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16. Abstract In February 2010, The Texas Department of Transportation (TxDOT) contracted with the Center for Transportation Research (CTR) at The University of Texas at Austin, the Texas Transportation Institute (TTI), and The Center for Multidisciplinary Research in Transportation (TechMRT) at Texas Tech University, to assist TxDOT in developing a Strategic Research Program (SRP). This report documents the work conducted from September 2010 to August 2011. The scope of the proposed SRP is to prepare TxDOT for the transportation challenges likely to be faced in the next 10–30 years. The SRP complements the current technical research program by addressing transportation issues that the State Legislature and TxDOT Administration foresee affecting the efficiency and viability of the statewide transportation system. Research recommendations could require legislative action and/or internal departmental adjustments.		
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Chapter 1. Introduction

1.1 Background

In late 2009, the Texas Department of Transportation (TxDOT) proposed the development of a Strategic Research Program (SRP) to prepare the department for the transportation challenges likely to be faced in the next 10–30 years. TxDOT invited representatives from three university transportation research centers in the state—the Texas Transportation Institute (TTI) at Texas A&M University, the Center for Transportation Research (CTR) at The University of Texas at Austin, and The Center for Multidisciplinary Research in Transportation (TechMRT) at Texas Tech University—to assist in developing the elements of the SRP and outline its procedures. This report documents the results of the work conducted by the three institutions in Fiscal Year 2011.

The scope of the proposed SRP is to complement the current technical research program by addressing longer-term and broader transportation issues that the state legislature and TxDOT Administration foresee affecting the efficiency and viability of the statewide transportation system. The intent is that it should examine challenges and opportunities presented by social and economic trends, transportation funding, energy resources, likely changes in the natural environment, and technological advancements, among others. It is envisioned that products would differ from standard research reports in that they would be more concise and audience-friendly, and would be disseminated in forms more appropriate to newer technologies. Research recommendations could require legislative action and/or internal departmental adjustments.

1.2 Research Work Plan

The following tasks were conducted by the research team, which was led by CTR.

1.2.1 Task 1: Makeup and Role of Oversight Panel/Advisory Committee (TTI)

In this task, researchers developed a proposed plan for an oversight panel, ultimately named the **SRP Advisory Committee**. The primary product of this task was a set of matrices of criteria for selection and, where possible, identification of specific individuals who might meet those criteria. The research team had no contact with anyone other than TxDOT about committee membership. A secondary product was a set of scenarios for alternative committee roles. The research team developed a document to lay out the role and expectations of committee members, so that TxDOT, or the Texas Transportation Commission, could agree upon the assignment, and allow invitation letters to provide the individuals a clear picture of their possible assignment. This task was led by TTI.

Subtask 1.1. Committee Membership: Researchers identified alternatives for membership on the committee, including the stakeholders groups from which members could be selected and an approximate number of members to be selected. A key factor in committee membership was the expected audience of the research products. It was assumed that one important role of the committee will be to validate and support the research to key stakeholder groups, so the members could be chosen with that role in mind. As an initial step in the subtask, the research team

interviewed TxDOT Administration and others as directed, to assure that TxDOT's intent for the committee is reflected in the membership.

Selection criteria were based upon the backgrounds that committee members are expected to bring to the committee, which included the following:

- Private sector executives who are users of the multimodal Texas transportation system and have experience with what-if scenarios in their own businesses.
- Private sector finance or international business experts.
- Technical experts with a broad base of transportation knowledge in one or more fields such as mobility, safety, economics, or demographics.
- Public or private sector individuals of national standing and credibility in the transportation field.

It was also recommended that the group should represent both urban and rural interests as well as general geographic areas of the state. Twenty-five names that responded to those characteristics were provided for consideration. Background information on each of the individuals was provided as well as contact information. It was recommended that the initial committee consist of five to seven individuals, with the opportunity for that committee to expand based on the experience of the committee as it evolves.

Subtask 1.2. Committee Institutional Issues: In this subtask researchers examined the potential term and rotation schedule of committee members. It was recommended that after an initial two-year start-up term, committee members would serve staggered terms, with the decision on that to be made as the committee naturally evolved.

Subtask 1.3. Committee Role Delineation: The research team identified alternative roles for committee interaction with the research projects and the support necessary for each role. For example, one alternative explored was full committee involvement with each project, such that the committee becomes the owners and proponents of the research findings. This role would be similar to that played by the Texas 2030 Committee, but would be time- and effort-intensive for both the committee and the research teams.

On the other end of the involvement spectrum is a role wherein committee members are designated as a liaison to a particular research project and become highly familiar with that project. In this scenario the committee members could see more meaningful involvement, which could inspire more interest in service in the group. Also considered was that the committee members may have personal staff with specialized expertise that could benefit projects underway and involve them as well in project liaison. This member role would be less time- and effort-intensive than the first alternative for the majority of members.

As prelude to the recommendations, the researchers examined other similar panels nationally and identified the potential roles and processes used.

Subtask 1.4. Committee Activities Determination: Researchers in this subtask fully described the expected committee member activities for performance of duties as envisioned by TxDOT and informed by work in previous subtasks. Proposed committee activities called for the group to guide the direction of the research program presented annually to the Commission, including anticipated research benefits and results. The committee would be responsible for identifying the universities or organizations that are to work on each of the selected research projects as well. Finally, researchers drafted a document summarizing the recommended activities that was included in a briefing of Commissioners and could be used to explain the program to potential members.

Subtask 1.5. Committee Support Requirements: In this subtask, the researchers considered travel and support requirements. However, the result was that no appropriate or allowable mechanisms were available to reimburse the committee members for expenses.

FY 2011: Work completed in the first year of the project was refined and concluded in FY 2011. All of those final actions are integrated into the task descriptions above, by task and subtask. TTI continued to lead efforts to support the Department and Commission in appointment of the Advisory Committee. Researchers met with Commission members and others as directed, to review ideal characteristics and background for the membership. TTI assisted Department staff by preparing background information on candidates and drafting a letter that could be used by the Department in requesting Committee participation. Throughout the year, TTI provided support as necessary for establishment of the Committee.

1.2.2 Task 2: Development of Alternative Project Management Approaches (TTI)

Because the new policy research program differs from the Department's established technical research program, researchers in this task provided an array of options for managing the planned work. This task was led by TTI.

Subtask 2.1. Identification of Program Management Scenarios: In this subtask, researchers identified alternative approaches used nationally to manage research programs, particularly policy research projects (e.g., TxDOT Research Management Committee (RMC) program, National Cooperative Highway Research Program (NCHRP), Texas 2030 Committee, other centers for policy research, etc.).

Subtask 2.2. Selection of Program Management Approach: Taking the information obtained in Subtask 2.1, researchers developed alternatives to reflect the committee roles determined in Task 1. Following a review of the alternatives by the appropriate TxDOT staff, a final recommended description of program management was developed, including a detailed implementation schedule. Researchers developed a schedule with the intent of initiating the first projects by September 1, 2010.

Subtask 2.3. Implementation Package for Program Management: In this task, based on the recommended role of the committee, the nuts and bolts of implementing that scenario were determined. Researchers provided the details for the day-to-day project management. The various entities' roles and timelines were outlined, as well as the format for appropriate forms or other mechanisms for program management.

FY 2011: TTI assisted RTI in the development of management guidelines for the program. Researchers were available to assist RTI, if requested, with the collection of qualifications materials from researchers at all of the targeted state universities. Department staff determined that additional qualifications materials would not be requested.

1.2.3 Task 3: Communicating Information (TechMRT)

This task, led by Texas Tech University, examined methods of internal communication for TxDOT's SRP, regarding the collection of information for research needs, calls for research briefs/white papers, problem statements and project proposals, and evaluation and award of problem statements and proposals.

The Texas Tech researchers examined a variety of internal/external communications models and selected a web-based model as the communications tool. The selection was largely a matter of economics, convenience, and control. A website can be built to store both public and secure information so it serves not only as a communication tool, but also an archiving tool.

