoc field lacking focused guidance and research-based understanding of land use response to transportation improvements". Moreover where guidance was available, the practitioners were skipping steps or substituting other methods.

The authors point out that failure to account for this induced demand is likely to overstate travel time savings attributed to the project, which is an important part of the transportation and economic benefits. They suggest this situation adds to public skepticism about the project and its benefits and is the impetus for legal challenges. The authors also indicate skepticism about the value of "packaged models" in use by states and MPOs in considering induced travel demand and the related land use effects.

[78] "Induced development" is meant in this report to be the indirect impacts on land use, population growth, or population density as described by Uri Avin, R. Cervero, et al in *Forecasting Indirect Land Use Effects of Transportation Projects*, (Washington, DC: Transportation Research Board, NCHRP 25-25, 2007)

[79] Reid Ewing, "Highway Induced Development: Research Results for Metropolitan Areas", Transportation Research Record No. 2067, Transportation Research Board, 2008.

[80] Payne-Maxie Consultants. "The Land Use and Urban Development Impacts of Beltways," (Washington, D.C.: U.S. Government Printing Office, 1980)

[81] Avin et al (2007),6-7.

The guidebook and several others included in the research[82] point to the need for careful scoping and the use of planning factors to help determine the type of analysis needed. Some of the state guidance includes flow charts to show the relationship of factors to indirect effects. The guidebook offers Oregon DOT's suggested factors for trying to determine if a project may have indirect land use effects, and thus whether detailed analysis is needed. As the following increase, the need for analysis also increases:

- Aggregate travel time change
- Estimated project cost
- Project length
- Number of vehicles/trips effected
- Capacity of project relative to existing capacity
- Whether other services (water, sewer) are located nearby
- Strength of market demand for development
- Professional opinion

The guidebook provides descriptions of current analytical approaches, how they can be used, and judges their contribution. Like Forkenbrock and Weisbrod (2001) and other research cited in the document, these approaches start with qualitative methods such as "planning judgment" using agreed to factors and weighting or elasticity's and "collaborative judgment" such as visioning and Delphi panels. The six approaches considered are summarized on the matrix below from the guidebook. Of these six, the authors consider the first three to provide a foundation for all analyses and the last three are discretionary, and should be used in combination with one or more of the first three, especially with complex projects or environments, as they answer the key questions with more "rigor". The six approaches are organized from simplest to most complex.

[82] The authors drew on prior guidance developed for TRB, including the Louis Berger Group, Inc., ***Desk Reference for Estimating the Indirect Effects of Proposed Transportation Projects*** (Washington, DC: TRB, NCHRP Report 466, 2002), and guidebooks individually prepared by state DOTs or their sister state agencies in California, Oregon, North Carolina, Maryland and Wisconsin.
[82] Reid Ewing and Keith Bartholomew, *Comparing Land Use Forecasting Methods*, Chicago: Journal of American Planning Association, 2009)

Table VIII.3. When and Where to Use Various Approaches for Indirect Land Use Effects Analysis[83]

Approaches	Amount of Land Use Change Anticipated		Context			Project Complexity		Resources			Comments
	Little	Much	Rural	Sub-urban	Urban	Simple	Compl-ex / Contro-versial	Low Cost	Little Data	Little Staff	
Planning Judgment	●	●	●	◎	○	●	○	●	●	●	Provides guidance on entire process and default values for simple applications
Collaborative Judgment	○	●	○	●	◎	○	●	◎	◎	○	Structuring process correctly is critical; use in combination with other approaches
Elasticities	◎	●	◎	●	◎	●	◎	●	●	●	Useful parameters; use in combination with other approaches
Allocation Models	○	◎	◎	●	◎	◎	○	◎	○	○	Easy to construct but require careful testing and calibration
Four-Step Travel Models	○	●	○	●	◎	○	●	○	○	○	If model is available, then resources available will likely be high
Integrated Transportation-Land Use Models	○	◎	○	●	◎	○	●	○	○	○	Most costly, complex, and time-consuming method

● = Applies strongly ◎ = Applies somewhat ○ = Applies weakly

Once the likelihood of the project resulting in indirect effects is confirmed, the authors suggest application of one or more of the six techniques shown in Table VIII.3. The following are described in detail in Chapter 4 of the guidebook and the discussion here relies heavily on that chapter, unless otherwise noted.

1. **Planning Judgment** is the simplest and described by the authors as "Best Practice", where available data and tools are used to inform the judgment of the professional planner. Techniques such as historical patterns, expert interviews, and rules of thumb from the literature are used to bolster the experience of the planner. Using this method alone is appropriate for projects not likely to have a big impact, involve little likelihood of controversy, and do not require and Environmental Impact Statement.

2. **Collaborative Judgment** has been tested for project-level planning and found to be informative in many examples. The most common form is the Delphi panel, which looks to achieve some

[83] Avins, et al, 2007, p. 33.

level of agreement on indirect land use effects through an iterative process of individual opinions and responses by the other experts to those opinions. Delphi panels are recommended for projects that are likely to impact a relatively small area, where understanding of local land use regulations and practices may be needed, when the public may not trust staff analysis, and/or when conflicting social values may be an issue.

The authors stress that this is much more structured than just convening a panel of experts to discuss the issue and has political appeal when put together with broad range of experts in the related disciplines because it appears to be achieving some level of consensus in a fair and unbiased manner. Delphi panels are often used in combination with one or more quantitative methods.

3. **Elasticities and Induced Travel** are also considered foundations of analysis of indirect effects because of the considerable body of literature that supports the relationships between expanding capacity and increasing travel demand and the corresponding importance of such induced travel on indirect land use effects. Unfortunately, most travel forecasting models do not incorporate induced travel and thus other methods to assess the level of induced travel are needed. Several methods have are reviewed involving some level of experience from other projects and using the resulting elasticity of demand to adjust model outputs (post-processing). The authors come down on the side of a larger number of projects to base the adjustment on through a "'meta-analysis' or summaries of elasticity estimates—i.e., arithmetic averages from multiple empirical studies".

   The following table[84] from the guidebook summarizes studies of induced travel demand estimated at a fine grain – percentage traffic increase - for specific facility improvements. This method compares traffic counts along an expanded road to what would have been expected had the project never been built.

[84] Avins et al, Table 4, p. 73.

Study	Setting	Data	Method	Facility Type	Variables		% Growth Attributable to Induced Travel		
					Demand	Supply	ST	IT	LT
Jorgensen (1947)	NY-CO	TS	GC	New parkway	ADT	New facility	25-30		
Lynch (1955)	ME	TS	GC	Turnpike	ADT	New facility			30
Mortimer (1955)	Chicago, IL	TS	GC	Expressway	ADT	New facility		3-33	
Frye (1964a)	Chicago, IL	TS	MP	Expressway	ADT	New facility			11[a]
Frye (1964b)	Chicago, IL	TS	MP	Expressway	ADT	New facility			7[a]
Holder, Stover (1972)	TX	TS	GC	Highways	ADT	New facility	0-21[a]		
Pells (1989)	London, UK	TS	MP	Highways	ADT	Widening			27[a]
Pells (1989)	London, UK	TS	MP	Highways	ADT	Widening		25	56
Pells (1989)	London, UK	TS	MP	Highways	ADT	Upgrade			80
Pells (1989)	London, UK	TS	MP	Expressway	ADT	New facility		77[a]	
Pells (1989)	London, UK	TS	MP	Tunnel	ADT	New facility			89[a]
Hansen et al (1993)	CA	TS/CS	GC/Reg	Highways	ADT	Widenings	--[b]	--[b]	--[b]
Kroes et al. (1996)	Amsterdam, NL	TS	MP	Tunnel	ADT	New facility		4.5	
Luk, Chung (1997)	Melbourne, AU	TS	MP	Freeway link	ADT	New facility	0		
Mokhtarian, et al. (2000)	CA	TS/CS	MP	Highways	ADT	Widenings	0	0	

Table VIII. 4. Facility Specific Studies of Induced Travel Demand[85]

4. **Allocation Models** allow land use and population forecasts to be allocated to smaller geographies, which enables estimates of development impacts. Like most analytical techniques allocation models run from simple spreadsheets allocating the total forecast to smaller areas such as transportation analysis zones or other census-based geographies. Increasingly, geographic information systems are used to do the spatial analysis and display results. ALL require planner judgment – in fact all 6 types of analytic techniques require planner judgment and hence the assessment that they are "foundational".

[85] **Key NOTES for Table VIII.4:**

TS = Time Series a -Thought to include significant amounts of diverted trips

CS = Cross-section b Presented as elasticities: 0.2-0.3 for short and intermediate

GC = Growth Comparison term; 0.3 to 0.6 for the long term

MP = Matched Pairs

Reg = Regression

ADT = Average Daily Traffic

ST = Short-Term (< 1 year)

IT = Intermediate Term (1-5 years)

LT = Long Term (> 5 years)

he authors describe the Allocation Models (AM) as ad hoc or off the shelf models that organize more information to help inform planner judgment, but they also describe the distinction between the AMs and more formal quantitative models as "a fuzzy line" between "rule-based and equation based". They are applicable to both systems planning and project planning and given the variety of types and complexity can be used by both the small MPOs for single projects and for more complex geographies and projects. The authors provide detailed guidance of the type appropriate to the area and project.

5. **Four Step Travel Demand Models with Heuristic Land Use Allocations** are another of the more formal types of modeling approaches referred to above. The authors assert that four step models do not account for induced demand, in part because they lack a feedback loop between travel assignments and land use allocations. The discussion though shows how adjustments to the 4 Step Model may allow analysis to account for aspects of indirect land use effects. Among these changes is linking land use and traffic assignments in a mechanical manner, or linking traffic assignments with expert judgment (Delphi panels as example). Generally, the authors look to the sixth category of techniques – the Integrated Land Use and Transportation models – as the better solution.

6. **Integrated Land Use and Transportation models** account for the co-dependence of land use and transportation and model a specific area over time – usually five years. Accessibility is the key in linking population and employment. In these models, accessibility is usually considered in terms of travel time measures, although other measures such as distance and connectivity are feasible. The authors clearly see this class of models as the most promising in terms of indirect land use effects – although the data and staff requirements mean that these models are only applicable in large metro regions or possibly regional models for state DOTs.

As indicated in other sections of the report, the planning question – whatever it is - often is best answered by a combination of methods, and the guidebook indicates the same for indirect effects. As an example of how such a combined approach may work, two researchers subsequently conducted an analysis of indirect benefits of a controversial multi-billion dollar highway project in Maryland: the Inter-county Connector. Reid Ewing and Keith Bartholomew[86] used a qualitative technique: a Delphi panel, and a quantitative method: a simplified spatial interaction model, to assess the induced development likely to result from the construction of the regional connector. The panel was made up of planners, appraisers, business interests, and a citizen activist. Among them, these experts were highly knowledgeable about the business environment of the region, its land use patterns, and their regulation. The two methods produced a distinct difference: the qualitative panel predicted minor impacts, while the quantitative method predicted much larger impacts.

[86] Reid Ewing and Keith Bartholomew, *Comparing Land Use Forecasting Methods*, Chicago: Journal of American Planning Association, 2009)

The authors noted that an integrated land use and transportation model should have been used but was not available for the region. They found that a combination of simple models and expert judgment provided a certain check and balance against the tendencies of each to overestimate key factors:

> "The subjective method seemed to give too little weight to accessibility effects and too much to zoning constraints, while a simple spatial interaction model seemed to do the opposite."

Having a good understanding of possible indirect development effects, as well as the direct user benefits, before deciding on the project is necessary for a complete understanding of economic potential, as well as to maintain credibility among the public as to the efficacy of the project.

What is Agglomeration and Why is It Important?

Another area that deserves attention is the effect of transportation investments on agglomeration, one meaning of which is to accumulate, as in dense urban development. Sorting out agglomerative effects from those of other factors such as natural resource or other advantages of a location, amenities, or availability of skilled labor has been the subject of much research, and the results, even the definition of agglomeration have varied. But, that there is a positive effect of concentration of activity and industry is little disputed.

