Developing Sustainable Transportation Performance Measures for ALDOT

By

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UTCA

University Transportation Center for Alabama
The University of Alabama, The University of Alabama at Birmingham, and
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UTCA Report Number 12302
June 2013

UTCA Theme: Management and Safety of Transportation Systems

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About UTCA The University Transportation Center for Alabama (UTCA) is headquartered in the Department of Civil, Construction, and Environmental Engineering at the University of Alabama (UA). Interdisciplinary faculty members perform research, education, and technology-transfer projects using funds provided by UTCA and external sponsors.

Mission Statement and Strategic Plan The mission of UTCA is "to advance the technology and expertise in the multiple disciplines that comprise transportation through the mechanisms of education, research, and technology transfer while serving as a university-based center of excellence."

The UTCA strategic plan contains six goals that support this mission:

- Education – conduct a multidisciplinary program of coursework and experiential learning that reinforces the theme of transportation;
- Human Resources – increase the number of students, faculty and staff who are attracted to and substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Diversity – develop students, faculty and staff who reflect the growing diversity of the US workforce and are substantively involved in the undergraduate, graduate, and professional programs of UTCA;
- Research Selection – utilize an objective process for selecting and reviewing research that balances the multiple objectives of the program;
- Research Performance – conduct an ongoing program of basic and applied research, the products of which are judged by peers or other experts in the field to advance the body of knowledge in transportation; and
- Technology Transfer – ensure the availability of research results to potential users in a form that can be directly implemented, utilized or otherwise applied.

Theme The UTCA theme is *"MANAGEMENT AND SAFETY OF TRANSPORTATION SYSTEMS."* UTCA concentrates upon the highway and mass transit modes but also conducts projects featuring rail, waterway, air, and other transportation modes as well as intermodal issues.

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16. Abstract

Sustainable transportation is generally used to refer to transportation that contributes to the sustainable development of the community that owns and uses the system. The Transportation Research Board defines sustainability as: "*Sustainability is not about threat analysis; sustainability is about systems analysis. Specifically, it is about how environmental, economic and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation*." The research project was designed to establish a baseline understanding of the potential for using sustainability performance measures in the Alabama Department of Transportation. Quite a number of sustainability initiatives have discussed various definitions and performance measures of sustainable transportation systems, but very few regional agencies have developed planning tools that successfully incorporate sustainability in the transportation sector. This study develops a working definition of sustainability from various proposed definitions, and demonstrates a feasible methodology for evaluating and quantifying sustainability performance measures, thus incorporating sustainability considerations into the regional transportation decision-making process.

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Table of Contents

List of Tables

Executive Summary

The purpose of this report is to describe how Alabama Department of Transportation (ALDOT) may increase its use of performance measures in transportation for sustainability. There simply cannot be improvement without measurement. Performance measurement is typically successful when meaningful measures are selected, the proper data needed for the measurement is obtained, and the measurement is incorporated into an overall planning process that guides decision making based off the measurement. Performance based planning uses various performance measures to influence agency decisions, particularly policy and resource allocation decisions, and implementing the "right" measures is a key element.

Sustainable transportation is generally used to refer to transportation that contributes to the sustainable development of the community that owns and uses the system.
The Transportation Research Board defines sustainability as:

"*Sustainability is not about threat analysis; sustainability is about systems analysis. Specifically, it is about how environmental, economic and social systems interact to their mutual advantage or disadvantage at various space-based scales of operation*."

Sustainability involves improving energy efficiency, reducing dependence on oil, reducing greenhouse gas emissions and benefiting the environment. The project aims at developing the indicators within the confines of strategic planning goals to measure sustainability of transportation systems. The project would increase energy efficiency by allowing for smooth and consistent travel speeds, with a reduction in the frequency of stops, continued braking, or downshifting in the roadway section under study, when capacity is reached. It is expected that consistent travel at a consistent speed would improve energy efficiency.

1. Introduction

1.1 Background

Identified as a global priority by the United Nations in the early 1980s, the concept of sustainable development is most commonly defined as "D*evelopment that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (World Commission on Environment and Development, 1987). There is no single definition for the "sustainable" transportation system. According to the definition given by the Transportation Research Board Sustainable Transportation Indicators Subcommittee, a sustainable transport system is one that

1. Allows the basic access and development needs of individuals, companies, and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.
2. Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.
3. Limits air, water, and noise emissions, waste, and resource use. Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

The aim of this project is to research current transportation systems and develop a set of performance measures appropriate for establishing the sustainable level of performance for Alabama's transportation system. Sustainable transportation goals include:

1. Environmental Quality
   - Public health
   - Ecosystem viability
2. Economic Development
   - Quality of life
   - Mobility that supports economic growth

3. Social Equity
   - Affordable mobility
   - Mobility for all socioeconomic groups

Why are Sustainability and Performance Measures Important in Transportation?