During FY 2011, discussions with RTI and TxDOT Technology Services Division (TSD) about who should maintain the website beyond the contract period led to a decision that TSD would build and maintain a functioning website for RTI in support of the SRP, with the following capabilities:

1. A collaboration environment via web interface (i.e., similar to SharePoint™) for joint production of research briefs (RBs) and other related documents.
2. Static portion of website (older RBs). This "archive" is the knowledge warehouse.
3. An "I have an idea" structure for generating new strategic research leads in collaboration with CTR (lead) and TTI.
4. A discussion-board type environment for researchers and other authenticated users to have moderated discussions on a topic, as well as a comment period on RBs.

The prototype website (http://www.rtfmps.com/SRPhome/) was used by TSD for development of the actual SRP website. The use of a commercial server (.com address) was again a matter of convenience. The prototype website has elements of the four main functions, but it is not currently, nor intended to be, functional in the sense that the TSD version is. No future maintenance of the prototype is anticipated.

1.2.4 Task 4: Topic Identification Process (CTR)

The objectives of this task were twofold: (1) develop a preliminary set of broad initial themes to get the SRP launched, and (2) define procedures for acquiring, screening, and developing research topics. This task was led by CTR.

The researchers recommended the following themes for the SRP:
Theme 1: Demand—who will use transportation, where, and how.

A. Demographics: the composition and location of population, and required services.
B. Commuting: modes by which people will travel, routes, and volumes.

C. Freight: modes by which goods will move, routes, and volumes.

Theme 2: Organization—how the agency responsible for transportation will function.
A. Funding: how the transportation system is paid for.
B. Performance: how the agency provides required services to its customers.
C. Partnerships: how the agency works with others to achieve its goals.

Theme 3: Infrastructure—how the transportation network will be engineered and maintained.
A. Engineering: materials and methods for designing and constructing the system.
B. Maintenance: materials and methods for managing the condition of infrastructure.

Theme 4: Network—how system elements will connect and operate.
A. Integration: the efficiency of transportation elements in moving people and goods.
B. Safety: minimizing disruption, property damage, and loss of lives on the network.
C. Technology: using technology to protect the network and improve efficiency.

Theme 5: Environment—how transportation will interact with society and nature.
A. Ecology: minimizing impacts of transportation on natural resources.
B. Lifestyle: enhancing the quality of life, health, and prosperity.
C. Challenges: ability to respond to short- and long-term natural phenomena and other challenges.

Recommendations for gathering research ideas include linking to a suggestion box from TxDOT's website, monitoring national and international research forums, conducting webinars, and issuing annual calls for ideas.

It was recommended that as ideas are received they be categorized under one of the sub-themes above. Semi-annually, about 10–20 ideas should be selected and presented to the Advisory Committee for development into RBs. The RB should cover the following:

- What is already known (literature review).
- What current research is ongoing on the topic.
- What can be researched (scope of required research).
- Potential applications/benefits (implementability).

FY 2011: CTR assisted RTI, when requested, in reviewing and refining the program themes. CTR was also available to assist RTI, if requested, in refining procedures for soliciting ideas.

1.2.5 Task 5: Topic Selection Process (CTR)

The objective of this task was to lay out procedures for screening and ranking research topics/ideas. This task was led by CTR. The following definitions of sub-themes were recommended by the researchers and adopted by the project management committee (PMC).

Theme 1A: Demand/Demographics—the composition and location of population, and required services. Topics in this area deal with population changes over the next 50 years by

sub-groupings, e.g., age, economic status, lifestyle, etc. The objective is to make projections of where people will live and work in the state, and transportation needs associated with the activities they will engage in. Activities such as education, health care, employment, business, leisure, etc., would be linked to transportation planning.

Theme 1B: Demand/Commuting—modes by which people will travel, routes, and volumes. Topics in this area deal with commuting patterns, modes, and volumes. The objective is to develop scenarios for the demand for commuting in the future in terms of modes, routes, and volumes, and the evolution of the transportation system that would be necessary.

Theme 1C: Demand/Freight—modes by which goods will move, routes, and volumes. Topics in this area deal with freight patterns, modes, and volumes. The objective is to develop scenarios for commodity movements in the future in terms of modes, routes, and volumes, and required changes to the transportation system.

Theme 2A: Organization/Funding—how the transportation system is paid for. Topics in this area deal with the costs of providing a transportation system, and the best options for a reliable funding stream. The objective is to investigate alternative revenue and investment models, including those from other industries such as manufacturing, services, utilities, etc., and scope out feasible options for funding transportation in the future.

Theme 2B: Organization/Performance—how the agency provides required services to its customers. Topics in this area deal with performance measurement and staffing of the transportation agency. The objective is to define what the agency is supposed to produce, establish standards of quality, measure its performance, and communicate/implement feedback from users of the transportation system.

Theme 2C: Organization/Partnerships—how the agency works with others to achieve its goals. Topics in this area deal with collaborating with public and private entities to ensure that transportation planning meshes with the strategic plans of major statewide entities. The objective is to understand the strategic plans of public and private organizations, and gain their participation in transportation planning, funding, construction, and operations.

Theme 3A: Infrastructure/Engineering—materials and methods for designing and constructing the system. Topics in this area deal with technical aspects of engineering and constructing infrastructure economically. The objective is to examine and adopt materials and technologies that incorporate the best technical knowledge available for construction of transportation infrastructure.

Theme 3B: Infrastructure/Maintenance—materials and methods for managing the condition of infrastructure. Topics in this area deal with technical and economic aspects of maintaining infrastructure. The objective is to examine and adopt materials and technologies that incorporate the best technical knowledge available for life-cycle maintenance of transportation infrastructure.

Theme 4A: Network/Integration—the efficiency of transportation elements in moving people and goods. Topics in this area deal with the efficiency and competitiveness of transportation

modes and connections in moving goods and people. The objective is to regularly evaluate how each mode and connection is performing in terms of cost, throughput, and revenue, and to establish thresholds for expanding/retiring/replacing/re-pricing modes and connections.

Theme 4B: Network/Safety—minimizing disruption, property damage, and loss of lives on the network. Topics in this area deal with ensuring the safety and security of users of transportation. The objective is to examine and monitor damages and vulnerabilities due to accidents and deliberate acts, and develop and implement solutions to reduce risk and losses to users.

Theme 4C: Network/Technology—using technology to protect the network and improve operations. Topics in this area deal with researching and implementing technologies to increase network efficiency and robustness. The objective is to find and implement technological applications that improve user productivity, reduce delays, wring greater efficiencies out of existing infrastructure, and provide innovative solutions for moving goods and people.

Theme 5A: Environment/Ecology—minimizing impacts of transportation on natural resources. Topics in this area deal with interactions between transportation and the natural environment. The objective is to examine the effects of transportation on natural resources, and develop solutions to increase synergies.

Theme 5B: Environment/Lifestyle—enhancing the quality of living, health, and prosperity. Topics in this area deal with interactions between transportation and human activities. The objective is to explore the effects of transportation on human life (e.g., health, activities, economics), and develop transportation solutions that improve the quality of life.

Theme 5C: Environment/Challenges—ability to respond to short- and long-term natural phenomena and other challenges. Topics in this area deal with potential changes in climate, natural phenomena, and other challenges that could impact future transportation. The objective is to outline various scenarios and prepare contingency plans for continuing operations.

FY 2011: CTR was available to assist RTI, if requested, in sorting and ranking research ideas for presentation to the Advisory Committee.

1.2.6 Task 6: Develop "White Paper" Concept (TechMRT)

RBs (originally called "white papers") in the SRP are reports explaining a specific issue or policy. Each paper is a referenced document that explains research or presents arguments on a specific issue. Unlike typical governmental briefs (White Papers), the SRP white papers would not have the intent to persuade, but instead to cover the issues in a more complete yet succinct way, so that all sides of a topic are given full treatment. It might look at different tactics to handle a situation or problem and give evidence regarding the effectiveness of these plans, or it may simply sum up all of the previous arguments for a subject of importance.

The purpose of the RB in the SRP is to discuss broad issues facing Texas transportation over the next several decades. RBs will be used to explain the issues in layman's terms to legislators and stakeholders, and to present an unbiased "pro and con" look at the issues and possible

resolutions. RBs are an educational document similar to a problem statement, but broader in scope and more accessible to general readers.

The envisioned audience for these RBs is the state legislature, the Texas Transportation Commission, the general public, and the research community—principally in that order. The broad directive for the SRP was to develop knowledge to meet long-term legislative concerns regarding transportation in Texas.

