

Towards Sustainable Transport Planning in the United States

Tara Ramani¹

Texas A&M Transportation Institute, Texas A&M University System, United States of America.

Josias Zietsman²

Texas A&M Transportation Institute, Texas A&M University System, United States of America.

Marie Ridley Pryn³

Center for Regional Development, Capital Region of Denmark, Denmark.

This paper provides an analysis of how sustainability concepts are currently addressed within the broad framework of surface transportation planning in the United States (US). We first discuss the overall transportation planning process in the US, and the role of key agencies and actors. This is followed by a brief assessment of how sustainability is addressed as part of national policies and programs. We then present a case study of the US Federal Highway Administration's INVEST (Infrastructure Voluntary Evaluation Sustainability Tool), and its application by four agencies. In general, the findings indicate that there is acknowledgement of triple bottom line sustainability considerations in transportation planning – though a cohesive and unified approach is lacking. We also note the presence of planning initiatives and discourse that implicitly address sustainability issues, by targeting related considerations such as liveability, health, climate adaptation, quality of life, and economic opportunity.

Keywords: *Sustainability, Sustainable Transportation, Sustainability Rating Systems, Sustainability Indicators.*

1. Introduction

The overall goal of this paper is to study how concepts of sustainability are applied in the realm of transportation planning in the United States (US). This work was conducted as part of a broader research effort focused on national sustainable transport planning (NTSP), which is defined as “deliberate, knowledge-based, and strategic endeavours to integrate sustainability principles, criteria and goals in the development, management, regulation and assessment of nationally significant transport systems and services” (Sørensen et al., 2013). Sustainability is recognized today as a broad concept that can hold several meanings (Beatley, 1995), and the most widely-cited definition of “sustainable development” remains that of the Brundtland Commission, which defined sustainable development as “development which meets the needs of current generations without compromising the ability of future generations to meet their own needs” (WCED, 1987). While the roots of sustainability thinking were in the environmental realm, the concept has since evolved into something broader, covering socio-economic aspects (Kidd, 1992). In the transportation context, the principles of sustainability are broadly defined in terms of the “triple bottom line” – namely the environmental, the economic, and social dimensions (CST, 2002; Zietsman et al., 2011; Holden et al., 2013; Gudmundsson et al., 2015). The focus of

¹ A: 3135 TAMU, College Station, Texas 77843, USA T: +1 (979) 845-9888 E: t-ramani@tti.tamu.edu

² A: 3135 TAMU, College Station, Texas 77843, USA T: +1 (979) 458-3476 E: zietsman@tamu.edu

³ Kongens Vænge 2, 3400 Hillerød, Denmark T: +45 2962 7749 E: marie.ridley.pryn@regionh.dk

this paper is on surface transportation planning, in the US context and we conduct a case study of the US Federal Highway Administration's INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) sustainability rating system. This paper analyses US planning practice and the INVEST system through the lens of the NTSP concepts, discussing normative, analytical, and governance aspects of practice (Sørensen et al., 2013).

2. Transportation Planning and Sustainability in the US

2.1 Organizational Arrangements and Key Actors

The United States is one of the world's largest nations, with a population of over 300 million and spanning a vast land area. The US is home to 50 states (as well as other non-state territories), several of which are individually comparable in size and population to other countries. In the US, transportation planning is conducted at the state and local (metropolitan area/city) level, following federally-mandated planning processes.

The US Department of Transportation (USDOT), under the Secretary of Transportation⁴ is responsible for federal-level actions on transportation, governed by legislation authorized by the US Congress. The USDOT is comprised of several operating administrations covering specialized areas ranging from rail, aviation, transit, motor carrier safety, pipeline and hazardous material transportation, etc. This paper focuses on the actions of the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) - the two entities that together drive surface transportation planning activities at the Federal level.

The mandated surface transportation planning process in the US (FHWA/FTA, 2015) is generally described as being characterized by "3-Cs" - continuing, cooperative, and comprehensive. Figure 1 depicts the process, as outlined in a joint FHWA-FTA guidance document on the subject.

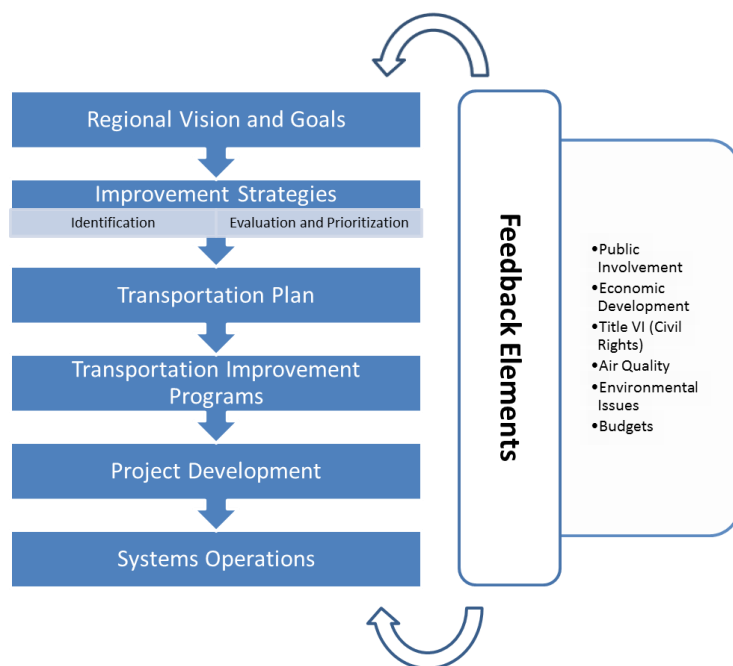


Figure 1. Transportation Planning Process -Adapted From (FHWA/FTA, 2015)

In the US, every area with a population of over 50,000 is required to have a Metropolitan Planning Organization (MPO). In simple terms, transportation planning for these metropolitan areas is led by MPOs, with State Departments of Transportation (DOTs) being responsible for nonmetropolitan areas and for statewide planning efforts. MPOs, however, do not own or

⁴ Analogous to a Ministry of Transportation/Minister of Transportation in other countries

operate transportation infrastructure. They play a coordinating role, with the involvement of state and local (county or city) transportation departments, elected policy board members, transit providers and other stakeholders including the general public.