Agglomeration is a complicated measurement and analysis issue. At the firm or industry level there are competing theories based on specialization and diversification. At the household level there are approaches based on various models of community economic interactions.

In both cases, data is needed on the regional and local economic activity and regional and local community socio-economic and demographic characteristics. Of interest are specific concentrations of activity and value above the averages or regional values. Measures of interest may consider concentration of firms, activities, employees, households and related economic demand, infrastructure and property value distributions, for example.

Specific models of agglomerative impacts then use such measures in concert with various classificatory and mathematical models to identify the scale and extent of any agglomerative impacts.

Analytical methods and data requirements are discussed in the NBER workshop report on Agglomeration Economics edited by Edward L. Glaeser[87], (as well as various other NBER reports). The report provides a wide range of views on what agglomerative benefits are, how

[87] Glaeser, Edward L., editor, *Agglomeration Economies* (Chicago, IL: University of Chicago Press, 2010) Introduction. Found at: http://www.nber.org/books/glae08-1

they vary, how they may be measured, and what are the many research issues that remain. In the Introduction to the Report, Glaeser observed:

> *"Agglomeration economies are the benefits that come when firms and people locate near one another together in cities and industrial clusters[88]".*

Glaeser attributes agglomerative effects ultimately to transport cost savings, which are broadly described as including "the difficulties in exchanging goods, people, and ideas". But then he points out that costs of both transportation and communication have declined and asks: if transport costs are so low "why has the urge to agglomerate remained so strong"?

One way of considering agglomeration is seen in an article in the same report by Stuart Rosenthal and William Strange[89], who observe "urban increasing returns, also known as agglomeration economies" have three dimensions of effects: industrial, geographic, and temporal. These effects decline with distance in both the geographic sense and in terms of time horizon. Industrial "distance" can be spatial, but also can be seen in terms of similar aspects of the production process, which might link different types of industries in another manner.

The article describes methods for evaluating the scope of agglomeration, including new analytical techniques made possible through the availability of smaller scale geographic data. Measures reviewed include growth as indicated by total employment over time and the birth of new establishments. The importance of wages as a measure of "productive locations" is discussed with advantages for the analysis being the ready availability of data from Census and other sources. They also argue for the older method of case studies that help put the formal, quantitative analysis in perspective.

Rosenthal and Strange are among many researchers that describe the tendency to concentrate among some industries, and that it appears not to be as strong in some industries as in others. The classic cases are the furniture industry and software producers in "Silicone Valley"[90]. The furniture industry of the U.S. is almost exclusively concentrated in western North Carolina, which is near forests that would supply the basic raw material, but other parts of the country also have ample forests. The concentration of software producers in Silicone Valley is not dependent on natural resources and is highly envied. If this success is to be replicated, the

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[89] Stuart Rosenthal and William Strange, *Evidence on the Nature and Sources of Agglomeration Economies* (Handbook of Regional and Urban Economics, Volume 4, Chapter 49: 2004)
[90] Ibid.

nature and source of the agglomeration benefits would be valuable information to policy makers.

Jerry Carlino, a senior economist at the Philadelphia Federal Reserve, writing in a recent journal of the organization[91], looks solely to urban agglomeration and points to the concentration of people and jobs leading to efficiency gains or cost savings - or agglomeration benefits which are of two types: business agglomeration economies and consumer agglomeration. Traditional measures or proxies of the former have included wages due to the relationship with productivity, and population size or density with studies indicating that agglomeration benefits increase with city size. Later studies have indicated that the phenomenon is more complicated and that larger cities may offer attractions to highly skilled workers, who are important factors in productivity. Other positive associations with city size include increasing wages and share of population with college degrees. Carlino points out that business agglomeration has been the focus of more research and empirical evidence, but that consumer agglomeration is attracting more attention, at least in part, due to the evidence that "a city's prosperity and growth depends on its ability to attract and retain highly-skilled workers". He cites recent research that demonstrates the importance of the amenities of a city that are attractive to these workers and that such amenities become a source of growth. Thus, the livability aspects of place should attract more attention in urban economic policy.

In terms of transit's role in agglomerative benefits, Robert Noland and Daniel Chatham[92] conducted research that concluded that by making already-central locations more accessible, improved transit would result in positive agglomeration benefits:

- By increasing the number of workers that can efficiently access/egress workplaces
- By reducing the amount of land required for roads and parking (more efficient mode), allowing for other productive land uses.

Moreover, the availability of transit has been shown to be valued as an important element of livability.

A need for continued research on the topic is underscored by the recognition that agglomeration varies by location. A critical result of the latest research that needs to be more widely appreciated is that the agglomerative benefit 'mechanisms' are highly reflective of the complex character of each different metropolitan area[93]. The genesis of the benefit is in a complex interaction among multiple economic factors; and the benefit has a correspondingly

[91] Jerry Carlino, *Three Keys to the City: Resources, Agglomeration Economies and Sorting* (Philadelphia, PA: Federal Reserve Business Review, Third Quarter, 2011)
[92] Daniel Chatman and Robert Noland, *How Transit Affects Economic Productivity* (New Jersey: Rutgers Bloustein School of Planning and Public Policy, 2004)
[93] Glaeser, p. 7.

variable result in wages, incomes, and overall activity. The role of transportation in this variability needs to be better understood.

This factor of uniqueness requires that more attention be given to the analysis of potential effects of individual projects in regions. Rosenthal and Strange acknowledge that there is still much to be learned about agglomeration. They point to researchers' recent access and use of large micro datasets as key to more reliable estimation and to addressing important issues such as the micro-geographic scope of agglomeration.

Another important point about agglomeration is that it impacts a number of measures or may be impacted by them. Thus, it is hard to isolate on a chart such as the Scorecard discussed in the prior chapter and here. For example, positive agglomerative benefits would be expected to affect jobs and population, and possibly economic shifts.

Back to Glaeser's question: if transport costs are so low "why has the urge to agglomerate remained so strong?"

He subsequently points to dramatically reduced cost of moving goods over the last half century or more, and then points out that the cost of moving people remains high[94]. This point leads to many other questions, including: What are the agglomerative benefits of more efficient movement of people? What are the quality of life implications of this same question? What are the implications: for evaluating transportation investments, for the various modes of transportation, and for the geographic focus of investments?

Considerable work remains.

Importance of Community of Practice

While problems can surface with specific methodologies, the fact that agencies are attempting to develop reasonable approaches through consensus building within the profession is very important. One impetus for this focus is the need to avoid the classical 'analysis paralysis' situation often seen in planning, yet still being able to maintain and advance 'best practices'.

[94] Ibid p. 7.

Having some degree of consensus or agreement on suitable approaches simply lets us all be able to consider projects on a somewhat comparable basis. The Cooperative Research Programs of the Transportation Research Board provide one way in which some degree of consensus emerges within the profession.

"Results from our survey also indicate that outcomes are not typically evaluated, although evaluations for transit projects tend to be conducted more so than for highway projects. In particular, 16 of 43 state DOTs reported that they have analyzed completed highway projects to determine whether proposed outcomes were achieved, while 13 out of the 20 transit agencies reported that they have conducted such evaluations."

GAO, 2005

An important aspect of such collaborations is building knowledge from detailed, third party evaluations of projects. Generally, the literature shows a small percentage of the thousands of projects funded each year under the federal highway program are evaluated for actual results. Transit projects, especially the competitive New Starts program, are more likely to be assessed.

A recent study by the GAO[95] found federally funded projects were not being evaluated after the project was completed to see how they met stated goals. Of the10 projects reviewed as part of the study, only four projects were subject to post-completion evaluations: 3 transit and 1 highway. And these four project evaluations did not compare outcomes to goals.

Under the Transportation Research Board's SHRP2 program, approximately 100 projects were evaluated for economic effects, but this is a fraction of those completed over several decades. FTA has adopted requirements for before and after studies for New Starts projects, but while these rules were in place at the time of the GAO study, completed projects of that timeframe had not been covered by the rule.[96]

A third party evaluation of a regular sample of all surface transportation projects with a consistent methodology would substantially enhance the public's understanding of what the taxpayer has bought. And the profession would be better for the knowledge.

[95] United States Government Accountability Office, *Highway and Transit Investments:* Options for Improving Information on Projects' Benefits and Costs and Increasing Accountability for Results (Washington, DC: GAO 2008 42-43).
[96] (49 C.F.R., Part 611 (2003)).

Chapter IX. Conclusions and Recommendations

Opportunity for State Practice

Conclusions

1. **Economic benefits should be viewed comprehensively** rather than considering just the direct user benefits, which have been the traditional focus of economic valuation of transportation investment. Such a limited focus will ignore many potential benefits that are important to an increasingly wary public who are seeking good return on their tax dollars.

2. Transportation agencies **show increased interest in reaping economic benefits**, and in demonstrating those benefits to the public, but have been slow to adopt measures of progress toward goals. In part this results from a professional concern with providing reliable measures supported by quality data that will stand up to scrutiny and provide a sound basis for decision-making. The increased interest is due in part to the emergence of highly competitive, multi-modal grant and loan programs at USDOT that require economic return, such as the Transportation Infrastructure Generating Economic Recovery (TIGER) program and the Transportation Infrastructure Finance and Innovation Act (TIFIA).

3. **State analysis is often focused on user benefits and the business effects of transportation** and thus looking to improve the key areas of manufacturing, logistics and goods movement**.** This emphasis is both desirable and understandable where the economic policy also is focused on manufacturing and logistics, and as a strategy to encourage exporting industry. This approach, however, is not broad enough to recognize the importance of services including medical services, of educational facilities, of retail, and of housing in today's economy. The economies of whole regions are now being fueled by major medical or university complexes and the agglomerative benefits that accrue to these activities. Another example is tourism. Many state transportation plans recognize the importance of tourism to their economies – Wisconsin and Washington both show it as one of the top three industries- but put their attention elsewhere in considering economic benefits. It often does not address the important effects these investments may have on households and on the cost of living at the household level.

4. **Only a small percentage of federally funded projects are evaluated** and fewer for their economic benefit. This leaves a gap in reliable information of actual impacts of transportation investments, which is needed for policy analysis, for developing reliable measures, and for informing funding decisions.

5. **Data and Tools are improving, but gaps remain** that require improved analytic techniques to predict and manage, particularly in emerging issues and practices areas of:

a. The importance of the geographic unit of analysis;
b. The role of local fiscal impacts such as property values and sales taxes in supporting investment;
c. The positive and negative impacts of induced development from investment;
d. The impact of agglomerative benefits and how and when they occur; and
e. The continued importance of community of practice – collaboration and evaluation.

6. The **benefit to analysis of more refined geographic levels** in the urban setting is clear, especially in considering economic distress, shifts in economic activity, or agglomerative benefits. Purchases of data and of the models that use the data should strongly consider this more refined level of analysis.

7. **Combining, managing and comparing the results from different impact estimation techniques is becoming the hallmark** of some of the newer visualization toolsets for transportation planners. And yet, when looking at the full (comprehensive) benefits and costs of transportation investments, no single tool or model is available to model or assess all such impacts – nor is it necessarily realistic, given the variety of conditions, projects, and goals of individual states.

Recommendations

1. All transportation agencies should conduct economic analysis of transportation **that looks at all the possible impacts** – and therefore benefits - of the types of investments made. While double counting should be avoided if tallying up the results in a cost benefit assessment, analyzing and laying out the various effects on users, non-users, and the community provides a much better understanding of the positive and negative impacts to taxpayers as a whole, and to the long-term effects that make the difference between temporary advantage and sustainable results.

2. **Economic evaluations of a percentage of the billions invested in projects each year should be conducted.** Evaluations of a selection of state transportation projects each year would greatly enhance planners and decision-maker's understanding of how best to increase economic development from transportation investment and of the value of the investment. This documentation would provide much needed information for individual economic analyses such as understanding likely induced traffic and related indirect economic and land use effects of projects. These evaluations would need to use common standards and be conducted over a timeframe that would capture the immediate effects (within 3 years) and again at 5-10 years – recognizing that good quality, sustainable development often evolves over decades.