A variety of models were examined for the RBs, and ultimately, the research team selected a hybrid of the Congressional Research Service (CRS) and *The Economist* magazine's special briefings as the type of document in terms of length and detail.

FY 2011: Texas Tech formalized the RB structure and published writing guidelines, referencing guidelines, and two example briefs. These materials are currently located online, as Figure 1.1 indicates. All the website activities are to be absorbed into the RTI website and managed by TSD. The URL is active but non-persistent, and will be disabled upon notification by RTI.

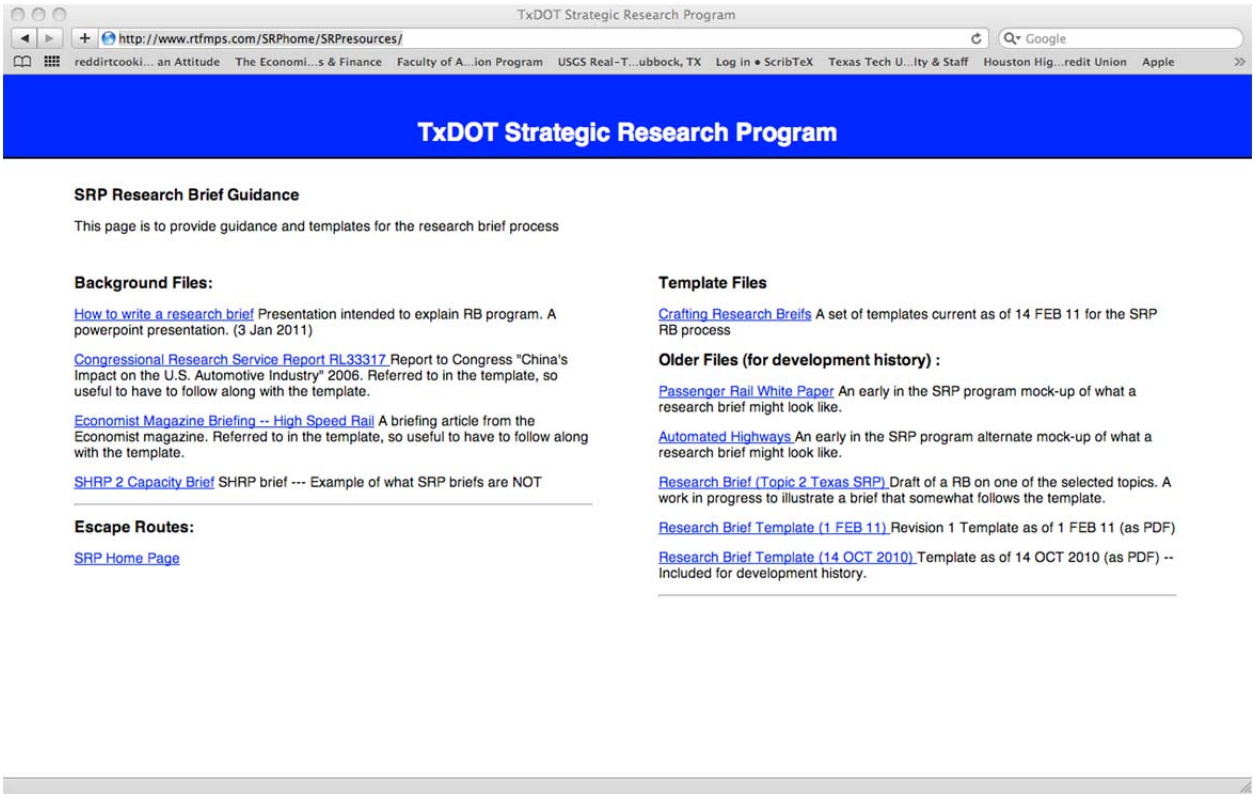

Figure 1.1: SRP research brief web page (http://www.rtfmps.com/SRPhome/SRPresources/

This web page has links to RB format guidelines and several examples to facilitate researchers writing briefs. One goal is that RB cover pages and reference pages have similar look-and-feel, and clearly indicate TxDOT ownership.

1.2.7 Task 7: Implement the Plan (CTR)

The objective of this task was to develop recommendations for implementing the SRP. This task was led by CTR.

The recommendations from each research task were organized into a logical series of steps. The requirements for implementing them (namely, resources, responsibilities, and timeline) were laid out in a work plan. The researchers worked with the designated parties to execute the plan and have the program up and running early in Fiscal Year 2011. As the research evolved, the research team documented changes to the procedures and other outputs, and the final results are included in the first year report (Research Report 0-6661-1).

1.2.8 Task 8: Development of Research Briefs (CTR/TTI/TechMRT)

FY 11: The objective of this task was to develop RBs. This task was conducted by the three universities. The topics were selected by the existing TxDOT PMC from among the 10 submitted under Task 4 plus others recommended by the PMC. The universities allocated the workload among qualified researchers in the three institutions, with the concurrence of the PMC. Following are the seven RBs selected for the first round of the SRP.

RB1. Theme: Demand\Commuting. [CTR] "What measures can *TxDOT and the State of Texas* take to reduce peak hour congestion and more efficiently use system capacity? What can TxDOT do to encourage flex hours, flex days, and telecommuting? Is pricing the answer?"
Wording of idea as submitted: "Looking into flexible work options. Most congestion is a result of mandatory 8–5 work hours. Flexible work options such as flex hours or telecommuting could reduce congestion and make the most of existing infrastructure. It is possible additional infrastructure may not be as necessary if these options are implemented on a broad basis."

RB2. Theme: Demand\Commuting. [TechMRT] "Examine *best worldwide practices* for mass transit and the conditions under which public transportation can play a larger role in reducing congestion in Texas."
Wording of idea as submitted: "We need to use Europe as a model to establish an infrastructure for mass transit that works for an ever increasing population. The single rider vehicle is just not viable now or in the future."

RB3. Theme: Demand\Freight. [CTR] "We need a comprehensive freight strategy that figures out the most efficient way to get products from source to consumer. Right now we have modes competing, with various levels of taxpayer subsidy. This is wasteful. Instead we should figure out a way to optimize supply chains, save some money, and invest it in increasing our freight capacity."
Wording of idea as submitted: "The following idea was discussed at the 2nd Annual Transportation Forum July 19–20, 2007, by Nathan Asplund (economist), General Director, PPP Burlington Northern Santa Fe RR. Background: since the Staggers Act of 1980 BNSF productivity has increased 100% while revenues have decreased by 10–15%. Rail currently spends 18% of revenue on capital expenditures (greater than many other industr[ies]). BNSF spent $1.5 B in 2002 and about $2.7 B in 2006 on infrastructure upgrades. Capital improvement costs still continue to increase even if the rail industry loses market share. Current trends suggest that rail will lose market share. Other modes of freight movement such as trucking and barges

pay less than their share for use of infrastructure. The trucking industry is BNSF largest customer—best value is long haul of truck trailers—trucking industry picks up and drops off. Currently rail bears investment risk; Senator Kent Conrad has proposed a 25% tax credit for rail capital improvements. Passenger rail or direct government subsidy isn't attractive based on studies we've conducted regarding rail in Eastern Europe and Russia. Strategic Research: To meet future US freight demands Rail needs to increase capacity—this means more track, facilities and support capacity. How can TxDOT work with Rail and Trucking industry to support increased freight capacity?" (Original wording)

RB4. Theme: Organization\Performance. [TechMRT/TTI] "Potential performance measures for TxDOT 20 years and beyond. External focus, but not the Missouri model."
Wording of idea as submitted: "Develop a new framework for organizational performance measures based on what users want of the transportation system, i.e., how is TxDOT doing in satisfying user needs."

RB5. Theme: Organization\Partnerships. [TTI] "Develop a partnership with the freight moving industry. Learn about their short- and long-term goals and the technologies that they plan (or want) to incorporate in 2015, 2020, and 2025. Understand how the transportation system can function as an economic engine. *Focus on the long term goals rather than technology.*"
Wording of idea as submitted: "Develop a partnership with the freight moving industry. Learn about their short- and long-term goals and the technologies that they plan (or want) to incorporate in 2015, 2020, and 2025. Understand how the transportation system can function as an economic engine."

