

GREEN GENERATES GREEN

PI: Asad J. Khattak, Ph.D.

Co-Investigators: Chris, Cherry, Ph.D. & P.E., Shashi Nambisan, Ph.D. & P.E.,
& David Greene, Ph.D.

The Tennessee Department of Transportation
Research Development and Technology Program

RES #: RES2016-10

PURPOSE OF THE PROJECT

The purpose of this project is to undertake the challenge of identifying, selecting and suggesting implementation of sustainable strategies in the Tennessee Department of Transportation. Specifically, the project will identify successful sustainable DOT practices and suggest development of performance measures that can be used to assess the value of sustainable project alternatives. As part of the project, a conceptual framework that measures return-on-investment of sustainable strategies and programs will be developed along with potential applications.

Sustainable transportation implies providing access and mobility in the most efficient and safe manner while being a good steward of public funds and environmental resources. The sustainability approach typically considers a wide range of issues that affect, or are affected by, transportation, e.g., issues in making transportation decisions should include diverse systems such as land use, growth plans and projections, economic development, adequate funding, construction materials, environmental quality, equity and other social issues and the cumulative impact of all of these on the quality of life. Transportation system improvement decisions are affected by the distribution of costs and benefits that accrue to various stakeholders. Economic analysis in the context of sustainability and transportation investment decisions examines how to make the best use of constrained resources over time. It can help define issues, assess benefits and costs that achieve sustainability goals. Transportation agencies are increasingly considering return-on-investment (ROI) when evaluating projects for inclusion in plans and programs. Notably, some of the benefits of sustainability projects are not traditionally included in benefit-cost analysis. This project will deal with developing a methodology that quantifies the key economic, social, and environmental benefits to evaluate return-on-investment of sustainable transportation projects using a broad perspective. Benefit-cost analysis (BCA) and Life-Cycle Cost Analysis (LCCA) will be used to measure the return-on-investment for available feasible options. The method developed in this research will better reflect the benefit of sustainable strategies and help TDOT make informed decisions about selection of sustainable options.

SCOPE AND SIGNIFICANCE OF THE PROJECT

This project focuses on sustainable strategies that can address the problems of congestion, energy consumption, pollution, and safety in Tennessee. There is a need to more widely use the sustainability lens for evaluation of programs and projects, which means capturing the economic, social and environmental aspects of projects. Various strategies can enhance the sustainability of transportation systems and reduce the negative impacts associated with movement of goods and

people. For example, sustainable options include using recycled materials in construction projects, retrofitting fleets to reduce vehicle emissions or investing in multimodal infrastructure to provide transportation options for the public. However, due to financial constraints, it is important to make informed decisions based on sustainable strategies that offer the most benefits. Thus, there is a need to assess what sustainable practices are feasible and given a set of options, which ones are cost-effective. We will develop and present an approach that is ideally suited to exploring sustainable practices, and assess their long-term value and success in Tennessee. The scope of the research work will encompass sustainable practices and projects under consideration or implemented by TDOT and related transportation agencies (Transportation Planning Organizations and localities) in Tennessee. Specific projects will be analyzed in detail using the federally developed INVEST tool. Through a review of sustainable practices at other DOTs, we will assess sustainable practices their transferability to TDOT, and conduct cost benefit/effectiveness analysis for return-on-investment, including difficult to quantify and intangible benefits of projects.

EXPECTED OUTCOMES

The overall outcome of this study is the consideration and future implementation of sustainable strategies and practices in TDOT that can address the problems of congestion, energy consumption, pollution, and safety. The study itself will generate useful information about existing sustainable practices in other DOTs and assess their transferability to Tennessee. The project will also identify successful sustainable practices in TDOT, and enhance TDOT's capacity to use performance measures that quantify costs and benefits and cost-effectiveness of sustainable projects. The study will suggest tools that evaluate return-on-investment and intangible benefits of potential strategies for sustainable transportation and identify potential funding sources for sustainable projects. Perhaps an important outcome will be the realization that green projects can be financially beneficial, especially, when using the sustainability lens.

TIME PERIODS AND STATUS OF THE PROJECT

This is an 18-month project (January 2016 – June 2017) and consists of four project milestones:

Action 1: Create conceptual framework to measure return-on-investment.

Action 2: Determine the transferability of other DOT practices in TDOT.

Action 3: Demonstrate methodology and performance measures regarding return-on-investment.

Action 4: Recommend best practices to TDOT for implementation.

Table 1 presents the tasks and the progress made. The project team has achieved the following:

- 1) A kick-off meeting with TDOT leadership and experts in Nashville on February 5, 2016. A presentation (PowerPoint) was given to TDOT staff, which focused on the need of sustainability driven projects, and associated economic, social, environmental and engineering benefits. The presentation also provided a detailed review of sustainable projects and practices which have been undertaken by the research team in the past. Several state-of-the-art analytical tools such as INVEST, BCA.Net, LCCA and Cal-B/C which can be used for analysis of projects were discussed.
- 2) A detailed review document of sustainable asphalt pavement materials used by other state DOTs, such as Texas, Florida, Ohio, Indiana and Missouri DOTs, was developed and provided to TDOT documenting the benefits of reclaimed asphalt pavements (RAP) and recycled asphalt shingles (RAS) in terms of reducing the use of virgin asphalt binder, aggregates and landfill space.
- 3) A follow-up meeting with Mr. Alan Jones occurred for obtaining input regarding the future direction of the project on June 13, 2016 in Nashville. Five high priority divisions in TDOT were identified by Mr. Alan Jones including construction, maintenance, planning, materials, and environment.
- 4) Currently, the research team has summarized the sustainable strategies adopted by other state DOTs, including Virginia, California, Colorado, New York, Oregon, Texas, and Washington. The reduction of greenhouse emission and energy consumption was emphasized through different

sustainable strategies, such as increasing alternative fuel vehicles, using recycled materials, upgrading lights with LEDs and improving public transit.

- 5) Using text mining technology, the research team is now working on analyzing sustainable practices and key performance measures used by other state DOTs.

Table 1. Project Timeline and Schedule (Note: Red marking indicates completed tasks)

Task #	Tasks	Anticipated Completion Date (month)																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Review TDOT's sustainable practices	■	■	■	■						■	■							
2	Perform a best practices analysis of other Transportation agencies' sustainability programs		■	■	■	■	■	■											
3	Coordinate with TDOT staff to determine transferability of practices/projects at other DOTs that can be potentially implemented in TDOT				■	■	■	■	■	■									
4	Develop performance measures and cost benefit/effectiveness analysis				■	■						■	■	■					
5	Write brief interim progress report summarizing findings & do a presentation of findings to TDOT staff													■	■				
6	Identify potential funding sources for recommended sustainable projects																	■	■
7	Coordinate with TDOT leadership and appropriate staff on findings	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
8	Document findings and suggest implementation of selected best practices																		■

CONTACT INFORMATION

Principal Investigator

Asad J. Khattak, Ph.D.
 Beaman Professor of Civil and Environmental Engineering
 University of Tennessee
 E-mail: akhattak@utk.edu

Co-Investigators

Christopher Cherry, Ph.D., P.E.
 Associate Professor of Civil and Environmental Engineering
 University of Tennessee
 Email: cherry@utk.edu

Shashi Nambisan, Ph.D., P.E.
 Professor of Civil and Environmental Engineering
 University of Tennessee
 Email: shashi@utk.edu

David Greene, Ph.D.
 Faculty Research Professor of Civil and Environmental Engineering
 University of Tennessee
 Email: dgreen32@utk.edu