3. Such analysis should be **conducted by independent third parties and put in an accessible format and web location**. There should be a compilation of the results from each state and a regular review and dissemination of the results, perhaps through a joint NCHRP-TCRP panel. A strong model for this would be the on-going program evaluation element that is part of every one of California's energy

efficiency programs. Putting aside .5% of federal funding and matching state share alone (estimated at $48 billion per year) would yield some $240 million. Not an unreasonable amount to be allocated among 50 states, the District of Columbia, Puerto Rico and direct federal projects to determine what types of projects and circumstances return the highest value.

APPENDIX

A. **Bibliography**

B. **Methodology**

C. **Selected Transportation and Economic Development Programs – TEDs**

D. **Looking at Selected Models**

E. **Washington State Freight Measure Analysis Draft Matrix**

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Appendix B. Methodology

This appendix includes the following sections:

1. Project Scope and Approach
2. Interview Guide
3. Interview List

I. Project Scope and Approach

The Research Questions

The increased interest and demand for better economic results from transportation encouraged the State Smart Transportation Institute (SSTI) to look for ways to help states improve their ability to predict and measure the economic impacts of transportation policies and investments. In carrying out this research, the key questions posed include:

1. What is economic development and how does it relate to transportation?
2. What is motivating state DOTs to measure economic performance?
3. What emphasis is placed on economic benefit of transportation investments? How is economic potential factored in to systems planning, project development, and project selection among the state DOTs and other transportation agencies? Do any States require the maximization of economic benefits from transportation or other infrastructure investments?
4. Is a distinction made between new economic activity and simply redistributing it from one area to another, one state to another?
5. How are States accounting for the economic effects of transportation investments? What models and tools exist or can be created to help achieve a better understanding of the relationship between transportation and economics, and thereby improve the results of transportation investment?
6. What are the barriers to adopting effective measures and analytical techniques and models among transportation agencies? What are the relative costs and time involved in collection and analysis.

Task Force Role

The SSTI contracted with the Center for Neighborhood Technology in Chicago (CNT) to conduct the study in August of 2011. A task force representing six state transportation departments oversees the research: Colorado, Kansas, Minnesota, Oregon, Pennsylvania, and Washington. The research methodology relies on an extensive literature review to document the state of the practice and interviews in selected states to look at specific experience with economic performance measures, models, and other tools.

The six states on the task force serve as the core group of states examined for current practices and interests. Three state DOTs were added to this group to provide other examples of state policy and practice, particularly where the agencies have relevant experience in the use of economic models or outstanding transportation and economic programs (referred to as TEDs) that have employed economic analytical techniques. This latter group includes: North Carolina, Iowa, and Wisconsin. Together, the nine states represent a range of experience, motivations, and practices. Additionally, the team interviewed Jack Wells, chief economist for US DOT and someone well acquainted with state efforts over the last several decades and with current economic policies of the Department, as well as being familiar with the objectives of the federal programs. Several states told us that they rely on the modeling (both traffic and economic) of Metropolitan Planning Organizations (MPOs). At the request of Colorado DOT, we interviewed staff at Pikes Peak MPO and, while additional interviews were outside the scope of the study, we also reviewed documents from the Metropolitan Planning Commission in San Francisco/Oakland, the Chicago Metropolitan Agency for Planning, and the Delaware Valley Regional Planning Commission, serving the Philadelphia Region.

Literature Review

The research began with a scan of relevant literature. The focus was on current economic analysis practices and performance measurement in transportation agencies. The annotated bibliography is an initial product of the project. The bibliography is, however, not a static one, as it will be added to and refined during the course of the project and made available as part of a webpage on the project. Over the next two years, it will be periodically updated as part of a larger CNT project, "Redefining Economic Progress: Making Communities Count".

In conducting the review, the team looked at "the usual suspects" in transportation research and paid particular attention to: the Transportation Research Board of the National Academies (TRB) and the Texas Transportation Institute, and university research centers, which are known for work in performance measures over the last several decades. The team examined the research publications of the major industry associations - the American Public Transit Association (APTA) and the American Association of State Highways and Transportation Officials (AASHTO), the American Association of Railroads (AAR), Association of Metropolitan Planning Agencies, as well as the sponsor agency, the State Smart Transportation Institute (SSTI). The review also tapped into research programs of federal agencies, such as US DOT administrations, the Office of Management and Budget, the Federal Reserves of Chicago and Philadelphia, and the Departments of Commerce and Treasury. There are a number of think tanks with transportation and economic development programs, as well as non-profits involved in this type of research. We looked for relevant publications at the Bi-Partisan Policy Center, the Brookings Institution, the Cato Institute, the Center for Clean Air Policy, the New America Foundation, Reconnecting America/CTOD, the Victoria Transport Policy Institute, the Organization for Economic Cooperation and Development, and the Center for Neighborhood Technology, among others.

In the subsequent interview phase, the team obtained documents and referrals from persons interviewed, which in turn led us to review certain state DOT and MPO websites as well as other

references and to interview additional people. It should be noted that we have not included numerous memoranda, program applications, and internal working papers we received from the agencies interviewed. These will be cited, however, in the report as they are used.

Interview Process

Following the initial literature review, the team conducted telephone interviews of representatives of the six agencies, followed by interviews in 3 other states. A total of 30 individuals were contacted and interviewed. The interviews generally reflected four major areas of inquiry: Agency use of performance measures (PMs) in general; Requirements for and use of measures in predicting or assessing economic effects; Experience with economic models and analytical tools; and Involvement/interest external (to the agency, to the government) in performance metrics. The interviews were tailored to emphasize certain aspects of the agency's program and policies that were identified in discussion with the task force and through the initial literature review.

A list of the individuals interviewed and the interview guide will be provided in the report. As a result of the interviews, the team added a new element to the methodology, a review of key requirements and the results of selected state DOT-funded economic development grant and loan programs (referred to in the text as TEDs). These programs were included in the research to show tangible evidence of:

- the level of commitment to transportation supported economic development by the states,
- the type of economic activity sought by the states,
- the mid- and long-term economic development results, when available, and
- the application of economic analysis to non-highway modes.

Regarding the last point, the scope of the report does not include organizational analysis of the institutions and its implications for economic analysis. Nevertheless, the fact that the preponderance of state transportation funding is primarily directed toward highways (and highway bridges) results in the analysis being focused on highway-only projects in many of the agencies. The literature shows this pattern and the states selected for interviews reflect this pattern. With the exception of three of the nine states interviewed: Kansas, Oregon, and Pennsylvania, the economic analysis is primarily directed toward comparison or selection of highway projects rather than to multiple modes. These exceptions relate to the special grant and loan programs that encourage economic development (referred to as TEDS) and often involve other intercity modes such as rail and aviation. The project selection process for these programs includes a number of economic development factors and is aided by the use of economic models in some cases. Thus, the inclusion of the TEDs enlarges the modal perspective of the study. The same is true for the selected review of MPOs.

It is worth noting that the scope of the research also does not explicitly consider the economic effects of recreational transportation and tourism programs, such as Scenic Byways, although these have demonstrated economic benefits and are important to state economies. Nor do we specifically look at Main Street programs, which in states like Kentucky, have consumed substantial transportation

resources. Where these are incorporated in the economic considerations of the long range plan (Washington state and Wisconsin) or in the criteria for funding programs (such as in Pennsylvania), they are included in the report. The focus of this report is on the use of economic performance metrics and analytical tools in the regular planning, programming, project selection and project development processes for highways and transit. The experience of these special programs, however, should be captured in any subsequent research to better define specific economic benefits from transportation projects.

2. DRAFT Areas of Inquiry for State DOT Interviews.

A. Agency Practices in Use of Performance Measures (PMs) in General

- Does your state have a requirement for use of performance measurement in law or Executive policy? If so, please describe the purpose and nature of the requirement? How long has the requirement been in place?

- What are current uses of PMs in your agency, and how have these changed in last 5 years? Used for:

strategic planning
systems planning
priority setting in programming and project selection
project development
organizational structure and
external relations

- Does management use performance measures in tracking overall agency performance? If so, how many measures and what types are considered key? Who is the audience for this information?

B. Use of Measures in Predicting or Assessing Economic Effects

(Give little intro about different types of economic analysis- effect of a project or program on one hand and overall economic development potential on the other, as well as predictive measures and evaluative ones after the fact.)

- Does your state require the maximization of potential economic benefits from transportation or other public investments? (May be answered in A, if so skip.)

- What types of economic benefits are considered? Such as: Improvements in travel time, travel time reliability, air quality-related health benefits, health benefits due to improved bike/pedestrian mobility, property value/property tax revenue, short term or long term job creation, increased access to employment centers? etc.

- At what point is the economic effect of a project considered? (Systems planning , project planning, annual program, strategic plan?) If used, how are PMs applied in this process? What measures are in use?

-How important is evaluating economic development potential of alternative investments/projects in either planning or programming projects? If used, how are PMs used in this process? What measures are in use?

- What measures do you think are most effective in improving economic outcomes?

- Are the data available for developing those measures? If not, what is or would be required? Do you know the relative cost of this effort?

-Who is the audience for the results of the economic prediction or assessment? (Internal and external)

- How does your agency measure the success of a project? Is there a post-project or program evaluation to see what happened?

- In the event of projects where similar transportation system benefits are anticipated but different economic benefits, does policy allow for flexibility in what's chosen? If

- Are you familiar with the current USDOT TIGER 3 grants? (May need to provide a specific list of criteria and measures.)

Is your organization prepared to answer the TIGER - NOFA questions? Which parts of the application are you least equipped to respond to?

Does your organization make an effort to exclude/identify local economic benefits generated by attracting business/jobs/development from other places (inside/outside of your state), as opposed to economic benefits that would not otherwise be created? If so, how?

Additional questions specific to the agency on PMs from Literature Review/ Task Force meeting – if any.

C. Models and Analytical Methods (More detailed questions to identified interviewees by model expert)

-What models and analytical methods are currently in use at your agency to predict economic performance of a project? Of the systems plan? Of the Annual or Multi- Year Improvement Plan?

-Have other models/methods been used previously? If so, how do you think your current method is working? Are you comfortable that it produces valid information? If you have changed methods, what is the reason for the change?-What are the relative costs and time involved in collection and analysis? (Try to be specific to data collection, analytical methods, especially any models used.)

-Is cost a limiting factor in the models and methods you use? What role does staff training play in use of the models and methods and in their acceptance?

-How much does available data drive your analysis? Are there questions you want answered? What would it take to answer the questions you cannot answer now?

-To what extent have surveys of the public or of defined interests been used to collect data, opinions, etc?

-Do your methods allow for cross-modal trade-offs, such as comparing transit, road, and non-motor vehicle investments to each other in achieving goals?

-Are you aware of other agencies (state DOTS, metropolitan planning organizations, cities, business organizations) that are collecting data, or using measures or models that would be helpful to you in assessing economic performance? What are barriers to their use or adoption?

D. External (to the agency, to the government) Involvement/Interest

-Who outside DOT has been involved in promoting or assessing economic results of projects or programs? (Who has identified, or evidenced interest in, external benefits and costs for a project or for the agency's program?)

-Are performance measures helpful in improving public support for your transportation program or individual project? Are PMs used primarily for promoting the benefits of investment or do they help the public and other stakeholders weigh the benefits? (Other stakeholders could include a sister agency or Governor or the Legislature.) Which measures?

-Have new partnerships been created to help advance or fund projects (to make up for the increasingly tight available resources)? Please describe. Has this affected the agency's interest or priority in economic performance of investments?

-What questions do external stakeholders ask that you can't yet answer?

-What should states do to better account for economic impact of their transportation plans and investments?