RB6. Theme: Infrastructure\Maintenance. [CTR] "*Examine proper funding strategies and levels for maintenance of pavements and bridges in Texas—strategically allocated funds for pavement maintenance and rehabilitation.*"
Wording of idea as submitted: "Maximizing the use of existing infrastructure for reconstruction and added capacity projects. Currently, most reconstruction projects that result in added capacity involve removing the existing infrastructure and then replacing with new infrastructure. There is a need to encourage the incorporation of existing infrastructure in such projects. For example, pavements that are still structurally adequate can be used as base material in the reconstruction, or simply overlaid with concrete or asphalt materials. The potential cost savings can be significant (possibly up to 50% savings over the current strategy of removing and replacing)."

RB7. Theme: Network\Integration New. **[TTI]** "*Effect of proximity to an Interstate Highway on economic development of a region, and costs and benefits. Look at 3 areas of state, i.e., Pharr, College Station, and Lubbock.*"

The format and scope of the RBs were in accordance with the recommendations from Task 6. Researchers provided monthly updates to the PMC on progress, and attended meetings to present results. The seven RBs were submitted to RTI in April 2011 in preparation for presentation to the Advisory Committee when seated. The researchers were also available to produce additional RBs if requested.

After the RBs are reviewed by the Committee, it is anticipated that the Committee could elect to commission in-depth research projects under separate research contracts.

1.3 Organization of This Report

This chapter presented the background and justification for this research effort, and the research tasks. This report summarizes the outputs of the research effort.

Chapters 2–8 summarize the seven RBs developed in Fiscal Year 2011, respectively. Conclusions and recommendations are contained within each chapter.

Chapter 2. RB 1: Using Telework and Flexible Work Arrangements as a Congestion Mitigation Strategy

2.1 Introduction

This chapter summarizes Research Brief 1, "Using Telework and Flexible Work Arrangements as a Congestion Mitigation Strategy." Following is the scope of the brief: "What measures can *TxDOT and the State of Texas* take to reduce peak hour congestion and more efficiently use system capacity? What can TxDOT do to encourage flex hours, flex days, and telecommuting? Is pricing the answer?" This RB was led by CTR. The authors are John Brady, Jeff Loskorn, and Randy Machemehl.

2.2 Executive Summary

Congestion is one of the most noted frustrations of American citizens today. Urban Texan commuters alone experience an estimated 49 hours of congestion-related delay annually and congestion shows no sign of subsiding in the long run without substantial action. Not only does it affect quality of life and economic competitiveness, congestion can result in reducing travel demand or increasing system capacity or both. This brief demonstrates that in the current environment of austerity and sharp political tension, it is of critical importance to implement low cost, politically amicable strategies to manage congestion and better utilize system capacity.

2.2.1 Strategies

Devising a comprehensive plan to handle congestion raises important questions about the very nature of congestion as well as the sustainability and practicability of congestion mitigation strategies. This RB proposes that publicly promoted flextime, compressed work weeks, and telework (collectively called *flexible work arrangements* in this brief) can offer one of the most cost-effective, readily implementable congestion mitigation strategies available. Such programs have demonstrated success in the private sector and have been successfully repurposed by local departments of transportation to more efficiently utilize the existing transportation network, reduce overhead costs, and save energy.

HR Magazine, a leading academic journal for human resources professionals, describes flextime, compressed work weeks, and telework this way:

- Flextime is a work arrangement with time of arrival and departure that differs from the standard operating hours. For example, a typical flextime arrangement is arrival at 10:00 a.m. and departure at 7:00 p.m.
- A compressed work week allows full-time employees to work longer days for part of the week or pay period in exchange for shorter days or a day off during that same week or pay period.
- Telework, or telecommuting, allows an employee to work at home, on the road, or in a satellite location for all or part of their regular workweek.

Flexible work arrangements have been developed in the private sector as a cost-saving measure and as a reward for exceptional employees. Each program allows workers substantial flexibility

in their schedule by adopting new telework technologies or by simply modifying institutional rules. Studies show employees prefer flexibility in their schedules so they can be more productive, strike a better home-work balance, and avoid the costs and stresses associated with a peak hour commute. Employers promote non-traditional work arrangements when they make sense from a business standpoint; companies report reductions in overhead, energy, and paid overtime with non-traditional schedules.

2.2.2 Characteristics

The key difference between flexible work arrangements and other popular demand management strategies, such as tolling and license plate rationing, is that they can be voluntary and still affect the transportation network. The extent to which a program will produce noticeable benefits to the transportation network depends on three characteristics.

1. **How we measure and understand social tolerance for congestion.** We know that urban areas are growing and that demand for highway use exceeds capacity in a growing number of places. Drivers who travel on a severely congested freeway either see that facility as the only way of reaching their destination or find the social and real costs of using the facility do not outweigh the benefits. A voluntary congestion mitigation strategy has drivers eliminate or shift the time of their trip so that they have a lesser impact on the transportation network. The rate of adoption of flexible work arrangements is unlikely to outpace the growth of congestion, but they can still create measurable benefits to the transportation network. Currently, congestion is usually expressed in terms of cumulative cost or time lost—measures that are difficult to compare and are not necessarily representative of the impact on individual drivers. Successful programs choose to measure their success in number of cars removed from the road each week or day and look to expand that number over time.

2. **Participation standards yield higher participation rates**. Not all flexible work arrangements are created equal. Some will benefit employers more than others and it is important that employers find a program that works for them while being held to a standard of participation that will substantially benefit the transportation network. States can make funding or recognition contingent on continued, minimum participation.

3. **High-quality implementation support is extremely helpful to employers**. At a minimum, public agencies should provide employers and employees with guidelines, sample policies, and resources regarding flexible work options. The most-cited reason that flexible work arrangements are left unadopted is resistance by middle management and employees who fear the new schedule will not benefit their career path or job security. High-quality support, funded by state or federal grants, can provide reluctant businesses with human resource professionals who can guide the employer to a strategy that is beneficial for the business and the transportation network. While some employers, such as IBM, Dell, and the Abilene/Odessa Districts of TxDOT, decided internally to implement alternative work arrangements without any outside funding, their programs were championed by top-level management who sought cost reductions and improved employee productivity.

2.2.3 Recommendations

Based on the findings of this brief, the following are recommended:

- **Further research into the state of flexible work arrangements is not necessary**. The numerous studies by public agencies, private companies, and human resource professionals over the past 30 years have clearly determined the benefits, caveats, and best practices of flexible schedules.
- **Flexible work arrangements should be a part of TxDOT's demand management toolbox because of their high cost effectiveness.** Depending on the program, the cost of implementing a flexible work initiative comes at little to no cost relative to other demand management strategies. There are examples of large, successful demand management programs funded by state and national grants and spurred by increasing investment from the private sector. While flexible work arrangements alone are unlikely to provide sustainable congestion management, their effective implementation can postpone the need for expensive congestion management strategies.
- **TxDOT should take a leadership role in demand management** by coordinating with various public agencies in severely congested urban areas. Because TxDOT is not the only public agency responsible for congestion mitigation, organizing comprehensive demand management strategies among all public agencies will be vital for a successful implementation program.

Chapter 3. RB 2: The Problem of Congestion and Mass Transit

3.1 Introduction

This chapter summarizes Research Brief 2, "The Problem of Congestion and Mass Transit." Following is the scope of the brief: "Examine *best worldwide practices* for mass transit and the conditions under which public transportation can play a larger role in reducing congestion in Texas." This RB was led by TechMRT. The authors are Hongchau Liu, Ted Cleveland, Phil Nash, and Wesley Kumfer.

3.2 Executive Summary

Congestion is a major problem throughout the United States. It not only afflicts highway systems but also halts traffic in urban areas. Congestion is also a serious problem throughout Texas, especially in the large metropolitan areas. To address this issue, multiple congestion mitigation practices are already used in Texas, including:

- Tolling
- High Occupancy Vehicle (HOV) lanes
- Mass-transit standards
- Light rail systems

However, many of the current methods of congestion mitigation have become inadequate, and TxDOT seeks to find new methods to alleviate congestion. Of particular interest are solutions using public transportation. This RB demonstrates the need for improved congestion mitigation practices, differentiates between different public transportation solutions, and highlights recommended solutions and actions that TxDOT should pursue. Adopting these techniques will be invaluable to contain the inevitable increase in congestion that will accompany an increased population 20 years in the future, as the population of Texas is expected to reach between 32 and 41 million in 2030 (Gaines, 2008).