The primary products of the transportation planning process include long-range plans, and shorter-range transportation improvement programs (TIPs). Transportation plans are meant to be strategic in nature, and outline goals, vision and strategies with a 20-year planning horizon. These long-range plans include Metropolitan Transportation Plans (MTPs) developed by MPOs, as well as Statewide Long-Range Transportation Plans developed by State Departments of Transportation (DOTs). Transportation improvement programs (TIP) derive from transportation plans and are developed by MPOs and state DOTs for a 4-year planning horizon in which transportation investments are identified. Since a majority of the US population (over 70%) lives in urbanized areas of over 50,000 people (USCB, 2010), MTPs represent the primary planning documents that govern how a majority of transportation planning is done in the US.

2.2 Legislation and Funding

As the executive branch of the US government, the USDOT and its operating administrations are governed by legislation passed by US Congress. The 1991 “Intermodal Surface Transportation Efficiency Act” (ISTEA) was considered a landmark piece of legislation that defined several of the collaborative planning requirements that are conducted in the US today. ISTEA was followed by other similar bills, the Transportation Equity Act for the 21st Century (TEA-21) and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). In 2012, the Moving Ahead for Progress in the 21st Century Act (MAP-21) was enacted. MAP-21 has also been viewed as milestone legislation due to the introduction of performance-based planning and several actions to streamline planning processes. Most notably, MAP-21 established national performance goals for which performance measures are to be established and reported by state DOTs and MPOs (FHWA, 2015d). These goals are shown in Table 1. In December 2015, MAP-21 was replaced by the Fixing America’s Surface Transportation (FAST) Act. The FAST act continues the performance management approach of MAP-21, with minor changes to the performance management provisions (FHWA, 2016).

The funding for transportation primarily comes from federal taxes on motor vehicle fuel, which is paid into the Highway Trust Fund and Mass Transit Fund. These funds are then disbursed to state and local areas, through programs such as federal-aid highway programs and federal-aid transit funding. Besides this funding, states may also fund additional initiatives at the state level through vehicle registration fees, by imposing their own fuel taxes or other taxes/fees. Over the years, the viability of the fuel tax as the primary means to funding transportation systems has been questioned, due to improved vehicle fuel economy and fleet hybridization/electrification. Mileage-based user fees and other alternative funding mechanisms are therefore being investigated at various levels (Hanley and Kuhl, 2011; GAO, 2012). Several large transportation projects in the United States have also been developed as tolled facilities or through public-private partnerships in recent times.

2.3 Sustainability in Transportation Planning

National-Level Transportation Policy

The US government has implemented a climate change and sustainability initiative via an Executive Order for its departments (CEQ, 2015), with a focus on energy savings and greenhouse gas (GHG) emissions reductions in internal agency operations. However, this has not translated to explicit policy in the transportation realm to tackle sustainability.

While the goals of MAP-21 (see Table 1) refer to “environmental sustainability”, the goal statement focuses only on the natural environment. Moreover, the set of goals as a whole does not align with a holistic sustainability approach – notably lacking is consideration of the social

dimension, as well as explicit consideration of society’s future needs or of equity. Also the implementation schedule for the performance measures under MAP-21/FAST focuses on more “traditional” performance metrics (such as congestion and safety measures) for initial implementation.

Table 1. National Performance Goals Established under MAP-21(FHWA, 2015d)

Goal	Description
Safety	To achieve a significant reduction in traffic fatalities and serious injuries on all public roads.
Infrastructure condition	To maintain the highway infrastructure asset system in a state of good repair.
Congestion reduction	To achieve a significant reduction in congestion on the NHS.
System reliability	To improve the efficiency of the surface transportation system.
Freight movement and economic vitality	To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
Environmental sustainability	To enhance the performance of the transportation system while protecting and enhancing the natural environment.
Reduced project delivery delays	To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies’ work practices.

Other research on how sustainability is addressed in the US transportation planning context has also discussed the lack of a social and quality-of-life focus and emphasized the need for the same (Amekudzi, 2013; Barrella et al., 2013). Recently, the USDOT has launched a “Ladders of Opportunity” policy initiative, which includes pilot programs in seven cities in the US (USDOT, 2015b). With a focus on community revitalization, access to jobs, and multimodal transportation, this initiative may somewhat address the social sustainability dimension in the future.

Also, it is widely acknowledged that there are vast differences among various states and metropolitan areas, with states and MPOs often driving sustainability initiatives based on local needs and priorities (Banister et al., 2007; Barrella et al., 2013).When discussing sustainable transportation planning in the US context, it is important to acknowledge the challenge of promoting triple-bottom-line sustainability in an exceedingly auto-oriented context. While there is support at the federal level⁵ for increasing transit, bicycling and walking, there are no restrictions or pricing practices to discourage car use in most areas, and automobiles continue to be the dominant mode of travel. Fuel prices are significantly lower in the US than in Europe. Additionally, studies have shown that car users in the US are found to be subsidized by the public sector, unlike in Europe where road-user generated revenue exceeds road expenditures, i.e. drivers subsidize other public sector activities (Gomez and Vassallo, 2014).

This has broad-ranging impacts: from auto-oriented planning that exacerbates the difficulties in promoting transit and other modes (Millard-Ball, 2015) to the focus on technological

⁵ At the time of writing – this may vary based on politics and presidential administrations’ priorities.

improvements rather than reduction in vehicle miles of travel (VMT) or fundamental changes to the system as a means of moving towards sustainability(Andress et al., 2011; Kamga and Yazici, 2014). At the same time, it is also clear that these issues are being acknowledged at the federal level – the USDOT recently put forward the Beyond Traffic framework (USDOT, 2015a), which discusses several aspects of sustainability, including transportation’s contributions to climate change, issues relating to urban sprawl and land use, and the need for multiple solutions, including promotion of alternative modes of transportation.