3. Individuals Interviewed

Representative	Position	Department
Jay Alexander	Director of Capital Program Development and Management	Washington DOT
Brian Alstadt **balstadt@tredis.com**	Senior Economic Analyst	TREDIS
Meiwu An *man@ppacg.org*	Transportation Engineer	Pikes Peak MPO
Scott Bassett *503-986-4462* *scott.bassett@odot.state.or.us*	ODOT Performance Measures Manager	Oregon DOT
Deanna Belden	Office of Capital Programs and Performance Measures	Minnesota DOT
Daniela Bremmer bremmed@wsdot.wa.gov	Director of Strategic Assessment	Washington DOT
Laura Cameron	Gray Notebook Production Manger, Strategic Assessment	Washington DOT
Craig Casper *ccasper@ppacg.org*	Director of Pikes Peak MPO	Pikes Peak MPO
Chris Cook Chris.Cook@remi.com (413) 549-1169	Assistant Economist	REMI
Kate Dill *303-757-9804* *kathryn.dill@dot.state.co.us*	Performance Analyst	Colorado DOT
Barb Ivanov	Co-Director Freight Systems Division	Washington DOT
Becky Knudson *503-986-4113* *rebecca.a.knudson@odot.state.or.us*	Senior Transportation Economist ODOT Transportation Planning Analysis Unit	Oregon DOT
Rachel Knutson *360-705-7529* *knutsor@wsdot.wa.gov*	Data Analyst, Strategic Assessment	Washington DOT

Representative	Position	Department
Lizbeth Martin-Mahar	Assistant Director, Economic Analysis	Washington DOT
Pat Morin	Capital Program Development and Management, Systems Analysis Manager	Washington DOT
Alpesh Patel *919-715-8717* *agpatel@ncdot.gov*	Strategic Planning Office	North Carolina DOT
Garrett Pedersen *515-239-1210* *Garrett.Pedersen@dot.iowa.gov*	RPA/MPO & District Planner Coordinator, Office of Systems Planning	Iowa DOT
Scott Richrath *303-757-9793* *scott.richrath@dot.state.co.us*	Policy and Performance Unit Manager Transportation Development Division	Colorado DOT
Robert Russell *608-266-2961* *Robert1.Russell@dot.wi.gov*	Transportation Economist, Bureau of Planning and Economic Development	Wisconsin DOT
Matt Shands *651-366-4893* *matt.shands@state.mn.us*	Office Policy Analysis, Research & Innovation	Minnesota DOT
Anne Turcotte *515-239-1009* *Anne.Turcotte@dot.iowa.gov*	Transportation Planner, Office of Systems Planning	Iowa DOT
Peter Van Sickle* *785-296-3273* *peterv@ksdot.org*	Economic Development Program Manager	Kansas DOT
Brian Wall *717-772-0827* *bwall@pa.gov*	Transportation Planning Specialist Supervisor	Pennsylvania DOT
Jack Wells *202-366-9224* *Jack.Wells@dot.gov*	Chief Economist	United States DOT
Denise Whitney-Dahlke *503-986-3517* *denise.d.whitney-dahlke@odot.state.or.us*	Transportation Economist, Long Range Planning Unit	Oregon DOT

Representative	Position	Department
John L. Wilson *651-366-3732* *john.wilson@state.mn.us*	Office of Capital Programs and Performance Measures	Minnesota DOT
Yesim Yilmaz	Policy Director	Office of the Chief Financial Officer, District of Columbia
Ed Young ceYoung@ksdot.org	Director Aviation	Kansas DOT

** Mr. Van Sickle is no longer with Kansas DOT.*

Appendix C. Selected Transportation and Economic Development Programs - TEDs

Program Scope and Scale			Measures/Requirements		Comment
State Program	***Scope/ Eligibility****	***State Yr ($000)*** **	***Key Measures***	***Anti-Economic Transfer***	
Kansas	Economic Development Multi-modal (One of several, including road revolving loan fund, railroad loan and grant and aviation grant that use same criteria for economic development.)	$10,000	# FTE/project by industrial category	Intra-state job transfers don't count for grant	Has 45 day approval process for "immediate opportunity" for new state jobs.
			Project cost per job		Wage must be higher than current industry average
			Average wage per job by industry (by NAIC code)		
			Location in Economic Distress area		Has economic distress index.
			Change in tax base		
			$ of other investment		
			Indirect benefits of livability or sustainability		
Iowa	**R.I.S.E. Highways**	$16,000; total since 1985 is $420 million.	# FTE created or retained	Interstate jobs count; intra state transfer jobs don't count	Review for 3 years post completion
			Non-RISE capital $ in area served by improvement, not including match		
	RR.L.G.P. railroad – loan and grant elements	$ 2-3 million varies due to loan payback and request quality Grant amt.	#Jobs created or retained	Same as above.	Reporting on jobs for 2 years post completion (Special $7.5 funding for FY11 for Rail-Port development)

		based on total FTE.	Meet or exceed average county wage;		The higher level of wage, the higher review points
Minnesota	Transportation Economic Development - highways	Current is $39,000; trunk highway $30,000, Other is $9,000	Improve access to one or more of 8 defined industries: manufacturing, ware-house & distrib, R&D, agri. processing, bioscience, medical, tourism/recreation. Net gain in state jobs Job creation in one of 8 industries Average wage + benefits Building & Equip $ Increase economic Viability in travelshed Changes in tax base	Requires a net gain in state jobs	$4 million from state E.D. Dept. (DEEDs) and $5 million of other funding is flexible by mode.
Oregon	Connect Oregon - multi-modal, except highways	First 6 years, @ $50,000 million/yr; FY 11&12, $20,000.	Reduces transportation costs for Oregon businesses Serves one or more of defined business clusters or tourism # of new or retained permanent jobs Average annual wage # short term jobs	Must certify jobs are new to state.	Unemployment rate of area, a factor, but each state region to receive min. 15%
Pennsylvania	Rail Freight Assistance	Varies annually	# Jobs Positive Cost Benefit ratio	No stated criteria	
	PA Community Transportation Initiative with smart growth objectives for multi-modes	$12,000	Quick implementation Business retention and recruitment Improve existing places, infrastructure	No stated criteria	Focus is reinforcement economically and socially of exiting communities.

Appendix D: Looking at Selected Models.

The following types of models are in use at a number of state DOTs. They illustrate 3 different methods of accessing economic effects of transportation projects.

1. Integrated Models: Combining Transportation, Economic and Land Use Modeling
2. REMI TranSight
3. TREDIS

1. Integrated Models: Combining Transportation, Economic and Land Use Modeling

Introduction

The transportation planning profession has long recognized the symbiotic relationship between transportation infrastructure, land use patterns, and economic activity. However, describing those relationships, modeling them mathematically, linking separate sub-models together, and then employing the resulting system to address the constantly evolving operational and policy issues faced by a transportation planning agency is a complex problem.

There are a number of frameworks or systems that can be and have been used together to define an Integrated Transportation, Economic and Land Use Model. But there remains tremendous variability in the final structure of each applied model, as they usually reflect different base regional economic models, policy geographies (e.g. transportation zones, land use zones, metropolitan boundaries, counties, etc.), transportation models, and even local policy emphases.

These types of models are referred to as 'Integrated' because they combine or integrate multiple models, such as a separate economic model with spatial components, land use and land development models, demographic models, even aggregate and disaggregate travel models, along with specific network assignment algorithms.

The breadth of issues addressed by an integrated model signals two other important characteristics of this approach; they are very data intensive and they are also analytically complex. Each sub-model requires very discrete historical detail in order to identify relationships and calibrate relevant mathematical models and relationships. And their use for forecasting often relies upon externally generated control totals or forecasts to constrain and limit model results to reasonable ranges of outcomes.

The Oregon SWIM2 Example

One of the more widely discussed and recently developed integrated models is the Oregon Statewide Integrated Model - Version 2, or Oregon SWIM2. Supprting the development of SWIM2 were extensive data collection and analysis efforts. Included in this effort were the expected range and geographic level

of detail for the myriad socioeconomic, landuse and transportation variables and characteristics. Also included was the collection of household survey data for use in calibration of the various models.

The Oregon SWIM2 Model is based in part upon a spatial economic modeling approach generally called the Production, Exchange, and Consumption Allocation System, or PECAS. This spatial economics framework is currently managed and promoted by the consultancy formed by the PECAS developers, HBASpecto (http://www.hbaspecto.com).

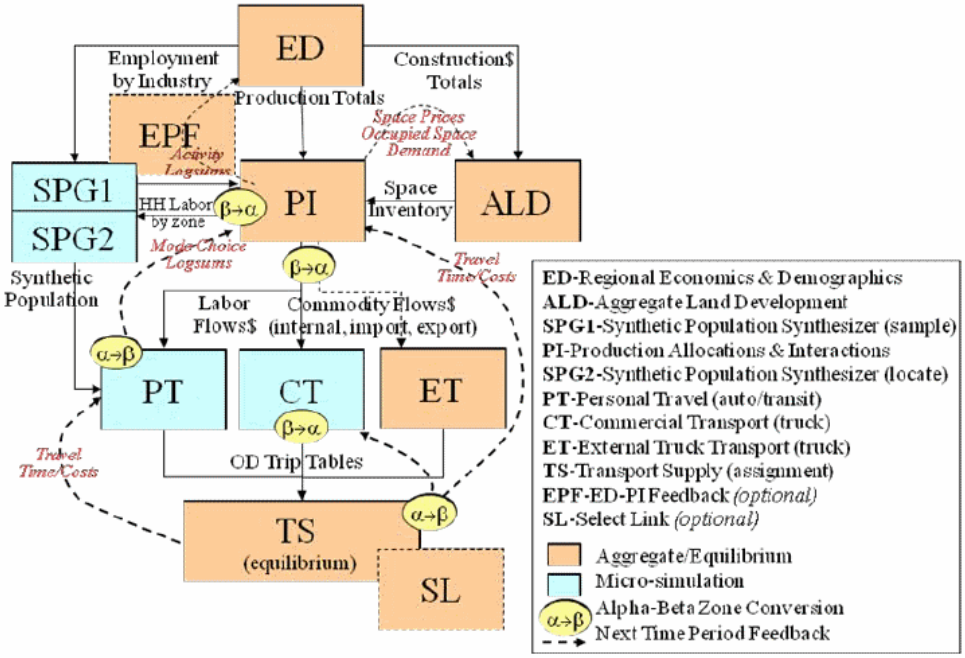
The PECAS system was actually developed to update the first version of the Oregon Statewide Integrated Model; and so resulted in the current version, Oregon SWIM2.

Another spatial modeling system called UrbanSim is often considered or discussed as an alternative to the PECAS based approach. While conceptually somewhat different, both frameworks, when realized in an operational model, can provide substantial support for various policy analyses and research.

The UrbanSim framework is also available for planners and modelers. Development efforts for this analytical framework are managed as an open-source software effort; current information is available at UrbanSim.org (http://www.urbansim.org/Main/WebHome).

The figure below, taken from the Modeling Report for SWIM2[97], easily conveys the complicated structure and relationships among the modules that comprise the Oregon SWIM2 model.

Figure 1.1. Modules and Flows in the Oregon Statewide Integrated Model (SWIM2)



[97]Found at: http://library.state.or.us/repository/2009/200903171503092/index.pdf.

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Oregon SWIM2 Modules[98] Briefly Explained

A somewhat simplified explanation of the majority of this model is presented in the following paragraphs.

Central to SWIM2 and to all of the PECAS type models is the idea that Regional Economics and Demographics (the ED Module) will describe overall Employment needs, Production/Economic Output levels, and new Construction requirements. Some of the economic information may be exogenously specified, based upon a third party source of regional economic data.

The Aggregate Land Development (ALD Module) begins to resolve these construction needs, modifying the Space Inventory of the region.

Balancing the needs of businesses to consume Space Inventory for facilities needed to support their Production Totals is the task central to the Productions Allocations and Interactions (PI Module) process; generating expectations about total Employment Levels in each production zone or area.

With the information on employment levels, and exogenously specified population characteristics, the Synthetic Population Generator Modules (SPG1 and SPG2 Modules) generate a realistic appearing sample population and locate that population within residential areas. In the Oregon SWIM2 model, the SPG1/SPG2 modules are implemented as a micro-simulation, which reportedly entails creating an individual record for each member of the synthetic population.

