

Regional Strategies for the Sustainable Intermodal Transportation Enterprise

Five Years of Research

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For the past 5 years the Regional Strategies for the Sustainable Intermodal Transportation Enterprise (ReS/SITE) project has worked on the development of new regional transportation planning frameworks that recognize the realities of modern-day regional economic development. The project began with the identification of a number of weaknesses in conventional regional transportation planning and set about the development of an expanded framework that would remedy these shortcomings (including intermodalism, technology scanning, freight, private-sector involvement, economic integration, national information infrastructure-telecommunications-transportation relationships, master plan perspective, and human resource development). A new framework emerged, based on the idea of scenarios, as advanced by Royal Dutch Shell in the 1970s, and on an expanded notion of regional architectures reflecting the new organizational interactions required to plan and manage transportation systems at a regional scale. This framework has been applied in case studies in Houston, Texas, and Mexico City, Mexico, over the past several years, and the methodology has been greatly refined as a result of those applications. How the new ReS/SITE structure addresses the shortcomings in the planning process is indicated, and some further steps in framework expansion and refinement are suggested.

Metropolitan area-based regions are increasingly important in modern society. These regions, called by some the basic geographic unit for economic competition and growth (1) and for consideration of environmental issues, have to date been the subject of some regionally scaled transportation planning. However, the advent of new technologies, intelligent transportation systems (ITSs), for example, gives the opportunity to manage and operate an intermodal, regionally scaled transportation system for the first time. "The Strategic Vision for ITS is as the integrator of transportation, communications and intermodalism on a regional scale" (2, p. 5; 3, p. 3).

Some have argued that the strategic vision for ITSs can drive new paradigms for strategic planning at the regional scale, supported by the information and organizational infrastructure developed in the ITS context. Of course, the institutional barriers to achieving this are immense (4). The prize for effectively doing so from a regional viability perspective, however, is immense as well. Thinking through the organizational changes that will allow sub-regional units some autonomy, but at the same time allow system management at the regional scale, is a critical regional planning issue (5).

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With this as context, the paper traces the development of a new proposed framework for regional strategic transportation planning developed at the Massachusetts Institute of Technology (MIT) over the past 5 years. At the outset, the authors emphasize that this planning has been applied only in the rarefied environment of academe (although with a good deal of input from and interaction with practicing professionals in the field). At this stage, the authors believe that it holds promise for practical use by metropolitan planning organizations and other regionally scaled transportation organizations. The authors would welcome any interest from the planning community in working together with them to validate this framework and add conceptually to it, on the basis of practical experience and insights. Space constraints preclude detailed treatment of all topics. The reader interested in more depth should consider the various references.

REGIONAL STRATEGIES FOR THE SUSTAINABLE INTERMODAL TRANSPORTATION ENTERPRISE

The Regional Strategies for the Sustainable Intermodal Transportation Enterprise (ReS/SITE) project had its beginnings in the mid-1990s, when MIT initiated a cooperative research program with the province of Mendoza in Argentina. As part of this large omnibus project, MIT was called upon to study transportation issues in Mendoza, as the province aimed to evolve from its agrarian economy to a more industrialized economy. Of particular interest to the Mendozans was a proposed railroad tunnel to go at a low altitude through the Andes Mountains (the province of Mendoza, in the far western part of Argentina, abuts the Andes) to provide access to Santiago, Chile, the major population center of Chile, and the Port of Valparaiso. The transportation link was intended to provide access for Argentina and other Mercosur trade alliance partners—Brazil, Uruguay, and Paraguay—to the Pacific Rim, as well as to Chile.

MIT's research group argued that one could not study this tunnel link, as important as it might be, without considering a broader regional strategic transportation plan for Mendoza. So, the research agreed upon was to provide a framework for a regional strategic transportation plan with special emphasis on the key decision regarding the tunnel to Chile.

The research group began its efforts with a study of the state of the art in regional strategic transportation planning worldwide. Xing Yang and colleagues (6) studied a number of such plans, and as a result of that analysis, the group concluded that regional strategic transportation planning as a discipline had failed to evolve with various important changes in the environment facing planners.