3.2.1 Solutions

Although numerous factors are involved in the efficacy of mass transit, the research team has focused on four specific solutions that can be used to improve congestion conditions in Texas:

- Engineering
- Deployment strategies
- Policy
- New Technology

Each of these four areas contains numerous solutions that could be implemented to reduce congestion in Texas. The research team discussed the benefits and disadvantages of each of these particular areas, as well as those of individual, specific solutions, to ascertain the ease and scope of each of these solutions. Many of the solutions presented could be implemented in the near

future, whereas others may not be supported by current technology and infrastructure. Therefore, the team has recommended various research paths to explore each of these topics.

3.2.2 Recommendations

Mass transit systems can be used to solve the transportation dilemma in Texas. However, various aspects and conditions of these systems should be researched to allow the state to make use of the most effective engineering practices, deployment methods, policies, and new technologies. Possible research paths to follow in order to determine how best to improve mass transit and eliminate congestion are discussed below.

Engineering

Multiple research projects could be conducted to determine the efficacy of improving engineering practices for mass transit systems in Texas. These include investigating the ease of implementation of "Pass-Through" lanes, determining the environmental impacts of altering existing infrastructure, and locating funding sources for changing infrastructure. Improving engineering practices may be the easiest changes to mass transit for TxDOT to make in many circumstances, as it may require no more effort than retiming signals and providing passes to buses. Effective engineering changes could significantly reduce congestion in busy metropolitan areas with bus systems over the next few decades.

Deployment Methods

There are two possible research paths for improving deployment methodology. One project could be to investigate how TxDOT will deal with and enforce policy with local and municipal government agencies for regulations on deployment methods. A second project could be studying the economic impact of increasing or decreasing mass transit fleet sizes in urban cities such as Dallas and Houston.

Policy

Multiple research topics are involved in improving mass transit policies. One topic could be to investigate the economic impact of growth management systems on a developing community. A second topic could be to investigate how TxDOT and the state government could regulate growth management policies in developing areas, such as the Dallas/Fort Worth Metroplex. A final topic could be to investigate the ease of convincing the public to use transit mapping software.

Technology

New technologies likely represent the most extensive research projects that TxDOT could undertake. Among the possible topics that could be investigated are

- Ease of implementation for new technologies like straddling buses.
- Ease of implementation for installing and integrating GPS into public transit.
- Environmental impacts of new technologies.
- Cost of changing infrastructure to accommodate new technologies.

- Public acceptance of new systems such as straddling buses.
- Safety of implementing new technologies.

The topics could each be researched extensively, and some could even produce new research topics themselves. This category of strategic research is a very complicated topic and would need to be approached from multiple angles.

The research team recommends that TxDOT explore each of these fields in detail. Numerous data exist for several of these topics, although not all of them, so TxDOT should instead focus on the necessary changes to current technology and infrastructure. However, careful research into various topics, such as ease of implementation, cost, safety, environmental concerns, and relations with local governments should be made before any solution is applied. After careful research and planning, it is likely that TxDOT could use mass transit to improve commuting conditions for Texans. These policies could not only affect congestion levels in the immediate future but also in decades to come. New technologies, in particular, seem essential for improving congestion conditions. TxDOT should explore emerging technologies strategically and take advantage of them in order to implement them and mitigate congestion as quickly as possible.

Chapter 4. RB 3: Determining a Comprehensive Freight Strategy for Texas

4.1 Introduction

This chapter summarizes Research Brief 3, "Determining a Comprehensive Freight Strategy for Texas." Following is the scope of the brief: "We need a comprehensive freight strategy that figures out the most efficient way to get products from source to consumer. Right now we have modes competing, with various levels of taxpayer subsidy. This is wasteful. Instead we should figure out a way to optimize supply chains, save some money, and invest it in increasing our freight capacity." This RB was led by CTR. The authors are Jolanda Prozzi, Robert Harrison, Lisa Loftus-Otway, and Nathan Hutson.

4.2 Executive Summary

TxDOT's responsibility for the provision of state highway infrastructure has resulted in a comprehensive understanding of the design, maintenance, and rehabilitation of highways. In rail planning, freight is the central concern. In contrast, those responsible for highway planning have, for a variety of reasons, focused attention on auto flows, particularly in urban areas. When a transportation specialist was asked why more attention was not given to freight, the answer was "freight does not vote."

4.2.1 Freight and Economic Development

Economists have long agreed that freight and passenger transportation infrastructure is a necessary, but not sufficient, condition for economic development. This brief argues that it is now time to capture freight movements into comprehensive transportation planning, particularly the role played by highways that provide around 60% of the ton-miles moved within Texas. Freight moves on single or multimodal systems and is dynamic, responding to commodity and shipper characteristics and competitive forces within the supply chains moving freight from producer, often through intermediaries, to final consumer. The components of a comprehensive state freight plan would vary with the adopted time horizons, which at this time are unknown.

4.2.2 Recommendations

The team recommends consideration of three levels of freight studies based on timing and complexity. The first are short-term, small-scale studies that can focus on specific elements of the topic area that most critically impact TxDOT. Typically, these will be closely linked to recent TxDOT sponsored research where teams are still available to provide inputs and data. The second are studies that illuminate issues of growing concern during the period 2011 and 2025/30. The final group are those that will be game changers beyond 2030 and worthy of consideration now so that TxDOT can transition its long term mission and strategy efficiently. Specific topics for consideration follow:

1. *Create a vision for the Texas Freight Transportation Infrastructure of 2050 considering key drivers and given a multi-stakeholder dialogue.* A better understanding is needed of what will drive freight transportation systems decades from now, i.e., what commodities will be moved, how much will be moved, how will they be moved, and where will they be moved. Key drivers

of change that could impact the vision for Texas's freight transportation infrastructure include both macro and micro drivers. Macro drivers typically influence the volumes of goods moved and include drivers such as global economic growth, the political environment, and technological development. Micro drivers affect specific dimensions of freight transportation and include energy costs, environmental policies, supply chain structures, industry structures, and governance. Given various assumptions about how these drivers will interact to impact freight transportation under different scenarios will allow Texas to create an informed vision for the texas freight transportation infrastructure of the future.

2. The cost of transportation can have a substantial impact on the competitiveness of major export industries in Texas, whether these industries export to foreign countries or to one of the U.S. states. The price of transportation (i.e., the freight rate charged) is the cost of providing the transportation service, but the more generalized cost of transportation reflects the impacts of legislation (e.g., safety regulations at ports and airports), regulations, or policies, border crossing issues, unreliability in the transportation system, damage and pilfering en route, lengthy transit times, etc. *It is thus recommended that the role of transportation in the logistics chains of a sample of Texas's major industries be explored.* This study will examine a number of options for reducing the generalized costs of transportation in the logistics chains, relating to policies, transportation legislation and regulations, infrastructure, and new technologies that can be adopted to increase the efficiency of Texas's transportation system. These options have the potential to decrease transportation costs and enhance the competitiveness of Texas's major industries.

3. In Texas, freight movements have and are expected to continue to increase substantially due to sustained and anticipated economic and population growth combined with Texas's optimal location along critical trade corridors. The forecasts of freight demand included in this paper clearly demonstrate that freight transportation by all modes will continue to grow in Texas. Good freight planning will thus become critical to ensure that Texas's infrastructure can accommodate the estimated increases in freight demand. *It is thus recommended that a detailed freight plan be developed for Texas that includes the role of freight in serving large urban areas in the megaregions.*

4. A number of states have benefitted from engaging the private sector as stakeholders (i.e., Freight Advisory Committee/Stakeholder Working Group) when conducting statewide freight planning. The potential role of a Freight Advisory Committee/Stakeholder Working Group can be to (a) assist an agency in identifying freight transportation needs, (b) provide input on freight transportation policies and the development of freight performance measures, (c) assist in the identification of funding opportunities and partnerships between the public and private sectors, (d) assist in the prioritization of freight concerns, (e) communicate the importance of freight investments to the public, elected officials, and other public agencies, and (f) recommend freight research areas and needs. During a recently completed TxDOT research study, 35 companies and agencies expressed an interest in working with TxDOT in developing and implementing a Freight Stakeholder Working Group for Texas. It is thus recommended that *the mission, purpose, objectives, and mandate of a Texas Freight Stakeholder Working Group be explored during a meeting of interested freight stakeholders.*

5. A study to be undertaken using the truck operating cost model developed in Project 0-6974 and calibrated using contacts at H-E-B, Frito Lay, and PepsiCo to examine a series of heavy truck, truck-load (TL) operation demand curves for SH 130. These would estimate the breakeven toll fees for various levels of congestion on IH-35 and gather information on how information on congestion and accident data levels that would trigger an advantage in using SH 130 could be sent to the drivers using IH-35.