After the synthetic population is generated, the next stage of the integrated model is to generate local Personal Travel (PT Module) and Commercial Travel (CT Module) activity for this population. This is also identified as a micro-simulation.

In addition to the local travel demand, the SWIM2 model also generates long-distance freight travel through the External Traffic (ET Module). In the current version of SWIM2, this travel demand model is identified as an aggregate model, not a micro-simulation.

Given the local Personal travel, local Commercial travel, and long-distance Truck/Freight travel, the final major element of the Oregon SWIM2 is Travel Supply (TS Module) assignment. The current travel

[98] This discussion is based largely on a report of the Oregon DOT: Parsons Brinckerhoff, HBA Specto Incorporated, and EcoNorthwest, *Oregon Statewide Integrated Model (SWIM2)* (Salem, OR: Oregon Department of Transportation, 2010), http://www.oregon.gov/ODOT/TD/TPAU/docs/References/SWIM2.pdf

assignment procedure used to assign the local travel has been identified as similar to that used in EMME/2.

In addition to these standard modules, SWIM2 in the figure above is shown with two optional modules. One of these, the EPF Module is an optional feedback process between the ED and PI Modules. There has already been some consideration for integrating that feedback process directly within the respective modules.

The other optional module, the Select Link (SL Module) is described as an alternate network assignment process, using some of the EMME/3 capabilities, that builds travel assignments more compatible with other modeling efforts in the state and with other MPO models.

Recent Reviews of Integrated Models

Whether the models are based on some of the older integrated modeling approaches such as DRAM-EMPAL or TRANUS, or the newer modeling approaches such as PECAS or UrbanSim, certain criticisms of this modeling approach are frequently encountered, and similar strengths recognized.

At a regional level, Integrated Models seem well suited to support long-distance freight policy studies and alternatives evaluation. At a larger long distance travel scale, often a roughly state-wide or even a multi-state level, certain criticisms based on geographic zone limitations and problems in creating small zone macroeconomic models disappear and may not be at all relevant. For these long distance models, relevant historical data is available at suitable geographic levels, and appears analytically tractable.

Conversely, the most basic criticism is that these integrated modeling approaches are not of great value for evaluation of small-area efforts, such as typical of transit oriented development. This was one of the criticisms mentioned in a 2007 comparison of PECAS and UrbanSim based Integrated Models for the Southern California Association of Governments (Fehr & Peers, 2007). This review is also available online as a clearinghouse resource in the land use topic area in the FHWA Travel Model Improvement Program website (http://tmip.fhwa.dot.gov/resources/clearinghouse/docs/landuse/ilutm/ilutm.pdf).

Similar concerns were made recently made when both the PECAS-based frameworks and the UrbanSim based models were considered as possible approaches for small area transit analyses. This report to the Federal Transit Administration concluded that the geographic scale at which integrated models generally operated was too large to be able to consider small areas impacts, such as encountered in transit oriented development efforts. (Cambridge Systematics, 2009)

Summary

Despite the daunting data, methodological, and implementation issues often accompanying the task, a number of states and MPOs have been developing and continue to evolve Integrated Models that combine transportation, economics, and land use modeling components. Integrated models can be useful planning agency tools. But this type of modeling approach or system is not a tool for quick analysis, nor are they easily used in the consideration of multiple scenarios and options.

Integrated Models have proven themselves valuable in a number of analyses – e.g. statewide freight studies - that are often at a much larger scale than that of many urban projects such as transit oriented development efforts. These models have been developed to answer questions about complex interplays between transportation services, land use, population and economic activity across large areas. It also seems likely that measurement and assessment of the social value or consumer surplus associated with small scale transportation projects will not be based upon spatial versions of classical regional economic models. For example, the area within ¼ mile of a transit stop only encompasses about 125 acres of land; even at a ½ mile radius the area is just above 500 acres. Most economic modeling and data analysis has focused on county and more recently some zip code based analysis areas. Thus the data and scale of analysis presents implementation and analysis problems at the individual urban project level.

References Mentioned

Deriving Economic Development Benefits of Transit Projects from Integrated Land Use Transportation Models - Review of Models Currently Used in the U.S. and Recommendations; Final Report prepared for Federal Transit Administration, Office of Planning and Environment; Prepared by Cambridge Systematics, Inc. with Dr. John Gliebe, April 8, 2009 www.camsys.com

An Assessment of Integrated Land Use/Transportation Models; Prepared for: Southern California Association of Governments; Prepared by: Fehr & Peers, 15707 Rockfield Boulevard, Irvine, CA 92618, June 17, 20007

SWIM2 Reference:

Oregon Statewide Integrated Model (SWIM2) Model Description, Draft Report version 2.5; Submitted to the Oregon Department of Transportation by Parsons Brinckerhoff, HBA Specto Incorporated, EcoNorthwest; November 2010 (Downloaded from: http://www.oregon.gov/ODOT/TD/TP/docs/Statewide/SWIM2.pdf?ga=t)

REMI TranSight

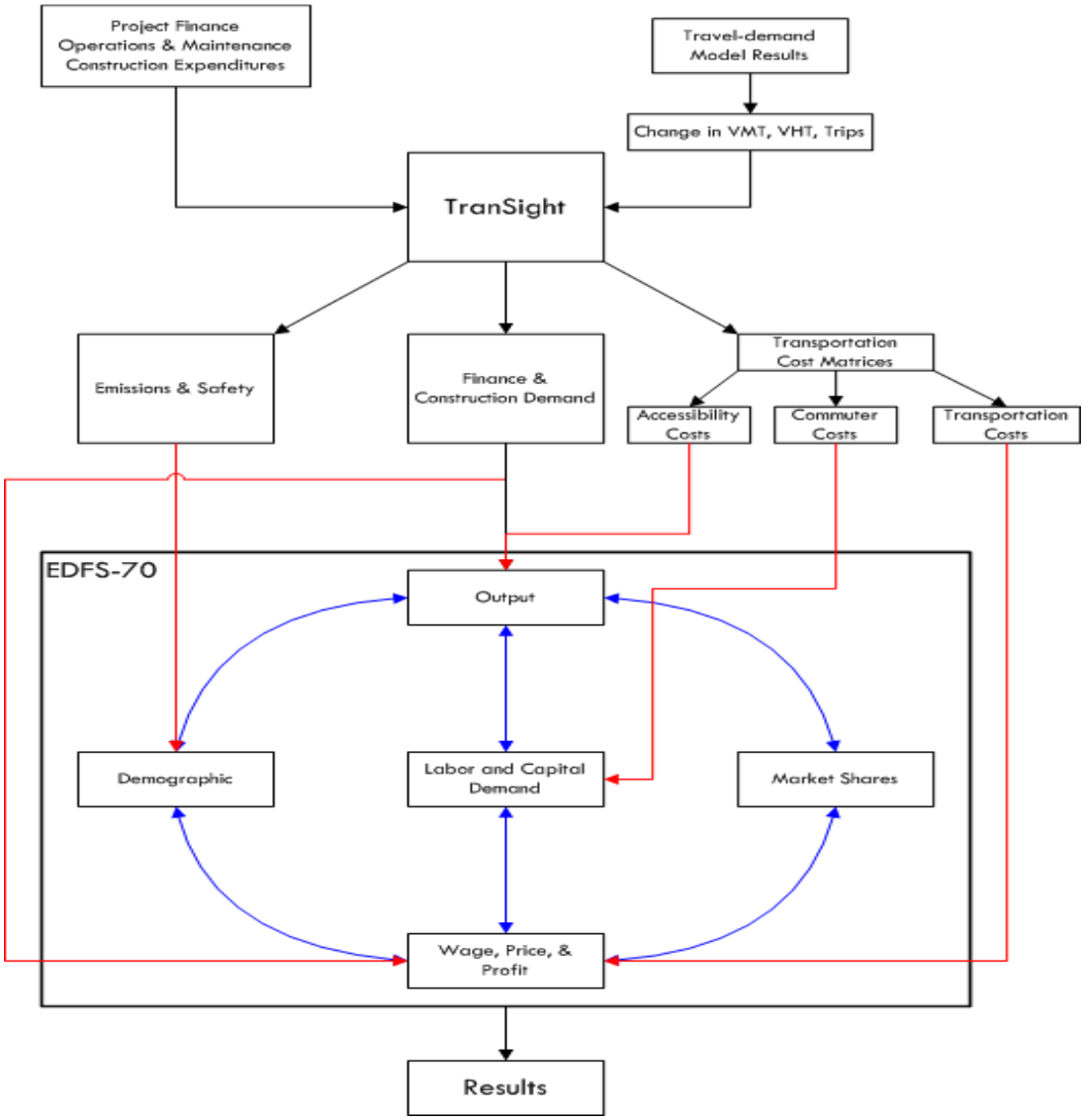
Regional Economic Models Inc. (REMI) is a public policy economic modeling software firm, whose products are in use in a number of states, including state DOTs. REMI Policy Insight is used to analyze regional economic impacts of policy change, such as the impacts of climate change regulations on energy prices and the wider economy. TranSight is a newer model from REMI that focuses specifically on transportation. TranSight allows the use of outputs from transportation demand modeling, such as vehicle miles traveled or vehicle hours traveled, as well as transportation project parameters including cost to estimate the economic impact of projects.

REMI TranSight's transportation-specific economic impact modeling uses the transportation model and project parameters to estimate impacts of changes in travel on emissions and accidents; shifts in fuel expenditures, related gasoline tax impacts, and other transportation expenses; as well as changes in commute time and access. Project costs for construction, operation, and maintenance are provided by the modeler along with any revenue, such as toll income. REMI's regional economic model then uses all of these elements to estimate impacts including employment, gross regional product, wages, and migration against the control of a state, national, international model forecast.

TranSight Structure and Module Functions

The primary difference between REMI TranSight and the other policy modeling tools offered by REMI is the ability to plug in factors from a travel demand model. Figure 1.2 is a diagram of how the transportation factors work within the REMI modeling system. A brief discussion of the model components is provided here, with more information available on the REMI website.

Figure 1.2. REMI TranSight Overview[99]



Changes in **travel demand** are input from the user's transportation demand model in the form of vehicle miles traveled, vehicle hours traveled, and trips and are used in TranSight in the following ways:

1. **Emissions** are calculated based on travel time and distance using standard emissions modeling and cost factors for five pollutants associated with fossil fuel vehicle travel. The health impacts of the emissions are also examined.
2. **Safety** impacts are calculated based on data about accidents rates per miles traveled and the cost impacts of accidents. Accidents that result in fatality, injury, and property damage are each calculated separately.

[99] Regional Economic Models Inc, "Introduction to TranSight, Session 1: Structure and Methodologies," (Amherst, MA, 2008)

3. **Transportation costs** are calculated from travel demand in three ways: accessibility costs—which include changes in connectivity to products and services by households and businesses; travel costs for commuters; and transportation costs for cargo and services.

TranSight Economic Modeling

TranSight feeds the transportation cost data into REMI's Policy Insight economic model. There are five general elements to that model as shown in Figure 2:

1. **Output** includes, "[O]utput, demand, consumption, investment, government spending, import, commodity access, and export concepts."[100] The model includes intra-regional, inter-regional, and international output changes. TranSight's model of finance and construction costs, as well as accessibility costs are factored into these calculations.
2. **Labor and Capital Demand** is modeled by industry and occupation and includes the impact of changes in commuting costs to the available labor pool for employers, as well as supply and demand impacts of other flows in the model that impact labor productivity, intensity, and capital.
3. **Demographic** elements of the model include, "Population data…age, gender, and ethnic category, with birth and survival rates for each group."[101] These elements feed into the labor supply portion of the model. The demographic and labor portion of the model also incorporates the entrance and exist of workers into the workforce as they age. It also looks at migration—whether inter-regional or international labor migration in responses to labor force and compensation changes.
4. The **Market Shares** element allocates supply and demand changes to industries based on factors that include production cost, demand elasticity, price, accessibility, and production.
5. **Wage, Price, and Profit** are modeled in terms of, "Delivered prices, production costs, equipment cost, the consumption deflator, consumer prices, the price of housing, and the compensation equation. Economic geography concepts account for the productivity and price effects of access to specialized labor, goods, and services."[102]

The REMI models are generally used at the geographic scale of analysis of the county, multi-county, or state level. REMI can provide clients with data at a smaller geographic level than county, but that needs to be requested by the client and will be an additional cost. Transportation data, often input by the user agency, also would need to be at the smaller geographic scale. To date, analysis at the county or state level is the standard in use at the DOTs. This limits the applicability of the models to larger scale projects or rural projects with benefits/impacts clearly discernible at a county, multi-county level, or state level rather than to metropolitan projects where the direct impacts would be sub-regional and often sub-county. For project level impacts, data at a finer level of geography is needed and has generally not been available or not an option selected by the states when acquiring the Regional Economic Models, whether REMI or other providers.