Other Programs and Activities of Federal Agencies

Apart from national-level policy, there are several actions and programs by federal agencies focused on sustainable transportation, including FHWA’s INVEST program, which is detailed in the case study section. Many of these initiatives have seen the FHWA play a leading role, working with other agencies. FHWA’s approach to sustainability is aligned with the triple bottom line, and the agency states that it is “... committed to improving social, economic, and environmental outcomes—the sustainability triple bottom line—of FHWA activities...”(FHWA, 2014). Additionally, it is also notable that several agencies in the US implement initiatives and programs that address aspects of sustainability, often implicitly, and sometimes without using the term sustainability in referring to goals and outcomes. Table 2 summarizes sustainability elements of some key guidebooks, programs and initiatives relevant in this context⁶.

Table 2. Sustainability Aspects of Selected Programs, Policies, and Documents

Item	Description
Advancing a Sustainable Highway System – Highlights of FHWA Sustainability Activities	This report (FHWA, 2014) provides an overview of how sustainability is incorporated into a variety of FHWA’s programs and policies. It includes descriptions of specific initiatives such as the creation of a sustainability working group, linking asset management and planning, sustainable pavements, climate change, and air quality.
Climate Change and Transportation	FHWA has compiled a resource page(FHWA, 2014) that features information and several publications regarding adaptation and mitigation programs and related research. Recent reports and initiatives include those focused on infrastructure resilience, FTA’s Climate Change Adaptation Assessment Pilot, a Climate Change and Extreme Weather Vulnerability Assessment Framework, etc.
Context Sensitive Solutions (CSS)	Over the years, CSS has evolved into a set of guidance and best practices aimed primarily at the highway engineering sector. It is defined as “a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions” (FHWA, 2015a).

⁶ This section does not address federally-mandated items such as Environmental Justice and other parts of the National Environmental Policy Act, transportation conformity (air quality regulations under the Clean Air Act), Civil Rights (Title VI), vehicle fuel efficiency and GHG standards, etc. The focus is on programs that go “above and beyond” to promote voluntary actions that may affect sustainability.

Health and Transportation Initiative	The FHWA commissioned the USDOT's Volpe National Transportation Systems Center to develop two reports to provide guidance on linking public health and transportation - titled <i>Metropolitan Area Transportation Planning for Healthy Communities</i> (Lyons <i>et al.</i> , 2012) and <i>Statewide Transportation Planning for Healthy Communities</i> (Lyons <i>et al.</i> , 2014). These reports put forward a holistic view of health in transportation that overlaps heavily with sustainability principles - consideration of a) active transportation b) safety for all, c) air pollution reduction, and d) access to opportunities for healthy lifestyles. The USDOT also collaborated with the Centers for Disease Control on the development of a Transportation and Health Tool (USDOT, 2015c) that provides a range of transportation, land use, and health indicator data for regions in the US.
INVEST Program	Web-based, voluntary sustainability rating tool (discussed in further detail in the case study section).
Ladders of Opportunity	Recent policy initiative termed as a "Transportation Empowerment Pilot" (USDOT, 2015b). Focuses on community transportation projects with an aim to revitalize neighborhoods and improve transportation connectivity, especially in urban downtown areas. While this is a new initiative with no concrete outcomes to date, it may address social sustainability elements in terms of access, jobs, and equity.
Livability Initiative (Partnership for Sustainable Communities)	Also called the Partnership for Sustainable Communities, this is collaboration between the USDOT, the Environmental Protection Agency (EPA) and the Department of Housing and Urban Development (HUD) to promote livability. The partnership put forward a set of "livability principles (PSC, 2015) that touch upon several sustainability-related elements. FHWA also developed a Livability in Transportation Guidebook (USDOT, 2010) that presents projects, planning approaches, and case studies focused on promoting the livability principles.
NCHRP Report 750 Foresight Series	A set of six reports dealing with the future of transportation was published by the National Cooperative Highway Research Program (NCHRP) under the umbrella of "Strategic Issues Facing Transportation" (NCHRP, 2014). One of these reports was on <i>Sustainability as an Organizing Principle for Transportation Agencies</i> . Other topics investigated in the series included freight, climate change, technology, energy, and socio-demographics.
Smart Growth	The EPA maintains a clearinghouse to support its Smart Growth program (EPA, 2015). Smart Growth is defined as " <i>range of development and conservation strategies that help protect our health and natural environment and make our communities more attractive, economically stronger, and more socially diverse</i> ". EPA conducts research, provides funding and technical support for implementation smart growth projects. The activities are linked to the Livability/Sustainable Communities initiative. EPA also maintains a Smart Location Database that provides a rich dataset of transportation, demographic and built environmental data relevant to sustainable transportation (Ramsey and Bell, 2014).
Transportation Planning for Sustainability Guidebook	This guidebook was prepared for the FHWA (Amekudzi <i>et al.</i> , 2011) as a means to compile current knowledge on sustainable transportation to serve transportation planning agencies in the US. It contains compilation of sustainability practices, tools and evaluation methods from across the US and around the world.

Concluding Remarks

As seen from this section, at the federal level, there is an acknowledgement of the need for sustainable transportation, including the need to move beyond auto-oriented planning, which is the status-quo in the US. However, considerable power is devolved to states and local agencies in the transportation planning process. Also, given the size of some of these states/regions (that can

have larger populations and economies than some European nations) it appears that the federal government is less prescriptive on what planning for sustainable transportation is.

It remains to be seen if future policy at the national level will evolve to address sustainability more explicitly. At the same time, as seen in the analysis of individual programs and initiatives, sustainability is being addressed, implicitly and explicitly in several ways. While these may not all be holistic in their application, and may also use other terms (such as “health” or “liveability”) as a proxy for sustainability, these serve to reinforce the observation that progress toward sustainability in the US is primarily driven by local initiatives and actions as opposed to broad national policy.