The team reviewed strategic plans in the Netherlands and the states of Washington, Iowa, New Mexico, Florida, and others. On the basis

of these reviews, areas in which current regional strategic transportation planning needs improvement were identified. These areas are as follows:

- **Intermodalism.** Intermodalism can be described as the use of different, interconnected modes of travel to complete a person trip or freight movement. The importance of intermodalism is often overlooked, as are intermodal connections and multimodal solutions to problems. In practice, many plans can be characterized as a set of modestly related unimodal plans instead of an integrated intermodal plan.
- **Technology scanning.** Technology scanning involves consideration of which technological developments will affect transportation systems and how. For example, one could examine new ITS technologies and vehicle developments to help determine what type of system management techniques may be available within the planning horizon but that are not available today. Few regional strategic plans include such an element.
- **Freight.** Many transportation plans do not adequately address the needs of freight movement. Much of transportation planning emphasizes passenger transportation; freight mobility is given less attention, despite its criticality for regional economic development.
- **Private-sector involvement.** Transportation planning today does not adequately involve private-sector entities such as major employers, shippers, and carriers. Public-sector agencies and citizen activists largely dominate the process, with modest opportunity for input from the business community. Although the ability of the private sector to deliver needed transportation infrastructure through creative public-private partnerships has been taking hold, the role of such partnerships in more process-related, regionally scaled planning has been limited.
- **Economic integration.** Transportation and economic development are inherently linked. Most transportation plans do not adequately assess the importance of transportation investment in retaining or achieving a competitive advantage, especially in the context of the global economy. Also, these plans sometimes fail to address the local economic development needs that can be spurred on by transportation investment.
- **National information infrastructure (NII)** (telecommunications-transportation relationships). The transportation system is placing increasing demands on NII as ITS technologies continue to be used around the world. Furthermore, the transportation infrastructure is often used as a right-of-way for the information infrastructure. The interdependence of these systems is rarely addressed in transportation plans.
- **Master plan perspective.** Many transportation plans are focused on capital investment instead of the operation of the regional transportation system. The plans often simply identify specific projects, implementation requirements, and timetables instead of considering the overall operation of the regional transportation system.
- **Human resource development.** Strategic plans rarely address the need to develop transportation professionals for the future. The plans fail to address the "human capital" needs of the transportation system.

To confirm this diagnosis, Christopher Conklin analyzed a series of Volpe National Transportation Systems Center (VNTSC) enhanced planning reviews (EPRs) developed for a number of metropolitan area-based regions in the United States. Throughout the mid-1990s the U.S. Department of Transportation, through the FTA Office of Planning and the FHWA Office of Environment and Planning, conducted a review of transportation planning in 21 major metropolitan areas. These reviews, known as EPRs, were performed by VNTSC,

Research and Special Programs Administration, U.S. Department of Transportation, located in Cambridge, Massachusetts. The motivation for conducting this review of metropolitan transportation planning was the enactment of the Intermodal Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendments of 1990. These two laws enacted by the federal government placed new demands on regional planning and required more rigorous efforts in regional planning. In this context, these reviews evaluated the effectiveness of transportation planning around the United States at the metropolitan planning organization level.

The ReS/SITE group conducted an extensive analysis of the EPRs that, for the most part, confirmed the weaknesses in regional strategic transportation planning described above. The various plans studied varied in outlook, quality, and scope; but as a general proposition, the research group was comfortable with the diagnosis of the eight problem areas listed above (7).

Two recent TRB conferences, entitled *Refocusing Transportation Planning for the 21st Century*, support the conclusion that current transportation planning could use some rethinking. These conferences support a "more robust planning process to address new areas of emphasis" (8, p. 3). Specifically, the conferences identify several crosscutting issues that are similar to those identified by the ReS/SITE team (8).

Michael Meyer, in his keynote address for the first of these conferences, reinforces the need to consider a transportation planning process that will meet the needs of the coming century (9). He cites demographic change, economic production and market forces, highways plus (intermodalism), an operations perspective, the role of technology, a sense of community, laying the groundwork for pricing, putting teeth into growth management, and transportation planning within a sustainability framework as the key areas in which transportation planning will likely face challenges. These 10 areas also correspond closely to the planning shortcomings identified by the ReS/SITE team.

NEW PROCESS AND STRUCTURE FOR REGIONAL STRATEGIC TRANSPORTATION PLANNING

The next steps in the ReS/SITE research were more theoretical. The group began to consider how regional strategic transportation planning might evolve methodologically to respond to the shortcomings in current practice that the group had identified. It is noteworthy that the group did not consider current federal-aid requirements or other regulatory and statutory constraints on the planning process. Instead, the group started with a "clean piece of paper." Two basic concepts emerged from this study: scenarios and regional architecture.