6. A one-year study to establish the bridge costs required to allow more productive trucks to use key interstate corridors in Texas. This would follow up on the final report of Project 0-6095 where the bridge costs were estimated from moment and fatigue based mechanisms using BRINSAP data. The team would examine each structure and determine the actual strengthening required. In other states, such field work reduces overall costs because not all bridges have to be replaced. These data would then form the base for calculating the marginal cost of the permits for heavier trucks and so meet the conditions of equity.

Chapter 5. RB 4: Strategic Directions for Performance Management in TxDOT: Customer Satisfaction as a Key Driver of Success

5.1 Introduction

This chapter summarizes Research Brief 4, "Strategic Directions for Performance Management in TxDOT: Customer Satisfaction as a Key Driver of Success. Following is the scope of the brief: "Potential performance measures for TxDOT 20 years and beyond. External focus, but not the Missouri model." The direction of the brief narrowed upon direction of the PMC liaison during the work. This RB was jointly led by TechMRT and TTI. The authors are Jennifer Farris of TTU and Tina Geiselbrecht of TTI.

5.2 Executive Summary

Performance Management (PM) can be used to provide increased understanding for both internal and external stakeholders regarding:

- Current performance versus goals.
- Areas of competitive advantage.
- Opportunities to improve performance.
- Priority of performance objectives among various stakeholders.
- Relationships between performance measures.
- Appropriate strategies for improving performance.

PM has undergone a significant shift in the last 20 years from primarily financially focused systems to holistic systems capable of identifying the interconnections between stakeholders' needs, financial performance, internal efficiency, and employee capabilities.

5.2.1 Performance Management Frameworks

Although many influential frameworks exist, perhaps the most widely adopted is the Balanced Scorecard (BSC), which has been cited as one of the top 15 management tools and is estimated to have been adopted by 70% of organizations worldwide. A similar framework was introduced in a report sponsored by the NCHRP (2010). The three categories at the far left of Figure 5.1, which represent key types of requirements impacting strategic planning and the development of an effective PM system, can be mapped to the BSC categories as follows:

- Customer – customer.
- Engineering – internal business process, and learning and growth.
- Fiscal – financial.

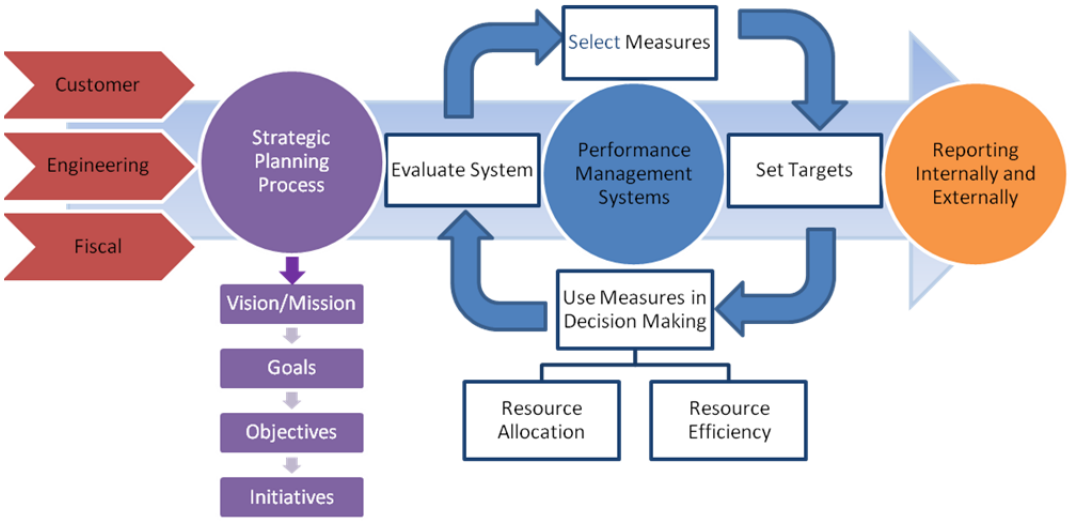

Figure 5.1: Performance management structure adapted from NCHRP report (2010)

It appears that TxDOT's current approach to PM encompasses each of the categories. TxDOT currently reports on a number of scientific and engineered measures, as well as other internal efficiency measures and legislated fiscal measures. These measures could, at least in theory, span all three categories in both BSC and NCHRP frameworks. However, analysis of the types of measures typically used within each element of the BSC and NCHRP frameworks, as well as the practices of other DOTs, is needed to identify opportunities for improvement in TxDOT's current PM system.

5.2.2 Focus on Customer Satisfaction

To effectively *manage* customer satisfaction, organizations must first be able to *measure* customer satisfaction. Customer satisfaction measures can be divided into types based on

- Type of data (qualitative or quantitative).
- Data collection method (interviews, focus groups, self-administered survey questionnaires, suggestion system drop boxes, or indirect [proxy] methods).

TxDOT is currently in the process of developing its customer satisfaction management program and the questions and subjects outlined in the brief may assist in its development.

5.2.3 Recommended System Changes

The majority of the PM system changes described in this brief focused on customer satisfaction measurement because it was identified as one of the key strategic areas most in need of additional development in TxDOT's current PM system. Despite the great amount of improvement that has been achieved in only a few short years, TxDOT's current PM system is still very young, and other, more specific areas may also present opportunities for further improvement, e.g., developing some metrics focused on employee satisfaction or capabilities within the internal performance dimension. We also recommend that TxDOT commit to a more detailed assessment and benchmarking study of its current PM system than this high-level strategic RB can provide. This assessment should include all organizational levels, including all

25 of the TxDOT districts and the central office. This will require a significant commitment of time and other resources from TxDOT personnel, as well as a partnership with a university, research institute, or external consulting agency.

We recommend that TxDOT seek to expand its current PM capabilities, while preserving its three current core performance measure categories—at least until a more detailed assessment is conducted—because these are aligned with the BSC and NCHRP frameworks. Based on a comparison of the BSC and NCHRP frameworks to TxDOT's existing system, one key avenue for additional development is the implementation of a formal customer satisfaction management program. A more detailed assessment of the entire PM system may reveal other key areas for improvement.

The brief identified specific questions to be addressed as TxDOT prepares to enhance its current PM program. Some questions refer to PM system design, while others refer to implementation. While there is an emphasis on those related to customer satisfaction management, additional questions are posed that relate to other facets of the overall PM program.

5.2.4 Benefits

A comprehensive customer satisfaction program can lead to substantial improvements in overall organization performance and credibility. To improve performance, however, managers must apply what they learn from customer satisfaction measurement activities to the decisions they make about a particular program. Furthermore, it is critical to communicate this information throughout the organization to help front-line employees make smart decisions when dealing with customers.

Careful consideration of the questions posed in the brief and others that may arise should prepare TxDOT to develop a comprehensive and robust plan to implement the needed changes to its current PM system. The benefits of such changes could be huge and are expected to far outweigh costs in the long term.

Chapter 6. RB 5: The Future of Texas Freight: Roles, Forces, and Policies

6.1 Introduction

This chapter summarizes Research Brief 5, "The Future of Texas Freight: Roles, Forces, and Policies." Following is the scope of the brief: "Develop a partnership with the freight moving industry. Learn about their short- and long-term goals and the technologies that they plan (or want) to incorporate in 2015, 2020, and 2025. Understand how the transportation system can function as an economic engine. *Focus on the long term goals rather than technology*." This RB was led by TTI. The authors are Stephen Roop, Jeffrey Warner, and Michael Yager.