3. Case Study - INVEST Program

INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) was developed by FHWA as a tool to help transportation agencies integrate sustainability considerations in their programs and projects and encourage progress toward sustainability outcomes (FHWA, 2015c). INVEST is a sustainability rating system for transportation, structured similarly to others such as the Leadership in Energy & Environmental Design (LEED) system, with individual criteria that function as sustainability indicators. INVEST was selected for the case study as it has broad applicability in the US, and is representative of FHWA’s approach to sustainability. Further, the application of INVEST covers the spectrum of functions for a sustainability indicator framework, namely the conceptualisation, operationalisation, and utilisation aspects (Cornet and Gudmundsson, 2015), which are explored in the case study.

3.1 Overview of INVEST

An initial version (INVEST 1.0) was launched in October 2012, and subsequent versions released in January 2015 (INVEST 1.1) and September 2015 (INVEST 1.2). INVEST was developed following years of developing a beta version, followed by a pilot version that was tested with subject matter experts and transportation practitioners. INVEST is free of charge to use, unlike many other third-party evaluation tools (such as Greenroads, ENVISION) used in current practice.

INVEST 1.1 was the latest version of INVEST available at the time of writing. INVEST 1.2 that subsequently became available, includes several updates⁷, though the fundamental structure and a majority of evaluation criteria in the tool remain unchanged. In our case study analysis, we therefore focus on the INVEST 1.1 version.

INVEST 1.1 is a rating system that consists of 60 criteria organized into three modules: System Planning (SP), Project Development (PD), and Operations and Maintenance (OM). Each module can be evaluated separately, but together these allow for the analysis of the entire life-cycle of a transportation project. The PD module is further divided into six scorecards depending on the project type and location - Paving, Basic Rural, Basic Urban, Extended Rural, Extended Urban, and a Custom scorecard. These six scorecards include different combinations of 29 criteria, with the Extended Urban scorecard alone including all 29 criteria. The PD module with the Custom scorecard allows for user-selected criteria in addition to 19 core criteria.

Each criterion allows for a maximum obtainable score ranging from 1-15. Each criterion description includes scoring requirements that allow the user to assign a score to the particular plan or project being evaluated. The scores for each criterion in a module are then aggregated to obtain a total score. Similar to other rating systems such as LEED, the total score is linked to a specific achievement level (Platinum, Gold, Silver, and Bronze) relative to the maximum number

⁷ The major changes in INVEST 1.2 include splitting of the System Planning Module into two versions (aimed towards states and metropolitan regions, respectively) and updated criteria. A full list of revisions in INVEST 1.2 can be found here: <https://www.sustainablehighways.org/1811/version-12.html>

of possible points in the module. The evaluation system is available as a web-based tool that allows users to create an account and perform the scoring online.

3.2 Analysis of Sustainability Principles and Intention

Overall, the INVEST tool was developed taking into consideration a definition of sustainability that covers environmental, economic and social aspects. Each criterion includes a discussion of the “Sustainability Linkage”, along with an indication of the affected triple bottom line principle (see example in Figure 2). The tool as a whole is also in line with a more holistic approach, where sustainable transport planning becomes more about “social, financial, and ecological solutions to multifaceted community problems” and “considers impacts on multiple systems” (Leuenberger et al., 2014). Similarly, one of the main strengths of the tool is its ability “to play a key role in a more ‘cradle to grave’ scoring process” (Olmsted and Lester, 2015).

SP-10: Air Quality 1-15 points

Goal: To plan, implement, and monitor multimodal strategies to reduce emissions and to establish a process to document emissions reductions.

Sustainability Linkage
 Reducing emissions and improving air quality supports the environmental and social principles by reducing emissions and improving quality of life.

Environmental
 Social
 Economic
 Affected Triple Bottom Line Principles

Figure 2. Sustainability Linkage for Example Criterion (Source: INVEST 1.1 Compendium, available at: <https://www.sustainablehighways.org/files/869.pdf>)

To further analyze how INVEST 1.1 addresses the sustainability dimensions, the criteria for each of the modules was tabulated, along with the maximum points possible and the affected sustainability dimensions as indicated in the tool’s documentation (FHWA, 2015b). Table 3 provides a summary of the various modules – including the total number of criteria, the maximum scores achievable, and the number of criteria addressing the three dimensions. Since several criteria were listed as addressing multiple dimensions, the totals for the three dimensions exceeds the total number of criteria in a module.

Table 3. Summary of INVEST 1.1 Modules and Scoring

Module	System Planning (SP)	Project Development (PD)*	Operations and Maintenance (OM)
Number of Criteria	17	29	14
Max. Score per Criterion	15 (except 2 bonus criteria for 10 points each)	Between 1 and 10	15
Coverage of Dimensions (Number of Applicable Criteria per Dimension)			
Economic	13	21	13
Social	13	16	10
Environmental	12	26	13

*Urban Extended Scorecard. Other scorecards include a subset of these 29 criteria

For the System Planning module as well as for the Operations and Maintenance module, all criteria are equally weighted with maximum scores of 15 points, with the exception of two

criteria in the SP module. The PD module offers a more nuanced picture with scores varying from 1 to 10 points, based on their sustainability impact. The maximum possible score of the criteria can thus be seen as an expression of the importance of each criterion in sustainable transportation planning. FHWA indicated that the gradation of scores in the PD module was possible due to more in-depth knowledge and expertise being available in this area to support the weighting of the criteria. On looking at the balance between the three sustainability dimensions, it is seen that the three elements are well-balanced in the planning (SP) module. The PD module is weighted more in the environmental dimension, while the PD and OM modules have relatively fewer criteria related to the social dimension.

A weakness of the INVEST tool, however, is that while it addresses and attempts to balance the sustainability dimensions, it does not secure more than a consideration of these multiple systems and criteria. The structure of the rating scale is such that it represents a weak definition of sustainability, where the three dimensions at best are considered equal and where trade-offs among the three dimensions are possible. As suggested by several authors, for a move towards stronger sustainability, certain critical criteria could be identified and characterized as absolute requirements (Rockstrom et al., 2009; Joumard and Gudmundsson, 2010; Ramani et al., 2011). Additionally, it is also important to consider that a single gold or platinum rating in INVEST only represents a slice in time or the rating for a particular project. Thus, the application of INVEST in a continuing and forward-looking manner is also important, and agencies should avoid a sense of complacency based on a positive rating.