Scenarios

Scenario planning is a methodology that the authors deem promising in this context. The definition of scenarios used by the Royal Dutch Shell team in the 1960s and 1970s is subscribed to here (10, 11).

Scenario development is a complex and challenging process. In this usage, scenarios are various structured views of the future. Future events and trends should be evaluated on the basis of their level of uncertainty and categorized as one of the following:

- Predetermined elements,
- Risks,

- Structural or critical uncertainties, and
- Unknowables.

Events and trends are then developed into scenarios on the basis of a rational sequence of events related by a cause-effect structure. These scenarios should reflect the central concerns and essential issues for the planning organization.

As discussed by Peter Schwartz in his work *The Art of the Long View* (12), Royal Dutch Shell prepared its business plan using scenarios that included significant price increases and supply shortages in the world energy markets. Shell fared much better than its competitors through the oil crises that then occurred in the middle and late 1970s because its use of scenarios allowed it to develop a business plan that was robust across a large variety of potential future circumstances.

It is argued here that scenarios can be valuable tools in the regional strategic transportation planning process as well. Scenarios can be applied in a transportation context to develop transportation plans that account for different possible versions of the future. Currently, many transportation plans project a "future condition" that does not reflect the many factors affecting what the future will look like and the logical construction of how that future develops. As defined here, scenarios can rationalize this process as a step toward the development of robust strategies.

Muñoz-Loustaunau (13) and Muñoz-Loustaunau and Sussman (14) worked on a first cut at a strategic plan for Mendoza by applying the scenarios methodology described above. They apply a scenario methodology similar to that outlined by Schwartz (12) to consider transportation strategies in Mendoza. The analysis consists of eight distinct but connected steps. These eight steps are as follows:

- Step 1: identify the focal issue or decision,
- Step 2: identify key decision factors of success,
- Step 3: identify driving forces,
- Step 4: rank key decision factors and driving forces by importance and uncertainty,
- Step 5: select the logic of scenarios,
- Step 6: flesh out the scenarios,
- Step 7: determine the implications (test the strategic choices), and
- Step 8: choose indicators for each scenario.

In parallel with the development of the application of scenarios to regional strategic transportation planning, the program on strategic planning for Mendoza was continued. Xing Yang produced a master's thesis that focused on project evaluation for the tunnel link and that investigated the trade-offs between overcapacity and undercapacity for that vital link in the Mendoza system (15). Tim Koehn did a careful financial analysis of the tunnel (16). Further applications of scenario-based methods for regional strategic transportation planning are described later in this paper.

Regional Architectures

The second methodological innovation in the ReS/SITE planning framework is regional architectures. This term had gained currency in the transportation field primarily through its use in the ITS field. In ITSs it is used essentially as a technical construct designed to allow effective interfacing and interoperability of the components of complex ITS deployments.

The ReS/SITE group expanded that definition to consider regional architectures as a methodology for designing organizational interactions among the various agencies and private-sector firms that would participate in providing transportation services of any type at a regional scale. In this context, the term "regional architecture" refers to the organizational context of providing transportation services instead of a narrower technical definition associated with ITSs. This work was advanced by Rodríguez, in his master's thesis (17), and Rodríguez and Sussman (18), in which they further defined concepts of regional architectures and studied how this methodology might be useful in the New York City metropolitan area; Houston, Texas; Boston, Massachusetts; and San Juan, Puerto Rico. Pendleton, in his master's thesis (19), and Pendleton and Sussman (20) continued this research by studying how regional architectures could be integrated into the strategic planning framework.

The regional architecture defines how institutions in a region provide transportation services. It establishes which institutions provide different functions and how information is shared among them. The distribution of control and information within these organizations is a key concern of regional architecture. The regional architecture defines what the lines of communication and lines of responsibility between organizations should be and informs each institution about what organizational characteristics will best accommodate these exchanges. This mechanism allows the region to consider how different organizational strategies work within the regional architecture-defined communication and responsibility links.

The ReS/SITE process suggests that the strategic planning process should result in a regional architecture that defines how the region manages transportation from an institutional point of view as well as from a communications and information perspective. The architecture should address what agencies are responsible for operating various components of the transportation system and how they should go about it. Furthermore, the architecture should define what information these agencies need to share and how to share it. As part of the strategic transportation planning process, the region should evaluate the institutional arrangements that govern the management of the transportation system through a broad regional architecture that addresses the following questions:

- What institutions are responsible for planning and operating the transportation system in the region?
- How do these institutions relate to each other and the underlying political environment?
- How can these current institutional arrangements be improved?
- How can the responsibilities and objectives of these institutions be better aligned with the transportation goals of the region?