[100] Regional Economic Models, Inc., *Resources: Technical*, Accessed May 9, 2012, http://www.remi.com/resources/technical
[101] Regional Economic Models, Inc., *Resources: Technical*, Accessed May 9, 2012, http://www.remi.com/resources/technical
[102] Regional Economic Models, Inc., *Resources: Technical*, Accessed May 9, 2012, http://www.remi.com/resources/technical

2. TREDIS- Transportation Economic Development Impact System

TREDIS, the Transportation Economic Development Impact System (http://tredis.com), is an analysis and evaluation software system that can provide both benefit-cost and economic impact assessments for transportation system investments. TREDIS systematizes the calculation of benefit-cost and economic impact measures. It combines economic modeling with the relevant economic benefit and impact calculations, and generates summarizations that can meet various benefit-cost and economic analysis requirements for transportation investment reviews.

TREDIS Structure and Module Functions

Significant effort has gone into maintaining this system and updating its capabilities to reflect generally accepted best practices in transportation project economic analysis as they evolve.

TREDIS has a modular structure, as is shown in figure 1.3 below.

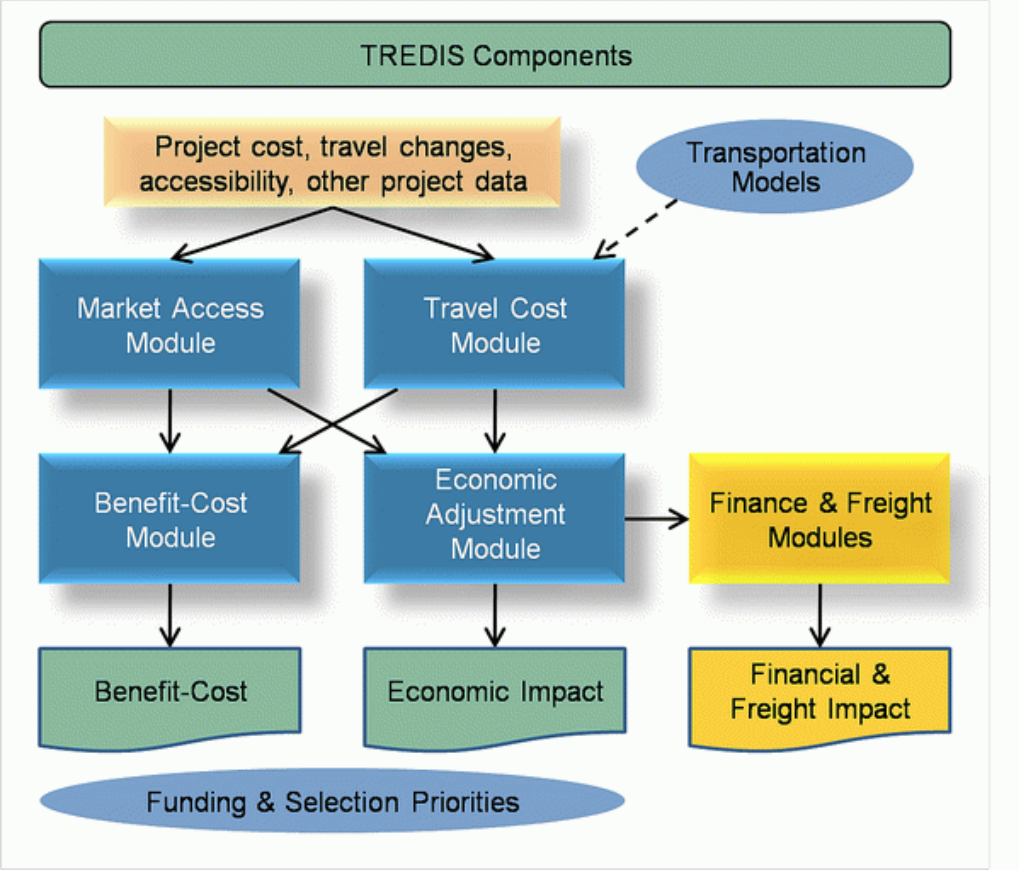


Figure 1.3. TREDIS Model. Source: TREDIS Software Group, "Modules and Structure," accessed January 24, 2012, http://tredis.com/product-info/modules-and-structure/

A brief review of this structure and module functions is useful; while a more detailed explanation can be found on the TREDIS website (http://www.tredis.com).

First, users of the TREDIS system supply relevant project and transportation model results. This information is then processed by a Travel Cost Module, a Market Access Module (at the option of the user), a Benefit-Cost Module, Economic Adjustment Module. A Finance extension, and Freight analysis module are provided with the basic package but may be used at the option of the user.

Usually both a baseline and one or more projects must be specified for any comparative economic analysis. The individual modules generally perform the following functions.

The **Travel Cost Module** calculates the monetary estimates for changes in travel time, travel cost, and accident rates. It can optionally calculate reliability, operating costs, tolls and fares, congestion, and air quality impacts.

The **Market Access Module** is designed to account for types of agglomeration and scale impacts; these are often of importance to larger projects and not usually a concern of smaller efforts, particularly those outside an urban area, with the exception of improvements to freight connectivity.

The **Economic Adjustment Module** uses a regional economic model to estimate short-term and long-term economic value changes expected from the project versus baseline forecasts. There is a default regional economic model supplied with the system, or other models can be integrated with TREDIS, as preferred.

The **Benefit-Cost Module** aggregates and organizes information from the Travel Cost Module and the Economic Adjustment Module to calculate economic benefit and economic impact measures.

Initial transportation data requirements are flexible, and a wide variety of travel model data sources can be used with TREDIS, from simple sketch planning tools through the more complicated activity based models.

TREDIS Economic Modeling, Market Access, and Small Area Projects

TREDIS currently includes a specialized economic impact model referred to as the Dynamic Response, Multi-Regional macroeconomic impact forecasting system as part of the Economic Adjustment Module. According to the software creators, "[T]his incorporates elements of Moody's Analytics® economy.com forecasting and IMPLAN® trade flows within a broader econometric framework."[103] And it is possible to substitute other regional models, such as those based on BEA RIMS II, or REMI. [104]

The use of these types of economic models could be seen as major limitation of this tool for some project analyses. This is because input/output based economic models are aggregate models, and until recently had limited geographic resolution – generally the lowest level of geographic coverage is the county level. Concerns with this issue resulted in the software developer providing economic data at the zipcode level.

[103] TREDIS Software Group, "Economic Adjustment Module," accessed January 24, 2012, http://tredis.com/product-info/modules-and-structure/economic-adjustment-module.html
[104] TREDIS Software Group, "Economic Adjustment Module," accessed January 24, 2012, http://tredis.com/product-info/modules-and-structure/economic-adjustment-module.html

As currently described, the TREDIS system considers accessibility primarily from the business or producer viewpoint. The optional Market Access Module provides in part what might be called a standard producer focused assessment of the impact of changes in accessibility. Value is ascribed to larger market areas, a larger labor pool, and the like. These are standard elements of such an analysis.

Some 36 state DOTs are reported on the TREDIS website as having used TREDIS in one or more applications as of March 2012. Of the nine state DOTs interviewed for this report, three were using TREDIS for one or more planning tasks, and reporting good results. Staff at other DOTs, who had reviewed the software and chosen not to use it, expressed concern over the lack of clarity of model inputs and analytical methods. Wisconsin DOT has both TREDIS and REMI; the economist in charge of the analysis tends to use REMI as part of a customized analysis that includes agency interviews with industry and other analytical tools.

As with other tools and models, there are instances where TREDIS outputs may need to be supplemented with other information and analytical results. For example, in discerning where economic benefit may be shifts in economic activity, rather than new jobs or development. (See Chapter VIII for discussion.) TREDIS does account for these shifts at the scale of analysis, which has generally been County or larger. Care and consideration also are needed in order to insure against double counting of either travel benefits or economic impacts.

Despite some potential shortfalls in terms of comprehensive economic analysis, TREDIS and REMI TranSight are proprietary tools that address many of the pertinent issues. As with Wisconsin's use of REMI, the combination of these models with good planning judgment and other data and tools provides a strong basis for a comprehensive economic analysis that considers the full range of economic impacts – from transportation conditions to cost benefit to regional and local effects.

Appendix E. Washington State Freight Measure Analysis Matrix – Draft October, 2011

Washington State Freight Mobility Plan
Global Gateway Technical Team Freight Benefit Evaluation Results **October 3, 2011**

Benefits		Means of Measurement/Variables of Potential Consideration	Consistency with State Criteria	Consistency with Federal Criteria	Importance to Freight System Users	Importance to Public	Direct Correlation to the State's Economic Vitality	Total five evaluation criteria	Number of Response
	Rank*		Rate of Importance*	Rate of Importance	Rate of Importance	Rate of Importance	Rate of Importance	Total Rate of Importance*	
Reduction In Cost	1	Truck freight corridor average travel time and variance	0.836	0.836	0.950	0.680	0.855	0.836	11
	2	Time to/from(Modal Connectivity) intermodal facilities to highway and other intermodal facility	0.800	0.782	0.933	0.720	0.891	0.829	12
	15	US/Canada border crossing time	0.527	0.618	0.767	0.480	0.618	0.607	12
	3	Truck Company Operating Costs: Reduction in fuel	0.740	0.760	0.927	0.733	0.840	0.804	11
	3	Total travel delay on truck freight corridors	0.764	0.764	0.967	0.640	0.855	0.804	12
	4	Time to/from(Modal Connectivity): Marine terminal/port	0.800	0.782	0.900	0.540	0.873	0.785	12
	5	Time to/from(Modal Connectivity): Intermodal facility:	0.782	0.782	0.883	0.500	0.836	0.764	12
	6	Value of Time: Trucking company cost ($/mile)	0.700	0.680	0.945	0.511	0.840	0.744	11
	7	Value of Time: Driver productivity	0.720	0.720	0.891	0.511	0.780	0.732	11
	8	Velocity/average speed of freight per ton	0.680	0.700	0.818	0.556	0.780	0.712	11
	9	Value of Time: Trucking company cost ($/hr)	0.640	0.620	0.909	0.467	0.840	0.704	11
	10	Port or other intermodal facility turn time	0.636	0.655	0.900	0.480	0.800	0.702	11
	11	Idle time (truck engine running) on truck freight corridors	0.655	0.655	0.817	0.660	0.673	0.695	12
	12	Time to/from(Modal Connectivity): Closest airport with air freight service	0.691	0.636	0.833	0.480	0.782	0.691	12
	13	Time to/from(Modal Connectivity): Intermodal facility: barge/truck	0.700	0.700	0.782	0.467	0.760	0.688	11
	14	Truck Company Operating Costs: Vehicle maintenance costs	0.580	0.580	0.891	0.467	0.720	0.656	11
Improved Travel Time Reliability	1	95th percentile travel times: how bad delay will be on specific routes during the heaviest traffic days.	0.711	0.689	0.840	0.571	0.756	0.723	10
	2	Planning Time Index: total traveler time allotted to ensure on-time arrival	0.625	0.625	0.800	0.575	0.733	0.679	10
	3	Buffer index: extra time that travelers must add to their average travel time when planning trips to ensure on-time	0.620	0.600	0.818	0.578	0.740	0.676	11
	4	Decreased speed variability by hour and day	0.640	0.620	0.764	0.578	0.700	0.664	11
	5	Correlating speed variances with average speed	0.575	0.575	0.720	0.500	0.667	0.614	10
	1	Reduced Truck-related Incidents: On highways	0.756	0.825	0.844	0.850	0.675	0.790	9
	2	Reduced Truck-related Incidents: fatalities and severe injuries	0.733	0.775	0.844	0.850	0.700	0.781	9
	4	Reduced Truck-related Incidents: At grade crossings	0.711	0.750	0.844	0.825	0.650	0.757	9
		Reduced Truck-related Incidents: on corridors							