Another aspect to consider is that the use of INVEST is not mandated, but voluntary. Thus, it is open to question whether true “cradle to grave” assessments are possible without collective commitment and active cooperation between agencies – specifically MPOs and state DOTs, who are responsible for different steps between project inception and implementation (planning versus project development, operations and maintenance). The final criterion in the SP module (Linking Planning and NEPA), does to some extent try to bridge this gap between institutions by putting emphasis on transference of consistent data between system-level and project-level planning. INVEST 1.2 further addresses this by differentiating statewide and regional planning.

Finally, INVEST is primarily highway-infrastructure focused tool. This is in keeping with the mission and scope of the FHWA, which developed the tool, and reflective of the reality of the US transportation system. The FTA therefore has a fairly limited role in the implementation of INVEST, and in our case studies. The SP module, being at the planning level, covers more multimodal perspectives and has more broadly-applicable criteria. The other modules, especially the OM module, contain several measures that are not applicable to non-highway projects. However, there are examples of INVEST being adapted and applied to other projects – a notable example was the application of INVEST 1.0 for Portland, Oregon’s light rail, conducted by TriMet, a transit agency. The project report describes how the PD and OM modules were applied, including use of a customized PD scorecard and the selection of a subset of OM measures relevant to the light rail context (TriMet, 2014).

3.3 Example Applications

Several transportation agencies across the US, including 16 DOTs, 22 MPOs, and 30 other agencies have applied INVEST for different purposes (FHWA, 2017). To provide an understanding of the applications of INVEST among transportation agencies in the US, we present case study examples from four agencies (two DOTs and two MPOs), namely:

- California Department of Transportation (Caltrans)
- Texas Department of Transportation (TxDOT)
- North Central Texas Council of Governments (NCTCOG) – the MPO for the Dallas-Fort Worth region in Texas

- Southern California Association of Governments (SCAG) – the MPO for six counties in Southern California, including the Los Angeles metropolitan area.

Texas and California are among the largest states in the US, with vast roadway networks. However, Texas and California represent, to a certain extent, two different ends of the spectrum in terms of state-level actions and policies towards sustainability. California's 2006 California Global Warming Solutions Act (AB [Assembly Bill] 32) was a landmark act that set statewide targets for GHG emissions. The Sustainable Communities and Climate Protection Act (commonly referred to as SB [Senate Bill] 375) followed from this, and set regional targets for GHG emissions from passenger vehicles. Similar state-level policies have not been enacted in Texas, where federal mandates therefore prevail on these topics.

When it comes to their State DOTs and their roadway networks, Texas and California are fairly comparable in scale – TxDOT is responsible for maintaining 80,000 miles of road, with 12,000 employees and an annual budget around \$10 billion. Caltrans manages over 50,000 miles of roadway, has 22,000 employees and a budget of almost \$14 billion. As with the respective state-level political climate, two State DOTs are very different in terms of their approach to sustainability. Caltrans' mission statement includes a reference to sustainability, and the agency has a sustainability office with its director reporting directly to the agency director. The agency strategic plan mentions climate and the environment numerous times, with goals that explicitly address sustainability and climate-related topics. TxDOT, on the other hand, does not mention sustainability or the environment in its mission statement or strategic goals. The strategic plan has limited mention of sustainability and the environment, and no mention of climate change. TxDOT does not have a sustainability office, and activities such as the INVEST application are instead coordinated through the relevant technical department.

While NCTCOG and SCAG cover areas in Texas and California respectively, the contrast between the two MPOs is not as stark. Both MPOs cover large metropolitan areas, with both Los Angeles and Dallas-Fort Worth known to be fairly sprawling and automobile-oriented in nature. However, SCAG follows the lead of California's state agencies in implementing legislation such as SB375. NCTCOG does not operate under such a framework, and is more "self-driven" in terms of pursuing sustainability endeavours. The remainder of this section discusses the INVEST applications for each of the agencies in further detail.

Texas Department of Transportation

TxDOT applied the INVEST tool for a large (\$800 million) bridge replacement project (Harbor Bridge) in Corpus Christi, Texas. The initiative started in 2014 came about due to an interest to include "green" and energy-saving elements as part of this large-scale project. The size of this project also made it a visible means of showcasing such efforts. TxDOT considered various rating systems, and settled on INVEST due to it being free, and due to the availability of FHWA assistance in the implementation process. Since this bridge replacement project was a "design-build" contract awarded to a construction firm, TxDOT conducted a pre-evaluation with the INVEST tool to determine to what extent sustainability elements could reasonably be incorporated into the project by the contractors. After this exercise, it was determined that a silver rating on the OM module and a platinum rating on the PD module were achievable targets – and these requirements were written into the procurement documentation for the project, along with the requirement for the contractor consortium to have a sustainability manager on staff.

In order to develop appropriate scores in the rating system the proposers were asked to describe how the following sustainability categories were to be addressed: energy and energy efficiency; community and environmental justice; green building; waste reduction and recycling; green project administration; materials and resources; construction practices; education and demonstration of energy efficiency; and a sustainability plan. The sustainability plan of the winning consortium is focused on "establishing, implementing, and maintaining sustainability

initiatives that will benefit the immediate and long-term interests of the Corpus Christi community." The winning bidder also exceeded the contract requirements and committed to delivering a platinum rating on both the PD and OM modules. Post-bid, the private sector company performed the scoring and the commitments were incorporated into the contract. These commitments will be monitored during construction, operation and maintenance.