6.2 Executive Summary

The transportation of freight is the life blood of the economy. Goods and materials flow in vast quantities from production sites to manufacturers and from manufacturers to customers in a highly complex, cost-minimizing system that has developed over many decades. This system has achieved high levels of efficiency and responsiveness that in turn have fueled economic growth in both domestic and international markets.

However, for all of the accomplishments of the modern freight transportation industry, real and significant problems are emerging that threaten to constrain trade and limit future economic development:

- Growing roadway congestion on a deteriorating highway infrastructure.
- Escalating fuel costs and a completely oil-dependent transportation sector.
- Safety concerns resulting from mixing freight and passenger transportation on highways.
- Air quality concerns.
- A capital- and capacity-constrained railroad system.
- Stagnant dredging activities in our nation's ports and waterways.
- Port congestion.
- Labor issues.
- Ever-increasing infrastructure maintenance costs.

6.2.1 The Texas Freight Landscape

Freight transportation is a private-sector undertaking with cost-minimization as a central goal. A clear understanding of the characteristics, motives, constraints, and goals of the goods movement industry is fundamental to developing a strategic approach for the public sector's critical facilitating role. The goods movement industry is highly competitive, profit oriented, and generally opposed to government regulations that restrict its operating freedom. Competitive advantage, once established, is fiercely guarded, and the closely held data that could help public-sector planning functions are either not collected or not disclosed.

Both the public-sector and private-sector freight transportation service providers are concerned with public and worker safety, but the private sector's focus is intensified by the potentially devastating economic consequences of negligent operating practices. Hence, risk management and insurance coverage are major issues along with the required compliance with safety regulations. Environmental regulation creates a similar contrast in point of view; the public sector seeks to protect the environment and its occupants, while the private-sector goods movement industry seeks beneficial regulation that does not adversely impact its bottom line.

The linkage between efficient and nimble freight transportation networks and a region's economic health becomes more obvious as freight performance measures deteriorate and commercial activity migrates to locations better suited to support goods movement. But the fact that logistics costs are passed along to the customer or consumer means that relative superiority in goods movement is more pertinent to freight transportation than absolute measures of efficiency. Strategically, from the state transportation planning perspective, this relativistic notion of beating the competition rather than the statistics should be at the heart of programs aimed at keeping Texas among the preferred commercial and business settings.

6.2.2 Recommendations/Solutions

The brief discusses several general and specific strategic solutions related to freight roles, forces, and policies:

- **Technology and Operations**
  Texas should conduct a forward-looking assessment of likely emerging technology and operational practices in response to changing logistic conditions. The result of this assessment should be used to understand how these trends could affect the public-sector role in providing and facilitating goods movement. It is equally important to understand that some, if not most, significant and transformative changes will not be well anticipated. In order to best respond, a statewide freight transportation steering committee could be established that can assist TxDOT in understanding the developments occurring in technology and operations and what pressures motivate these developments.

- **Macro-Level Decision Making**
  A corollary to the relativistic notion that being better than the competition is more meaningful, in practical terms, than being judged good by some absolute standard is that providing relatively superior infrastructure and relatively efficient network systems will attract users, induce economic growth, and foster prosperity. Thus, staying ahead of the competition (i.e., other states) is as important for Texas as it is for a freight transportation provider. Major, proactive decisions need to be made that enable economic development conditions to emerge.

- **Planning and Investment**
  The state needs to strategically address the intrinsic link between transportation efficiency and economic development. As a result, a freight advisory committee could be formed whose goal is to develop a closer and more efficient linkage to the Mexican economy and Canada. Mexico's proximity to Texas is among the most important geographical advantages for the state. While Texas is an east-west crossroads with important links to California and the East through New Orleans, it is the single state with

major access to the Mexican industrial heartland and in that capacity serves as the conduit to most of the Canadian business interests with Mexico.

The geo-political implications of this are enormous. By creating economic development in Mexico (rather than China), increased commercial relations with Mexico will:

- Stem the flow of money abroad.
- Create good jobs in Mexico and slow the rate of illegal immigration into the United States from Mexico and Central America.
- Reduce the cost of goods for U.S. consumers.
- Put Texas in the position to gain economic advantage and grow through mutually advantageous economic ties.

6.2.3 In Conclusion

A concluding set of thoughts should include the recognition that positioning Texas for future economic health and prosperity must include strategically conceived, planned, and executed steps that support the state's freight transportation networks and the efficient interaction of those networks. An expansive view of the goods movement industry should involve knowledge from far outside our borders and the recognition that global impacts are often fostered by very local actions. Working with other states to develop a more comprehensive vantage point relative to freight networks can help Texas build on its substantial geographical, business, and human resource advantages to become an increasingly important force in international trade and thereby ensure economic health and prosperity for future Texans.

Chapter 7. RB 6: An Integrated Approach to the Maintenance and Rehabilitation of Pavements and Bridges

7.1 Introduction

This chapter summarizes Research Brief 6, "An Integrated Approach to the Maintenance and Rehabilitation of Pavements and Bridges." Following is the scope of the brief: "Examine proper funding strategies and levels for maintenance of pavements and bridges in Texas—strategically allocated funds for pavement maintenance and rehabilitation." This RB was led by CTR. The authors are Zhanmin Zhang, Randy Machemehl, and Khali Persad.

7.2 Executive Summary

As demand continues to grow for Texas highways, the consumption rate of our roads increases, but with fewer dollars to maintain them. Not only do we risk losing a significant amount of our highways, but we are also putting Texans' lives at greater risk. In this brief, an integrated approach is proposed to find the proper funding strategy and level of existing infrastructure maintenance through the implementation of integrated systems, services, and projects.

7.2.1 Multi-Tier Service, Maintenance, and Fees

In the proposed approach, a multi-tier infrastructure system is established. Resources will be allocated among tiers according to their level of service and performance goals. Moreover, a usage fee-based public finance system is also included in the proposal.

Multi-Tier Systems. When resources are constrained, hard decisions must be made in terms of prioritizing elements of the road network. This process is usually accomplished by establishing the relative importance of the road links in the network, where the resources are tilted more toward the road group or tier that is deemed the most important. To conduct the multi-tier analysis, the first step is to define the tiers, using criteria such highway functional class, ADT, truck ADT, etc. A proposed three-tier system was initially selected for conducting the preliminary analysis.

The "Backbone" system is defined as corridors that are essential to the economy of Texas. Examples include IH-10 through the southern part of the state, and IH-20 from east of Dallas/Fort Worth to IH-10 southwest of Midland, along an extended IH-27 through western Texas. The level of service of the Backbone system will be defined as Premier, meaning that all measures (safety, efficiency, dependability, and comfort) should be fully satisfied. The Backup and Connection road systems are defined as supplements to the Backbone systems. The required level of services of those two systems is not as strict as that of the Backbone system.

Define the Level of Services and Performance Measures. The performance measures used in this proposal focus on a broad set of transportation goals, including safety, efficiency, dependability, and comfort. One means to support a performance-based level-of-service approach to infrastructure maintenance management is to establish a few overarching goals and identify supportive performance measures within each goal area that TxDOT could incorporate into its transportation planning process.

User Fees. This proposal suggests that user fees and user-fee-backed public finance be considered as potential solutions to ensure a dedicated revenue source for transportation infrastructure and to provide congestion relief through demand-based pricing. Direct user fees, or tolls, on the usage of the Backbone system is a promising solution to Texas's challenges of insufficient funding and congestion. An important collateral benefit to rationing highway space with direct user-fees is the potential to relieve congestion, keep the transportation system operating at higher speeds and efficiencies, and achieve environmental benefits.

7.2.2 Recommendations

In order to implement a sound funding and maintenance strategy, we need to focus the study on the integrated approach outlined above. The issues that need to be addressed immediately are as follows.

1) Define the Multi-Tier Networks. The following questions need to be answered in order to define the multi-tier networks under the strategic maintenance plan.

a. ***What are the economic centers in Texas?*** Because the objective of the program is to support Texas's economic growth, defining the networks should start by identifying economic centers across the state. These form the primary nodes of the Backbone network.

b. ***How to identify corridors connecting economic centers?*** Once the nodes are clearly identified, the corridors can be defined by examining the existing travel routes and determining whether new routes are necessary. These routes form the corridors connecting the economic centers.

c. ***How to identify the tiers in the highway network?*** As part of the proposed approach, different levels of service have to be set for different tiers. Therefore, classifying the networks into tiers is necessary. The primary tier or the backbone will be maintained at the highest standard. The second and third tier will receive less maintenance. Studies need to be carried out to decide which links will form the first, second, and third tiers.