The concept of regional architecture, as presented here, is applicable in the context of many different strategic transportation decisions. Take, for example, the case of a public transit agency deploying a new light rail transit (LRT) system. Over the last 15 years, there has been a renewed interest in developing LRT systems in many metropolitan areas in the United States. New LRT systems have been started in Baltimore, Maryland; San Diego, California; Los Angeles, California; Portland, Oregon; Dallas, Texas; St. Louis, Missouri; and Denver, Colorado, to name just a few. In many of these cities, LRT systems have been seen as a way to improve the attractiveness of transit in the face of growing traffic congestion and air quality problems. Some of these systems

have proved quite successful, and system expansions are planned. Most of the agencies implementing these new systems were essentially unimodal, simply providing bus transportation in each metropolitan area.

Two types of challenges face a transit agency in the process of planning and deploying a new LRT service. These challenges are engineering challenges (the technical, planning, permitting, design, and construction problems) and institutional challenges (strategy development, financing, workforce planning, implementation scheduling, organizational structuring, and contractor management).

The planning, operation, and maintenance of an LRT system are significant institutional challenges for agencies that have experience only with the operation of buses. Much like the situation that a highway agency faces when it deploys a new ITS, one can imagine a whole host of new managerial problems that might accompany implementation of such a system. Regional architectures can be a useful tool that a region can use to consider the organizational and managerial questions that it may face when developing new transportation strategies. Conklin, in his thesis (21), illustrates different organizational strategies that transit agencies might consider when faced with this challenge. Often, such new system deployments require new kinds of cooperation and interfaces between agencies in a region. Doing this well is fundamental to a successful transportation system. Consideration of these institutional interactions in a structured, organized way is the intent of regional architecture.

With the integration of scenarios and regional architecture, the ReS/SITE framework takes shape as shown in Figure 1.

The concepts shown in Figure 1 are

- Scenarios;
- Strategic issues, directions, and options;
- Strategic plans, including regional infrastructure and regional architecture; and
- System management and operations.

Scenarios and regional architecture were described in some detail in the previous section. The remaining components are now discussed.

Strategic Issues, Directions, and Options

Once scenarios of possible futures have been developed, the next step in the ReS/SITE process is focused on determining the region's strategies. In this step, the decision makers involved in the planning process evaluate the potential futures illustrated by the scenarios and decide on the strategies that are robust across those possible future conditions that they should follow. This step of the process is a strategy-oriented process instead of a project selection process. At this stage, decision makers should decide, for example, that the region needs to improve its freight-handling operations but that it is too early to consider building specific terminals. At this stage of the process, one is looking at transportation needs and families of solutions instead of specific projects.

This activity includes the setting of goals for the region in terms of competitiveness in the global economic environment, regional and local needs, mobility, accessibility, safety, security, and many other factors.

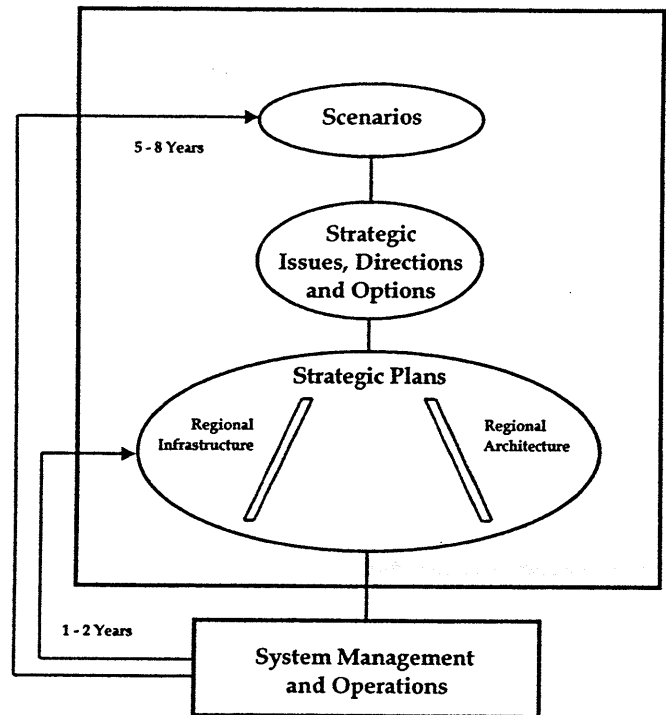


FIGURE 1 ReS/SITE planning process.