TxDOT described the process of pre-scoring with INVEST as a learning experience, especially the process of customizing the PD criteria. Communication was also identified as an important element of the process. While the planning module was not used, the importance of addressing the whole life-cycle was acknowledged. TxDOT was open to requiring sustainability elements or a specific INVEST achievement level for future projects, similar to this one. While sustainability elements may not be the primary criteria for the selection of a specific contractor over another, it may provide a good means of differentiating bidders in a close race. TxDOT indicated that a difference was made by using INVEST for the Harbor Bridge project, and while being easy to use, also served to challenge practitioners to think about sustainability.

California Department of Transportation

As directed through its strategic plan, Caltrans is involved in many sustainability related initiatives through its divisions and districts. Additionally, in 2014 Caltrans created a new position – Assistant Director of Sustainability to oversee the implementation of the department's newest goals: "sustainability, liveability and economy." This position reports directly to the director of Caltrans. The assistant director has the job to develop the sustainability goal, create objectives for it, and formulate performance measures to evaluate how well those objectives are achieved.

The director of Caltrans also issued their policy on sustainability: "Caltrans embraces and is committed to its role in improving the environment, the economy and social equity for all Californians. Caltrans strives to improve Californian's quality of life without compromising that of future generations. Caltrans meets this commitment by applying sustainability principles in the planning, design, construction, maintenance and operation of California's integrated multi-modal system". As part of this initiative the office of the Assistant Director of Sustainability facilitated the application of INVEST.

Caltrans implemented all modules of INVEST, working with the State Smart Transportation Institute of the University of Wisconsin/Madison and the FHWA. Caltrans was interested in developing performance measures for sustainability, looking at aspects such as mode shift, liveability, and resiliency. There was also an interest in prioritizing projects. While INVEST is not meant for project selection or prioritization, Caltrans still decided to apply INVEST as a learning experience. In applying the SP module, four existing transportation plans were evaluated. Similarly the PD and OM modules also evaluated existing projects. The evaluations for each section were done by teams working in that specific area.

An outcome identified by Caltrans staff was improved communication about sustainability – INVEST can be viewed as a "conversation starter" on the subject. The process was termed a learning experience for practitioners. However, there were higher levels of interest among planning staff, less interest among those working in operations and maintenance.

In terms of the tool itself, the criticisms included that in some cases, the "maximum" points were exceeded by current practice. Another issue raised was the "siloed" characteristics of the tool. It was also observed that in many cases, practitioners approached the evaluation process as an "optimization", i.e. to score the maximum number of points possible. Caltrans indicated that future applications may focus more on planning level –it was observed that greater impact can be made when the tool is used earlier in the process. The tool is also being looked at for possible

application in developing a sustainability score as part of an internal prioritization system of projects.

North Central Texas Council of Governments

North Central Texas Council of Governments (NCTCOG) was among the agencies to test the INVEST tool as part of FHWA's pilot program. NCTCOG is expecting a significant growth in inhabitants over the next 20 years and is thus facing increasing demand on their transportation system. This combined with a strengthened focus on environmental and quality of life issues led to the participation in the INVEST pilot study.

INVEST offered an opportunity for NCTCOG to put sustainability on the agenda, as well as to move away from sustainability being just a buzz-word. While "sustainability" does not always have a positive connotation among politicians and government officials in Texas, NCTCOG itself recognizes that "Among the key components of sustainable development are consideration of the interface between land use and transportation, planning for bicycle and pedestrian modes of transportation, and transit oriented development" (NCTCOG, 2015). NCTCOG also realized additional solutions beyond building roadway capacity to target congestion would be necessary as the region continued to grow.

NCTCOG applied the INVEST pilot tool's planning (SP) module for a post-adoption analysis of their metropolitan transportation plan (Mobility 2035) in 2012. The scoring with INVEST revealed areas that had been focused on the past as well as areas to emphasize in the future. Following the release of INVEST 1.0, NCTCOG repeated their assessment of the Mobility 2035 plan to serve as a baseline for comparison once the new Mobility 2040 plan was adopted.

The use of the INVEST tool created an opportunity to expand collaboration between the staff within the different expertise areas of NCTCOG. It furthermore presented the chance to discuss common goals for development. The result of the assessment using the pilot version and the INVEST 1.0 version resulted in slightly different ratings in the overall results - a platinum rating and gold rating, respectively (NCTCOG, 2014). Some of the reasons cited by NCTCOG for this difference in scores included staff turnover (different people conducting the evaluation), as well as changes in the scoring process. The inability to assign partial credit for actions within a criterion was mentioned as a main reason for the changed scores. The possibility for partial scoring had been removed in the INVEST 1.0 version. Additionally, it was noted that for several criteria, NCTCOG staff did not claim credit for several efforts where explicit documentation of actions in the mobility plan were not available.

The maximum available points for most criteria under the SP module were increased to 15 from 10. As seen in Figure 3, while several criteria received maximum credit of 10 points under the pilot version, none were assigned the full 15 points under INVEST 1.0. FHWA indicated that changes were made in the INVEST 1.0 based on feedback that it was relatively easy to score high on the beta version.

NCTCOG noted that the experience with INVEST has led to an increased focus within the more neglected areas and a continued focus on the remaining areas. Some of the areas and initiatives identified by NCTCOG as a result of the INVEST implementation include:

- Developing sustainability related performance measures
- Improving planning and environment linkages
- Linking asset management and planning
- Promoting infrastructure resiliency

Overall, the use of INVEST has helped NCTCOG identify their own strengths and weaknesses with regard to sustainable planning, and NCTCOG is planning to use INVEST to evaluate their

next MTP (Mobility 2040). However, they do not have control over the application of the PD and OM modules to projects in the plan.

One of the main lessons learned was the importance of evaluating within a local context. NCTCOG reiterated FHWA's caution that the tool is not intended for comparison of projects or among states. This subjectivity of the tool also became evident from the differences in scoring with the two versions of the tool.