Safety	3	Reduced Truck-related Incidents: Involving trucks and pedestrians/bicycles	0.711	0.775	0.822	0.825	0.675	0.762	9
	5	Reduced Truck-related Incidents: Per Vehicle Mile Traveled (VMT)	0.711	0.750	0.822	0.775	0.625	0.738	9
	6	Reduced Truck-related Incidents: At intersections	0.689	0.675	0.844	0.825	0.650	0.738	9
	7	Reduced Truck-related Incidents: Change in insurance costs	0.600	0.550	0.822	0.700	0.700	0.676	9
Economic Vitality	1	Productivity Measures: Volume of imports and exports through ports (air, rail, marine, and border)	0.756	0.778	0.900	0.622	0.925	0.796	10
	2	Productivity Measures: Volume of freight through Washington State	0.800	0.711	0.860	0.622	0.925	0.782	10
	3	Improves job creation and expansion: Number of long-term jobs created or preserved	0.733	0.711	0.756	0.844	0.850	0.777	9
	15	Industrial Land Preservation: Total zoned industrial acres-provides access to industrial land-acreage served by truck	0.625	0.600	0.800	0.600	0.767	0.674	8
	4	Comparative Advantages for Washington State Transportation Companies: Travel time velocity and reliability compared to other ports	0.733	0.622	0.920	0.578	0.943	0.755	10
	5	Productivity Measures: Tax revenue generated by freight-dependent businesses	0.711	0.689	0.667	0.733	0.850	0.727	9
	5	Improves job creation and expansion: Average wage of jobs	0.680	0.680	0.680	0.800	0.800	0.727	10
	6	Improves job creation and expansion: Number of transportation and warehousing jobs	0.660	0.640	0.760	0.760	0.778	0.718	10
	7	Productivity Measures: Volume of discretionary cargo through ports	0.711	0.644	0.840	0.556	0.825	0.716	10
	8	Industrial Land Preservation: Acres with close access to major ports &/or interstate highways	0.733	0.600	0.844	0.600	0.771	0.707	9
	9	Comparative Advantages for Washington State Transportation Companies: Evidence of port efficiencies	0.660	0.620	0.855	0.560	0.850	0.706	11
	10	Productivity Measures: Delivery time (2-hr ring around urban core)	0.667	0.578	0.820	0.622	0.775	0.693	10
	11	Improves job creation and expansion: In high-unemployment area	0.689	0.644	0.667	0.689	0.775	0.691	9
	12	Improves job creation and expansion: Number of manufacturing or other high-wage jobs not requiring advanced degrees	0.660	0.620	0.640	0.780	0.756	0.690	10
	13	Comparative Advantages for Washington State Transportation Companies: Evidence of 'Green' logistics through WA ports	0.711	0.622	0.667	0.756	0.686	0.688	9
	14	Improves job creation and expansion: Time from urban	0.689	0.644	0.778	0.622	0.700	0.686	9
	16	Improves job creation and expansion: In high-poverty area	0.689	0.622	0.644	0.667	0.725	0.668	9
	17	Productivity Measures: Change in regional GDP related to imports and exports	0.667	0.600	0.711	0.578	0.750	0.659	9
	18	Productivity Measures: Value of imports and exports at border crossings and ports	0.622	0.644	0.667	0.556	0.775	0.650	9

	19	Improves job creation and expansion: Number of short-term jobs	0.556	0.556	0.644	0.711	0.675	0.627	9
	20	Productivity Measures: Value of goods delivered per day	0.556	0.556	0.733	0.467	0.725	0.605	9
Environmental Impacts	3	Total Decreases Vehicle Emissions (PM2.5, NOx, CO2, Diesel PM, Black carbon, Other GHG Emissions)	0.662	0.662	0.617	0.796	0.561	0.663	52
	1	Water quality	0.711	0.733	0.644	0.844	0.625	0.714	9
	2	Total Disease Risk/rate (Cancer, Cardiovascular disease, Asthma)	0.659	0.644	0.659	0.815	0.550	0.668	27
	4	Noise	0.600	0.578	0.600	0.822	0.550	0.632	9
Resiliency		Improves resiliency of the freight system (ability to restore service quickly after a disruption)	0.800	0.780	0.891	0.860	0.889	0.844	11
Other Benefits	1	Household affordability	0.600	0.550	0.578	0.822	0.750	0.662	9
	2	Improves land use efficiency/Smart growth	0.644	0.600	0.644	0.689	0.625	0.641	9
	3	Improves emergency evacuation network	0.660	0.560	0.600	0.700	0.578	0.620	10
	3	Improves disaster preparedness	0.620	0.580	0.620	0.700	0.578	0.620	10
	4	Preserves historic district	0.550	0.525	0.422	0.622	0.425	0.510	9

Description

Rank: Benefits/mesures are ranked by "total rate of importance".

Rate of Importance: It is calculated by dividing the ratings from all respondents by total maximum possible ratings.

Total maximum possible rating: If respondent rates the benefit between 1 ~ 5 without leaving it blank or indicating "Don't know", then the maximum possible rating to this criterion is 5, otherwise is 0. The total maximum possible value is the sum of the maximum possible ratings from all respondents.

Total rate of Importance: For each proposed benefit, the total rate of importance is calculated by dividing total ratings of all 5 evaluation criteria by total maximum possible ratings of all 5 criteria.

Color code:

Highlighted is the priority list of freight benefits decided by the technical team.

Washington State Freight Mobility Plan
Urban Goods Movement Technical Team Freight Benefit Evaluation Results
October 3, 2011

Benefits		Means of Measurement/Variables of Potential Consideration	Consistency with State Criteria	Consistency with Federal Criteria	Importance to Freight System Users	Importance to Public	Direct Correlation to the State's Economic Vitality	Total five evaluation criteria	Number of Response	Comments from SDOT
	Rank*		Rate of Importance	Rate of Importance	Rate of Importance	Rate of Importance	Rate of Importance	Total Rate of Importance*		
Reduction In Cost	1	Truck freight corridor average travel time	0.700	0.733	0.767	0.567	0.700	0.693	6	
	2	Total travel delay on truck freight corridors (including arterials)	0.700	0.667	0.771	0.633	0.667	0.690	7	
	3	Time to/from(Modal Connectivity): Closest airport with air freight service	0.640	0.680	0.767	0.560	0.600	0.654	6	
	4	Time to/from(Modal Connectivity): Interstate highway	0.650	0.650	0.700	0.600	0.650	0.650	4	
	6	Time to/from(Modal Connectivity): Marine terminal/port	0.640	0.680	0.720	0.520	0.640	0.640	5	
	7	Time to/from(Modal Connectivity): Intermodal facility: rail/truck	0.600	0.650	0.650	0.500	0.600	0.600	4	
	7	Time to/from(Modal Connectivity): Intermodal facility: barge/truck	0.600	0.650	0.650	0.500	0.600	0.600	4	
	5	Truck Company Operating Costs: Reduction in fuel consumption	0.680	0.680	0.700	0.640	0.520	0.646	6	
	7	Port or other intermodal facility turn time	0.680	0.560	0.680	0.400	0.680	0.600	5	
	8	Idle time (truck engine running) on truck freight corridors	0.633	0.567	0.686	0.533	0.533	0.594	7	
	9	Value of Time: Driver productivity	0.600	0.600	0.700	0.300	0.600	0.587	4	
	10	Value of Time: Trucking company cost ($/mile)	0.600	0.600	0.680	0.350	0.640	0.582	5	
	11	Value of Time: Trucking company cost ($/hr)	0.600	0.600	0.760	0.350	0.550	0.581	5	
	12	Time in security screening processes	0.500	0.500	0.600	0.350	0.467	0.490	5	
	13	Truck Company Operating Costs: Vehicle maintenance costs	0.440	0.440	0.633	0.320	0.440	0.462	6	
	14	Velocity/average speed of freight per ton	0.450	0.450	0.500	0.400	0.400	0.440	4	
Improved Travel Time	1	95th percentile travel times: how bad delay will be on specific routes during the heaviest traffic days.	0.680	0.720	0.767	0.640	0.560	0.677	6	*Suggest metric of on-time reliability be used.*
	3	Decreased speed variability by hour and day	0.680	0.720	0.733	0.400	0.633	0.646	6	*Use 95th percentile factor to measure.*
	2	Buffer index: extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival.	0.600	0.600	0.800	0.720	0.560	0.662	6	*Too variable*

Travel Time Reliability	4	Planning Time Index: total traveler time allotted to ensure on-time arrival	0.480	0.480	0.633	0.520	0.520	0.531	6	*Same issue as buffer index*
	5	Correlating speed variances with average speed	0.450	0.450	0.520	0.350	0.400	0.438	5	
		Freight related congestion on local streets outside of ports								*Addresses all last mile needs*
		Ability to maintain or increase system capability for transporting over-dimensional vehicles and cargo								*Over-dimensional not included in metrics*
Safety	1	Reduced Truck-related Accidents: In severity	0.767	0.733	0.686	0.700	0.467	0.671	7	
	2	Reduced Truck-related Accidents: At intersections	0.733	0.700	0.657	0.733	0.486	0.656	7	
	3	Reduced Truck-related Accidents:	0.733	0.700	0.657	0.667	0.500	0.652	7	
	3	Reduced Truck-related Accidents: Involving trucks and pedestrians/bicycles	0.733	0.667	0.629	0.767	0.467	0.652	7	
	4	Reduced Truck-related Accidents: On highways (and arterials)	0.733	0.700	0.600	0.700	0.500	0.645	7	*Add arterials*
	5	Reduced Truck-related Accidents: At grade crossings	0.733	0.700	0.600	0.700	0.467	0.639	7	
	6	Reduced Truck-related Accidents: Change in insurance costs	0.520	0.480	0.600	0.560	0.400	0.515	6	*Not within WSDOT control*
	1	Industrial Land Preservation: Acres with close access to major ports &/or interstate highways	0.867	0.800	0.867	0.533	0.800	0.773	3	
	1	Industrial Land Preservation: Total zoned industrial acres	0.867	0.867	0.800	0.600	0.733	0.773	3	
	2	Productivity Measures: Volume of freight through Washington State	0.767	0.767	0.800	0.567	0.700	0.723	7	
	3	Productivity Measures: Volume of imports and exports through ports and border	0.700	0.700	0.767	0.500	0.767	0.687	6	
	4	Improves job creation and expansion: Time from urban freight hub (downtown, port, etc) to regional destinations	0.680	0.720	0.760	0.560	0.640	0.672	5	
	8	Improves job creation, retention and expansion: Number of long-term jobs	0.640	0.640	0.560	0.680	0.720	0.648	5	*Highly variable over time*
	5	Productivity Measures: Change in regional GDP related to imports and exports	0.700	0.650	0.750	0.550	0.650	0.660	4	
	6	Productivity Measures: Delivery time (2-hr ring around urban core)	0.650	0.650	0.760	0.600	0.600	0.657	5	
	7	Productivity Measures: Value of goods delivered per day	0.650	0.650	0.750	0.550	0.650	0.650	4	
	7	Productivity Measures: Volume of discretionary cargo through ports and borders	0.650	0.650	0.750	0.450	0.750	0.650	4	
	9	Improves job creation and expansion: Number of transportation and warehousing jobs	0.640	0.640	0.680	0.600	0.680	0.648	5	*Not total jobs benefits*
	10	Improves job creation and expansion: Average wage of jobs	0.600	0.600	0.450	0.600	0.700	0.590	4	*Highly variable over time*