2) Determine Usage Fees. If one portion of the network is maintained better than other portions, it will definitely attract a larger portion of travelers, ultimately leading to congestion. In order to develop a mechanism to control usage, the following questions must be answered.

a. ***How to Determine the Usage Fees for General Usage?*** The primary tier has been proposed to charge a flat usage fee for general use and additional fees for usage during rush hours. Studies need to be carried out to determine the flat usage fee for using the Backbone system in order to make the primary tier a self-sustained system.

b. ***How to Identify Extra Fees for Rush Hour Usage?*** In order to control congestion during rush hours, a dynamic usage fee should be considered for the Backbone systems. Further studies need to be carried out to determine how the dynamic usage fee should be developed and implemented for rush-hour usages.

3) Develop Appropriate Maintenance Strategies. The impetus of the proposed strategic maintenance approach is that the highway network in Texas will be maintained by tiers where each tier has a different level of service in terms of safety, efficiency, dependability, and comfort. This implies that the maintenance strategies or treatments will be different for different tiers. Studies will have to be conducted to develop appropriate maintenance strategies for each tier, considering the impact of these strategies on the measurements that are used to define the level of service.

7.2.3 Benefits

The benefits of the proposed approach include the following:

1) The user is given the flexibility to choose from three levels of service and pays an extra fee only if the premier service is chosen.
2) The extra fee for the Backbone system will require a reduced amount of appropriated funds and could potentially be self-sustainable.
3) With a Backbone system that could potentially be self-sustaining, funding can be reallocated to better address the needs identified for the backup and connection systems.
4) The implementation cost is low.
5) It will make Texas the leader in reconfiguring and maintaining highway networks.

Chapter 8. RB 7: The Interstate Shield: Time to Reconsider a Roadway Icon?

8.1 Introduction

This chapter summarizes Research Brief 7, "The Interstate Shield: Time to Reconsider a Roadway Icon?" Following is the scope of the brief: "Effect of proximity to an Interstate Highway on economic development of a region, and costs and benefits. Look at 3 areas of state, i.e., Pharr, College Station, and Lubbock." In discussions with the PMC liaison, the evaluation of specific locales was dropped in favor of urban and rural impacts. This RB was led by TTI. The author is Cynthia Weatherby.

8.2 Executive Summary

The brief provided an overview of the history of interstate development in Texas, and its past and present impacts on the state's growth and economy. It described how the private sector makes decisions about where to locate, how those decisions relate to transportation, and how changes in transportation could affect that process. Finally, the RB suggested some potential actions that could possibly help deal with the designated but un-built future interstate highways in Texas and the rest of the country and with sections of roadway that meet or nearly meet interstate guidelines but are not yet designated.

8.2.1 Evolving Interstate Program

Since its beginnings in the mid-1950s, the Texas interstate program has experienced nearly continuous maintenance and rehabilitation, with growing demands for expansion. However, the final appropriations for the interstate construction program were made in 1996, even though in 1995 Congress began identifying previously designated high-priority corridor programs as future interstates. Congress has now identified more than 4,000 miles of such future interstates but has not provided the dollars to build them. In addition, there is demand for maintaining the now-aged interstate roadways and building additional interstate roadways to serve areas that have greatly expanded since the initial system was built. Also, interstate designations have resulted from political action; however, strict federal interstate standard requirements must be met before acceptance into the program. Requirements have become even more stringent in the intervening years.

In Texas, major strides have been made to meet needs and expectations. In the example of the future IH-69 in Texas, 160 miles of controlled-access improved roadway are already in place and at or near interstate standards. One of the major hurdles for having the interstate shield applied to the upgraded sections is that completed sections are not part of a continual interstate highway. Congressional actions on designation of the IH-69 route have taken place in every surface transportation authorization act since 1991, each time slightly adding or amending language on the routes, but no federal actions provide implementation funding. A recent TxDOT estimate to bring all designated Texas IH-69 sections up to full interstate standards—including construction, right-of-way, and engineering—is $6.8 billion (TxDOT 2010). The IH-69 Texas highway is being developed piecemeal as funding becomes available from a variety of sources, including $270 million from the recent American Recovery and Reinvestment Act to make incremental

progress on sections of US 59, US 77, US 281, and US 83. But sections that are improved and possibly operating at even higher efficiency than sections of signed interstate do not carry what some economic development specialists believe necessary: the interstate shield.

8.2.2 Is the Interstate Shield Necessary for Economic Development?

In today's business environment, how important is that shield? No quantifiable research backs up the claim of its absolute necessity, but transportation access is almost always a factor in the business location decision-making process. Site-selection consultants use screening criteria to evaluate alternative new-business or relocation sites. The list of criteria varies depending upon the business type. However, all lists include an examination of transportation access.

In summarizing the results of the economic development-related research, the implication is that a new interstate may result in little improvement in the economic development picture. Results imply that counties with already partially successful employment expansion programs will have more successful programs if an interstate is nearby. Other research does conclude that transportation investments can have broad benefits to regional economies. Finally, most of the major studies have concluded that the impact of a given transportation project is difficult to measure. While this may be true, it does not preclude the possibility that economic benefits from designating current highways to interstate or interstate-equivalent corridors could result in substantial long-term economic benefits for Texas. Even though it does not appear that a sufficient body of research is in place to prove that an interstate highway is necessary for future economic development in either urban or rural areas, this does not diminish the belief of economic development professionals and community leaders that interstate highway availability in an area is needed for economic growth and the long-term vitality of the region.

8.2.3 Possible Solutions

Two positive steps could be considered while also pursuing the eventual construction of the desired additional interstate miles in the state.

Enhanced Information for Economic Development. In real estate, the catch phrase is "location, location, location." But the power of information is also respected. A low-cost, positive action that could be undertaken without legislative action is the development of simple, clear information on the existing Texas roadways that are at least at four-lane capacity and clearly provide attractive access. For example, approximately 160 miles of future IH-69 in Texas meet interstate highway standards, except that they are not continuously connected to an existing interstate. Because maps do not identify the roadway with the interstate shield, parties involved in commercial site selection may not be aware of the upgraded roadway. An interdisciplinary task force could consider preparing data and maps to brief and continually update the national site-selection community on improved highways statewide.

TxDOT could work with other roadway developers, such as regional mobility authorities or regional tolling authorities, and metropolitan planning organizations to prepare the information on all such improvements in the state. Possible other participants in determining the desirable data and format could include the Governor's Office of Economic Development and Tourism, representatives of the economic development community throughout the state, and other interested stakeholders (such as the Alliance for IH-69 Texas). It would be prudent to highlight

upgrades occurring on four-lane highways in all areas of the state. It may be necessary to create a new database that accurately reflects and maps the improved roadways. An internal TxDOT working group or researchers could help develop the database. Existing TxDOT databases do not include a category that highlights sections of highway that are at interstate standards except for meeting the interconnectivity requirement; adding this subcategory could be helpful. Surveying a sample of regional and national economic development specialists to verify the type of information and formatting needed to make it most useful could also be considered.

Pursuit of New Interstate Connector Signage Category. If no substantial transportation funding results from the current debates on federal and state funding, the idea of creating a new category of interstate connector signage might be an attractive interim action. Described in detail in the brief, there is an existing proposal by two former federal and state DOT employees for a new designation or signage that is similar to the existing interstate sign. It could achieve a substantial number of the objectives of interstate designation at much less cost than improvements to interstate design levels. A TxDOT-related champion—possibly a SRP Advisory Committee member or someone within the department—or a representative of a major transportation advocacy group would likely be necessary to develop an approach and gain acceptance nationally. Key states that could be prime supporters of the concept include California, Kentucky, New York, Pennsylvania, and Tennessee.

Additional research could be helpful to develop this strategy. To pursue the idea further, the Advisory Committee or TxDOT might wish to receive a briefing by one of the initiators of the idea of interstate connector signage. TxDOT staff is already conversant in the federal legislative and administrative requirements related to interstate designations. Assistance might be required to reach out to other states to test interest and gather data on the status of completion of future interstate links elsewhere.