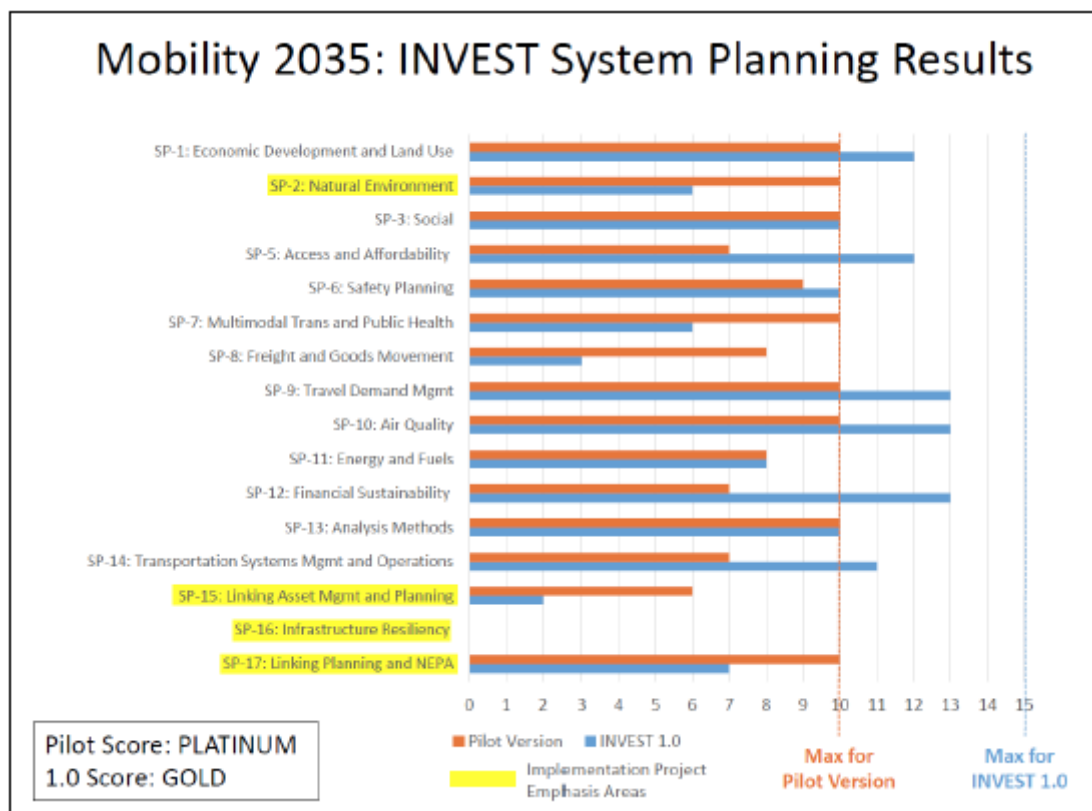


Figure 3. NCTCOG INVEST Scoring Results – Source (NCTCOG, 2014)

Southern California Association of Governments

SCAG is facing tremendous challenges with regards to growth and limited resources in the region, and at the state level, California's SB375 legislation and the regional GHG emissions targets make the need for sustainable community strategies very important. At the same time, SCAG noted that the lack of control over land use sometimes limits the amount of progress that the transportation sector can make towards sustainability.

SCAG worked with FHWA on the use of INVEST SP module for their regional transportation plan (RTP) adopted in 2012. The main motivation for doing so was to formally assess the plan – SCAG noted that they felt they were “ahead of the curve” in terms of addressing sustainability, but were not sure. FHWA worked with SCAG on the application of INVEST, which was very helpful to the practitioners. The plan was evaluated based on the three dimensions of sustainability - environmental, economic, and social. In response to the region's challenges and the sustainability requirements of SB 375, SCAG developed the 2012 RTP, which utilizes a system management approach based on comprehensive system monitoring and evaluation and the use of performance measures. The plan scored at the Platinum level (score of 176 of 250 possible points), but also identified areas with room for improvement. The high score is attributed to the following factors:

- Effectiveness of SB 375 in pushing the sustainability envelope

- Effectiveness of SCAG's heavy investment in several areas of strength
- Effectiveness of SCAG's broad spectrum of expertise and balanced approach to planning.

INVEST also revealed several areas of improvement for SCAG. For example, for the Infrastructure Resiliency criterion (SP-16) SCAG earned 0 points - the only non-bonus criterion that it did not earn any points in. In this regard, it was recommended that SCAG develop a white paper to assess the feasibility of developing a Regional Infrastructure Resiliency plan that will provide a blueprint for SCAG's future engagement in this area.

While SCAG is only using INVEST for system planning, it was noted that the tool can be used to make an impact at other levels as well - especially on the operations and maintenance side, which is a huge issue in California, with aging infrastructure and limited resources. Future applications could also include the PD module for corridor planning studies. Overall, SCAG felt that the use of INVEST was a fruitful exercise, that allowed different divisions within the agency to work together. It helped staff to understand sustainability better, fostered dialog and forced people to work together and do better. Since INVEST is a self-evaluation tool, the users were expected to be brutally honest - it was made clear at the outset that the results were not going to be used to point fingers or assign blame - and this helped obtain a realistic assessment of things. SCAG plans to apply INVEST to the next regional transportation plan, where it hopes to see improvements made to the existing scores.

4. Assessment and Conclusions

In terms of national-level policy, it is clear that the US does not have a strong, holistic policy that explicitly supports or incorporates sustainable transportation. However, this is not unexpected, keeping in mind the realities of the US context. This includes having a transportation system that is exceedingly automobile oriented, and where personal car ownership and use is relatively cheap compared to a majority of regions around the world. Another related aspect is the overall mind-set that prioritizes maintaining current system performance, in contrast to fundamentally changing the system. Furthermore, there is a focus on mostly technological solutions to tackle sustainability issues related to energy consumption and GHG emissions. An additional factor is the lack of control that transportation agencies have over land use - which makes it a challenge to effect significant change on transportation demand patterns. Further, the USDOT is divided into operating administrations by functional area (such as highways and transit), which creates organizational siloes in how transportation is funded and administered.

Also, transportation planning is conducted primarily at the local (state/metropolitan area) level, and considerable autonomy has been granted to states and local entities. These states and regions vary vastly in terms of politics, including attitudes and policies towards climate change and environmental stewardship. While planning responsibilities are primarily devolved to MPOs, the mandated federal processes (involving DOT-administered funding, federal oversight, and engagement of multiple stakeholders) generally mean that MPOs cannot unilaterally effect significant change without state-level support.