Strategic Plans

The work described earlier informs the development of the strategic plan that concentrates on a long-term strategy with a 5- to 20-year planning horizon. It is argued here that the strategic plan is manifested in two major components, the regional infrastructure and the regional architecture.

For the most part, modern transportation planning adequately addresses the infrastructure needs of a region. Indeed, planning infrastructure investment has been the traditional focus of regional strategic transportation planning. It is undeniable that planning this investment is an important component of the planning process. The region must ensure that it is allocating its resources to meet its transportation goals and objectives. The ReS/SITE process goes beyond infrastructure planning to include the development of a regional architecture, as described earlier.

System Management and Operations

Closely related to the planning process, system management and operations is the short-term analog of regional strategic transportation planning. This activity ensures that the transportation system, in its current state, operates as effectively as possible and works toward meeting the region's short- and long-range transportation and economic development goals.

Any long-range plan must be complemented by a system management and operations component to ensure that the current system operates well. The first step in planning is the effective management of today's transportation system. These management measures include operation and maintenance plans, congestion

management strategies, and other measures focused on maintaining the performance of the transportation system. A system management and operations plan should be focused on the same goals as the strategic transportation plan. However, these measures are generally focused on immediate and short-term items, those within a 1- to 2-year time frame, whereas long-range measures generally extend 5 to 20 years into the future.

SOME APPLICATIONS AND FURTHER REFINEMENT

The next steps in the ReS/SITE research agenda were the application of this preliminary methodology to real-world cases. The group studied the metropolitan area-based region centered on Houston, Texas, and exercised the new ReS/SITE framework in that geographic area, learning much in the process.

The application of the ReS/SITE process in Houston considered a wide array of possible transportation strategies that the region might consider. Some of these were actual plans being considered in Houston, whereas others were more extreme ideas included to test the effectiveness of the process. Three different scenarios were developed for the future of Houston. These scenarios are listed below.

1. The United States of North America:
 - Increasing economic activity,
 - Limited environmental regulation,
 - Stable technological development, and
 - Increased financial means.
2. Earth Day 2020:
 - Increasing economic activity,
 - Strict environmental regulation,
 - Advancing technological development, and
 - Decreased financial means.
3. Balkanization of the world:
 - Declining economic activity,
 - Limited environmental regulation,
 - Stable technological development, and
 - Decreased financial means.

The exercise proceeded to evaluate the various strategic options available in the context of the three scenarios described above, considering the robustness of these strategic options across different but reasonable futures, and ultimately identified those that operated most effectively (22).

As a next step in the research, the ReS/SITE group applied its methodology in the developing country context of Mexico City, the capital city of Mexico, which is plagued by both transportation and environmental concerns. The Mexico City project has been described in detail (23). Also, as part of the Mexico City project, Jon Nappi Makler worked on advancing the ReS/SITE framework itself to reflect the differences between "planning architectures" and "service architectures," as shown in Figure 2 (24).

In Figure 2, the regional planning architecture (RPA) represents the organizational structures involved in advancing the planning agenda for the regional transportation system. The regional planning architecture is also the organizational mechanism for planning the

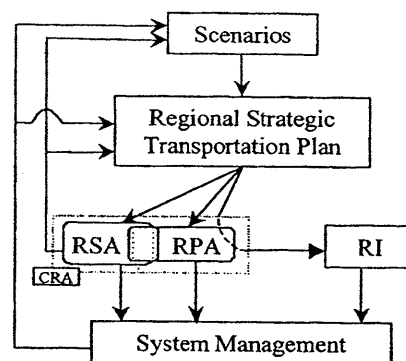


FIGURE 2 Regional service, planning, and comprehensive architectures (RSA = regional service architecture; RPA = regional planning architecture; CRA = comprehensive regional architecture; RI = regional infrastructure).

regional infrastructure (RI), which is the traditional output of regional strategic transportation planning. The regional service architecture (RSA) reflects that set of organizations concerned with operating the transportation system; they are perhaps similar to but are certainly not identical to the organizations involved in planning. As Figure 2 shows, the regional planning architecture and regional service architecture overlap; collectively, these are called the comprehensive regional architecture (CRA).