Economic Vitality	11	Comparative Advantages for Washington State Transportation Companies: Evidence of 'Green' logistics through WA ports	0.600	0.600	0.480	0.680	0.480	0.568	5	*Explain what "Green" means. How is it measured?*
	11	Comparative Advantages for Washington State Transportation Companies: Evidence of port efficiencies	0.600	0.600	0.600	0.440	0.600	0.568	5	
	12	Comparative Advantages for Washington State Transportation Companies: Travel time velocity and reliability compared to other ports	0.567	0.567	0.700	0.400	0.600	0.567	6	
	13	Productivity Measures: Tax revenue generated by freight-dependent businesses	0.550	0.500	0.500	0.600	0.650	0.560	4	
	14	Productivity Measures: Value of imports and exports at border crossings and ports	0.550	0.500	0.500	0.450	0.550	0.510	4	
	15	Improves job creation and expansion: In high-poverty area	0.560	0.600	0.280	0.560	0.520	0.504	5	*Replace with distressed areas*
	16	Improves job creation and expansion: Number of manufacturing or other high-wage jobs not requiring advanced degrees	0.500	0.500	0.500	0.500	0.500	0.500	4	*Highly variable over time*
	17	Improves job creation and expansion: In high-unemployment area *(Replace with - In distressed areas)*	0.520	0.560	0.280	0.520	0.480	0.472	5	*Replace with distressed areas*
	18	Improves job creation and expansion: Number of short-term jobs *(Replace with - Number of jobs*	0.440	0.440	0.360	0.480	0.480	0.440	5	*Highly variable over time*
		Number of jobs retained or created In distressed areas								*Consistent with Fed regs*
		Improved processing at border crossings								*Broader potential benefit*
		Serves designated MICs or industrial/employment centers								*Consistent with GMA*
Environmental Impacts	1	Total Decreased Vehicle Emissions (PM2.5, NOx, CO2, Diesel PM, Black carbon, Other GHG Emissions)	0.900	0.900	0.500	0.800	0.500	0.720	36	
	2	Total Disease Risk/rate (Cancer, Cardiovascular disease, Asthma) (Replace with - Health Impacts)	0.829	0.840	0.507	0.880	0.480	0.705	15	
	3	Water quality	0.771	0.771	0.400	0.829	0.600	0.674	7	
	4	Noise	0.743	0.771	0.400	0.800	0.600	0.663	7	
		Improves land use efficiency/Smart growth (moved from Other)								
Resiliency		Improves resiliency of the freight system (ability to restore service quickly after a disruption)	0.700	0.700	0.800	0.700	0.667	0.716	7	
		Improves emergency evacuation network (moved from Other)								

		Improves disaster preparedness (moved from Other)								
Other Benefits	1	Improves emergency evacuation network	0.700	0.700	0.550	0.600	0.500	0.610	4	
	2	Improves disaster preparedness	0.680	0.680	0.560	0.560	0.520	0.600	5	
	3	Improves land use efficiency/Smart growth	0.650	0.650	0.400	0.600	0.550	0.570	4	
	4	Household affordability	0.450	0.450	0.400	0.700	0.550	0.510	4	*Subsumed in smart growth*
	4	Preserves historic district	0.550	0.550	0.400	0.550	0.500	0.510	4	*Subsumed in smart growth*

Description

Rank: Benefits/mesures are ranked by "total rate of importance".
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Total maximum possible rating: If respondent rates the benefit between 1 ~ 5 without leaving it blank or indicating "Don't know", then the maximum possible rating to this criterion is 5, otherwise is 0. The total maximum possible value is the sum of the maximum possible ratings from all respondents.

Total rate of Importance: For each proposed benefit, the total rate of importance is calculated by dividing total ratings of all 5 evaluation criteria by total maximum possible ratings of all 5 criteria.

Color code:

Highlighted is the priority list of freight benefits decided by the technical team.

SDOT comments. SDOT also suggested add a new evaluation criterion--"Importance to Freight Customers"

Washington State Freight Mobility Plan

Rural Economies Technical Team Freight System Benefit Evaluation Results **October 3, 2011**

Benefits		Means of Measurement/Variables of Potential Consideration	Consistency with State Criteria	Consistency with Federal Criteria	Importance to Freight System Users	Importance to Public	Direct Correlation to the State's Economic Vitality	Total five evaluation criteria	Number of Response
	Rank*		Rate of Importance*	Rate of Importance	Rate of Importance	Rate of Importance	Rate of Importance	Total Rate of Importance*	
Reduction In Cost	1	Time to/from Interstate & Four-Lane Highway (Ag. Processing Centers, distribution centers and Intermodal Centers)	0.943	0.943	0.956	0.625	0.850	0.862	9
	2	Port or other intermodal facility turn time	0.800	0.829	1.000	0.450	0.900	0.800	9
	2	Truck freight corridor average travel time	0.829	0.829	0.933	0.575	0.825	0.800	9
	4	Time to/from(Modal Connectivity): Highway to Marine terminal/port	0.857	0.857	0.933	0.500	0.800	0.790	9
	5	Total travel delay on truck freight corridors	0.767	0.733	0.975	0.629	0.800	0.788	8
	6	Time to/from(Modal Connectivity): Intermodal facility: rail/truck	0.857	0.857	0.844	0.500	0.775	0.764	9
	7	Truck Company Operating Costs: Reduction in fuel consumption	0.714	0.857	0.900	0.575	0.700	0.747	8
	7	Time in security screening processes	0.800	0.833	0.825	0.543	0.743	0.747	8
	9	Value of Time: Trucking company cost ($/mile)	0.657	0.686	0.971	0.543	0.771	0.726	7
	10	Value of Time: Trucking company cost ($/hr)	0.657	0.686	0.971	0.514	0.771	0.720	7
	11	Time to/from(Modal Connectivity): Intermodal facility: barge/truck	0.800	0.800	0.778	0.450	0.775	0.718	9
	12	Value of Time: Driver productivity	0.657	0.686	0.971	0.514	0.657	0.697	7
	13	Idle time (truck engine running) on truck freight corridors	0.667	0.767	0.857	0.629	0.500	0.688	7
	14	Time to/from(Modal Connectivity): Closest airport with air freight service	0.686	0.686	0.733	0.350	0.650	0.621	9
	15	Velocity/average speed of freight per ton	0.533	0.533	0.800	0.433	0.667	0.600	7
	16	Truck Company Operating Costs: Vehicle maintenance costs	0.486	0.600	0.900	0.375	0.525	0.579	8
Improved Travel Time Reliability	2	Buffer index: extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival.	0.767	0.567	0.800	0.829	0.733	0.744	7
	1	Planning Time Index: total traveler time allotted to ensure on-time arrival	0.733	0.567	0.829	0.857	0.767	0.756	7
	3	95th percentile travel times: how bad delay will be on specific routes during the heaviest traffic days.	0.733	0.600	0.833	0.733	0.633	0.707	6
	4	Decreased speed variability by hour and day	0.700	0.500	0.800	0.657	0.633	0.663	7

	5	Correlating speed variances with average speed	0.640	0.533	0.767	0.567	0.633	0.628	6
Safety	1	Reduced Truck-related Incidents: At intersections (severity and freq.)	0.857	0.857	0.911	0.956	0.689	0.854	9
	2	Reduced Truck-related Incidents: On highways (severity and freq.)	0.886	0.829	0.911	0.933	0.689	0.849	9
	3	Reduced Truck-related Incidents: In severity	0.867	0.833	0.971	0.971	0.600	0.848	7
	4	Reduced Truck-related Incidents: At grade crossings	0.857	0.857	0.867	0.911	0.644	0.824	9
	5	Reduced Truck-related Incidents: Per Vehicle Mile Traveled (VMT)	0.829	0.829	0.889	0.900	0.600	0.810	9
	6	Reduced Truck-related Incidents: Involving trucks and pedestrians/bicycles	0.714	0.714	0.750	0.875	0.500	0.711	8
	7	Reduced Truck-related Incidents: Change in insurance costs	0.600	0.600	0.857	0.714	0.571	0.673	7
Economic Vitality	4	Improves job creation and expansion: Number of long-term jobs and wages	0.667	0.700	0.700	0.900	0.833	0.760	6
	5	Industrial/Commercial Land Access and Availability: Acres with close access to major ports &/or interstate highways	0.771	0.771	0.825	0.625	0.750	0.747	8
	1	Improves job creation and expansion: Time from urban freight hub (downtown, port, etc) to regional destinations	0.800	0.767	0.933	0.700	0.800	0.800	6
	2	Comparative Advantages for Washington State Transportation Companies: Travel time velocity and reliability compared to other ports	0.800	0.829	0.933	0.500	0.822	0.780	9
	3	Comparative Advantages for Washington State Transportation Companies: Evidence of port efficiencies	0.771	0.867	0.867	0.571	0.800	0.779	9
	6	Productivity Measures: Volume of imports and exports through ports	0.714	0.767	0.850	0.575	0.800	0.741	8
	7	Productivity Measures: Change in regional GDP related to imports and exports	0.767	0.867	0.600	0.550	0.844	0.719	9
	8	Productivity Measures: Delivery time (2-hr ring around urban core)	0.700	0.720	0.900	0.567	0.667	0.710	6
	9	Improves job creation and expansion: Average wage of jobs	0.600	0.700	0.600	0.867	0.767	0.707	6
	11	Improves job creation and expansion: Number of transportation and warehousing jobs	0.567	0.600	0.700	0.833	0.700	0.680	6
	13	Productivity Measures: Volume of freight through Washington State	0.686	0.767	0.700	0.525	0.725	0.676	8
	14	Improves job creation and expansion: In high-unemployment area	0.533	0.700	0.500	0.833	0.700	0.653	6
	15	Improves job creation and expansion: Number of manufacturing or other high-wage jobs not requiring advanced degrees	0.533	0.600	0.500	0.867	0.733	0.647	6

	16	Productivity Measures: Volume of discretionary cargo through ports	0.600	0.750	0.686	0.467	0.714	0.643	7
	17	Improves job creation and expansion: In high-poverty area	0.533	0.700	0.500	0.767	0.700	0.640	6
	18	Productivity Measures: Value of imports and exports at border crossings and ports	0.629	0.686	0.600	0.450	0.750	0.621	8
	19	Comparative Advantages for Washington State Transportation Companies: Evidence of 'Green' logistics through WA ports	0.657	0.743	0.500	0.600	0.575	0.610	9
	20	Industrial Land Preservation: Total zoned industrial acres	0.600	0.600	0.600	0.550	0.600	0.589	8
	21	Improves job creation and expansion: Number of short-term jobs	0.467	0.467	0.533	0.667	0.533	0.533	6
Environmental Impacts	3	Total Decreases vehicle emissions (per unit of freight moved)	0.582	0.667	0.505	0.617	0.481	0.568	48
	1	Noise	0.667	0.733	0.571	0.800	0.525	0.657	8
	2	Water quality	0.633	0.733	0.567	0.725	0.550	0.641	8
	4	Total Disease Risk/rate	0.522	0.556	0.400	0.667	0.387	0.510	18
Resiliency		Improves resiliency of the freight system (ability to restore service quickly after a disruption)	0.833	0.800	0.943	0.886	0.829	0.861	7
Other Benefits	1	Improves disaster preparedness	0.714	0.771	0.725	0.800	0.800	0.764	9
	2	Improves emergency evacuation network	0.714	0.771	0.725	0.778	0.775	0.754	9
	3	Improves land use efficiency/Smart growth	0.714	0.743	0.450	0.675	0.600	0.632	8
	4	Household affordability	0.486	0.686	0.429	0.800	0.640	0.606	7
	5	Preserves historic district	0.543	0.600	0.400	0.600	0.486	0.524	8

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