The US also faces considerable debate on the role and size of government, dating back to the country's founding. This, coupled with the politicization of the climate issue, has hampered progress in this regard. Thus, at the federal level, guidance and policies are somewhat constrained in being able to prescribe or mandate a more strong approach to sustainable transportation.

It can be argued that at the federal level, there is acknowledgement of the need for a triple bottom line sustainability approach, and specifically in the transportation arena, progress has been made in promoting at least a weak conceptualization of sustainability. Progress is clearer in terms of issues such as environmental stewardship, and less so for the social dimension of sustainability.

This is consistent with the US' focus on economic growth rather than economic equity/promoting a welfare state, when compared to many European nations. Also, a clear future-focused outlook on sustainability is lacking, as evidenced by the MAP-21/FAST national performance goals. The need for a change in paradigm is acknowledged by reports such as the Beyond Traffic framework; however, it is not clear how future policies will evolve to address this needed paradigm shift.

Further supporting the "weak sustainability" notion is the numerous examples by which sustainability is addressed implicitly – through initiatives focused on liveability, health, climate adaptation, quality of life, etc. Many of these programs do not directly characterize as 'sustainable', but nevertheless support sustainability. Questions remain as to whether: 1) these programs or initiatives came about as more "politically palatable" alternative to sustainable transportation planning, and 2) whether addressing sustainability through these implicit means helps or hurts the overall cause of sustainability. Overall, there is the need for further research into the discourse surrounding transportation and sustainability in the US, and how the emphasis on system performance (from an auto-oriented perspective) affects policies and programs.

In the case study of the INVEST tool (as well as the overall assessment of national-level programs and policies), it is seen that the FHWA is very aware of the concept of sustainability and had done a lot of work framing their approach to the issue⁸. The INVEST program, being their flagship sustainability program, is a comprehensive sustainability evaluation system, that operates effectively to promote sustainability, albeit within the constraints and context discussed above. At a minimum, its application can help advance dialogue on sustainability considerations, even if outcomes are not measurably affected. This, in turn can influence practitioner knowledge and mindset over the long term (Innes, 1998; Gudmundsson and Sørensen, 2013).

Some key takeaways from our case study analysis of INVEST and its applications are as follows:

- "Cradle to Grave" Implementation – the maximum progress can be made where sustainability considerations play into the entire spectrum from planning to project implementation (i.e. use of all modules). However, in the absence of a mandate to use INVEST (which the FHWA has no plans/current authority to require), it is up to different local entities to work together to apply INVEST in a comprehensive manner. A related question from a sustainability perspective is whether true sustainability can be achieved without application at the planning level (i.e. the system planning module) – which holds the potential for the most 'radical' change and offers the most opportunities for collaboration with other planning disciplines and a holistic approach to sustainability.
- Tradeoffs, Weak Sustainability – The structure of the INVEST tool allows for tradeoffs between the sustainability dimensions. The social dimension of sustainability is given relatively less importance in the PD and OM modules. Moreover, the scoring system is set up such that it is possible to just focus on environmental or economic aspects, with minor consideration of other dimensions, and still obtain a certification. This also runs the risk for a business-as-usual approach to be repackaged as sustainable.
- Weighting and Prioritizing Criteria – In the analysis of the INVEST 1.1 system, it was seen that the individual criteria for the SP and OM modules were more or less equally weighted, whereas there was a more nuanced weighting of criteria in the PD module. The PD module also allows for greater flexibility in customizing the criteria and context. A similar approach may be desirable for the SP module and OM module as well – as both represent important areas to tackle sustainability – planning for the ability to truly affect the future and promote

⁸ An interesting contrast was observed with the FTA – whose approach to sustainability was much more implicit. To a certain extent, FTA viewed the provision of transit in and of itself as being sustainable – and the case can certainly be made for this in the US context, where any shift of mode away from automobiles can be viewed as supporting sustainability.

multi-modal, holistic solutions, and operations/maintenance of infrastructure, as it represents a majority of the activities of state DOTs in the US.

- **Self-Selection Bias and Ability to Effect Change-** Several of the applications of INVEST studied involved existing plans or projects - which raises the question of whether INVEST truly acted as a change agent in all cases. Another aspect to consider is whether the users of INVEST generally tend to be organizations that are already trying to take actions toward sustainability, i.e. if INVEST is being applied to evaluate what would have anyway been a relatively "sustainable" plan or project. At the same time, as seen in the case study, all organizations interviewed indicated that using INVEST helped them identify areas for improvement. INVEST is still a relatively new program, and it may take further time for its use cases to mature for more comprehensive evaluation.
- **Context and Comparisons -** a recurring theme among the organizations in the case study (which is reinforced by FHWA) is the fact that context of the evaluation is still key. INVEST relies on self-evaluation and there is room for subjectivity in several of the criteria (not very data-driven). Thus, project prioritization and comparison of agencies is not entirely feasible currently.
- **Communication and Understanding of Sustainability -** another common thread was the notion that INVEST promoted cross-departmental (and occasionally cross-agency) collaboration, as well as an awareness and understanding of sustainability. These are initial positive outcomes that can possibly lead to more meaningful impacts in the future.

In conclusion, we see that INVEST has emerged as a tool that is uniquely suited to the US. Its flexibility allows for different states or regions to apply it in their particular context, its focus is primarily on highways, and it is a voluntary tool that is not tied to any regulatory requirements. At the same time, the broad and flexible nature of INVEST allows it to have applicability beyond the US, by providing a set of reference points for systematic assessment of sustainability in the highway context. In contrast to the US, transportation planning and project selection in Europe tends to have a more multimodal emphasis. We therefore anticipate that INVEST may be of greatest relevance to highway projects subsequent to project selection, rather than at the planning level. The PD and OM modules can help agencies systematize sustainability assessments and identify opportunities to implement sustainability-oriented practices.

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