Makler's work also considered the linkage of environmental goals related to transportation activity. In his thesis he outlines the process by which Mexico City might more explicitly consider that linkage (24).

HOW DOES ReS/SITE PROCESS ADDRESS PLANNING SHORTCOMINGS?

A new planning framework (ReS/SITE) has been developed. This section discusses how ReS/SITE addresses the shortcomings in conventional transportation planning identified earlier. The fundamental differences between conventional planning and the ReS/SITE process, as proposed here, include the use of scenarios as inputs to the planning process and the development of a structured regional architecture as an output of the planning process. In some cases, the shortcomings discussed earlier are remedied directly in one or more of the ReS/SITE components. In others, these shortcomings must be addressed by specific consideration of the shortcoming in the planning process. The following points briefly identify how the ReS/SITE process addresses each of the planning shortcomings.

- **Intermodalism.** The ReS/SITE process is inherently intermodal in nature. Intermodal planning is enhanced by the regional architecture output of the planning process. This regional architecture defines how agencies with different modal responsibilities should cooperate in providing transportation services. The process encourages consideration of different modal solutions to problems that the region is facing, with different outcomes for the various scenarios considered.

- Technology scan. A technology scan is an important component of the planning process. The planning agency should apply the scenario process to consider the impacts of technology. The agency can then consider what new technologies may have an impact on the future requirements and operation of the transportation system and prepare the plan to accommodate these future developments. Furthermore, the regional architecture, with its ITS roots and an emphasis on information technology and communications, is responsive to new technological approaches to the solution of transportation problems.

- Freight integration. Providers of freight services should be included in the regional architecture. These entities, such as railroads and motor carriers, have the explicit business responsibility for operation of a service. The relationships between these operators and the providers of the infrastructure that they use should be explicitly addressed in the development of a regional architecture. Freight mobility is an important service provided by the transportation system and is essential to maintaining the economic health of a region. Different freight transportation requirements will be highlighted in different scenarios.

- Private-sector involvement. Similarly, private-sector entities, such as the major employers, manufacturers, and service providers in the region, should be involved in the regional architecture. It is important that the needs of the local business community be addressed in the products of the ReS/SITE planning process. The role of the business community in the regional architecture and the private sector's ability to deliver new infrastructure should be outlined in the plan. The private sector can also be included in the planning process through scenario development in which the perspectives of private-sector organizations on the future can be explicitly reflected.

- Human resource development. To an extent, scenarios, viewed as a mechanism to broaden the perspectives of planners, have a human resource development aspect. In addition, it is important that the planning agency address these human capital issues independently as part of its planning process. The human resource requirements for operation of the transportation system should be identified, and a plan for development of these resources should be outlined.

- Integrated economic consideration. This shortcoming is addressed through the development of scenarios. Different economic effects can be explicitly reflected in the planning process. Furthermore, the scenario development process can assist the region in developing a plan that is robust across various degrees of economic vitality.

- NII. NII should be an important component of the regional architecture in that it enables high levels of interaction between different institutions. Furthermore, it is appropriate to consider how changes in NII may affect the transportation system through the scenarios, in addition to development of an independent assessment of the interactions between these two systems. The planning process should outline the communication requirements for operation of the transportation system in terms of both the institutions involved and the infrastructure needed.

- Master planning perspective. The ReS/SITE process is focused on regional competitive and quality-of-life goals instead of on a project selection process. Furthermore, through the development of a regional architecture focused on information sharing, the process is not focused solely on infrastructure delivery. Instead, the ReS/SITE process is focused on meeting the transportation needs of the region through operations as well as investment.

CONCLUSION AND FUTURE WORK

This paper was intended to summarize a body of work that was undertaken over a 5-year period and that dealt with new concepts in regional strategic transportation planning. Space constraints prevent the provision of substantial detail on the various methodologies and case studies. The reader is invited to study the various references for more in-depth treatments of both the concepts and the regions studied.

In the future, the authors hope to have the opportunity to apply this framework in various regions in both the developed world and the developing world. Such applications will doubtless lead to further refinements of the methodological framework.

As the next step in developing the ReS/SITE framework, the authors will use Michael Porter's competitive diamond framework and his study of regional clusters as a way to integrate the notion of regions as competitive with each other in the planning process (1). Furthermore, the authors hope to draw upon some of the recent research in the relationship between economic growth and regional infrastructure investment to help guide regional investment strategies (25).

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