The importance of sustainable development in the transportation sector is clearly indicated by the fact that a large number of transportation agencies have started to consider and integrate the concept of sustainability in their activities. In the United States, for example, over 40% of state departments of transportation (DOTs) have incorporated some element of sustainability into their vision or mission statements (Jeon et al., 2007). State DOTs are mission-driven organizations that strive to simultaneously achieve multiple strategic goals such as improving safety, reducing congestion, enhancing economic opportunity, contributing to community vitality, improving air quality, improving reliability, and preserving system assets. They have been experimenting with, refining, expanding, and enhancing their performance measurement systems over that period. Transportation agencies are arguably often on the leading edge of results-oriented management and performance measurement practices at all levels of government.

The goal of the Transportation Division (State DOT's) is to provide adequate, efficient and safe transportation services and mobility for the general public while considering the economic, social and environmental needs as described in Table 1-1.

Table 1-1: Sustainable Transportation Issues (Litman and Burwell, 2006)

Economic	Social	Environmental
Accessibility quality	Equity/ fairness	Air pollution
Traffic congestion	Aesthetics	Climate change
Infrastructure costs	Affordability	Noise pollution
Consumer costs	Human health impacts	Water pollution
Mobility barriers	Community cohesion	Hydrologic impacts
Accident damages	Community livability	Habitat and ecological degradation
Depletion of non-renewable resources	Impacts on mobility disadvantaged	Depletion of non-renewable resources

1.2 Objectives

The following are the main objectives of this project:

1. Develop an understanding of sustainable transportation.
2. Review major studies and initiatives of sustainable transportation.
3. Create a framework for using sustainable transportation performance measures based on the types of applications that need to be supported.
4. Develop a methodology that can be implemented in the form of a sustainability enhancement tool.
5. Develop sustainable transportation performance measures to address ALDOT's strategic plan goals.
6. Identify data elements and data sources required to quantify the measures.

1.3 Work Tasks

The state of Alabama is a leader in providing an opportunity for researchers. The project is organized into the following sequential tasks:

Task 1. Literature and Information Collection

The first task for the study is to conduct a literature review and summarize relevant literature and ongoing relevant research, including that related to independent sustainability and environmental stewardship certification systems.

Task 2. Developing Sustainability Objectives and performance parameters of Importance for Alabama

After completing Task 1, the team will develop a performance-measurement framework for the implementation of sustainability enhancement specific to highways.

Task 3. Developing sustainable transportation performance measures

The items identified in Tasks 1 & 2 will be analyzed and related to sustainable performance measures that can be applied to ALDOT. Task 3 objectives are to identify best practices used by other transportation departments that have incorporated sustainability in their goals and objectives.

2. Literature Review

In order to effectively determine which performance measures were appropriate for Alabama's transportation infrastructure, it was necessary to examine the existing research and literature on performance measures. Several other state DOTs have well-established performance measurement systems and mission statements (Table 2-1) from which best practices can be learned.

Table 2-1 [5]**:** Sustainability in the Missions of State Departments of Transportation (U.S.)

Departments/States	Mission Statement
U.S. Department of Transportation (Sep. 21. 2007)	"Serve the United States by ensuring a fast, safe, efficient, accessible, and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future."
Alabama	"To provide a safe, efficient, environmentally sound intermodal transportation system for all users, especially the taxpayers of Alabama. To also facilitate economic and social development and prosperity through the efficient movement of people and goods and to facilitate intermodal connections within Alabama."
Florida (Sep. 21, 2007)	"The Department will provide a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity and preserves the quality of our environment and communities."
Georgia (Sep. 21, 2007)	"The Georgia Department of Transportation provides a safe, seamless, and sustainable transportation system that supports Georgia's economy and is sensitive to its citizens and environment."
Hawaii	"To provide a safe, efficient, accessible, and inter-modal transportation system that ensures the mobility of people and goods, and enhances and/or preserves economic prosperity and the quality of life."
Indiana (Sep. 21, 2007)	"INDOT will build, maintain, and operate a superior transportation system enhancing safety, mobility and economic growth."
Louisiana	"To deliver transportation and public works systems that enhances

(Updated, Sep. 21, 2007)	quality of life and facilitates economic growth and recovery."
Michigan (Sep. 21, 2007)	"Providing the highest quality integrated transportation services for economic benefit and improved quality of life."
Montana (Sep. 21, 2007)	"Montana MDT's mission is to serve the public by providing a transportation system and services that emphasize quality, safety, cost effectiveness, economic vitality and sensitivity to the environment."
New Hampshire	"To plan, construct, and maintain the best possible transportation system and State facilities in the most efficient, environmentally sensitive, and economical manner, utilizing quality management techniques consistent with available resources and mandated controls."
New Jersey (June 26, 2007)	"Improving Lives by Improving Transportation."
New York (Sep. 21, 2007)	"To ensure our customers -- those who live, work, and travel in New York State -- have a safe, efficient, balanced, and environmentally sound transportation system.
Nevada (Sep. 21, 2007)	"To efficiently plan, design, construct and maintain a safe and effective transportation system for Nevada's travelers taking into consideration the environment, economic and social needs and intermodal transportation opportunities."
North Carolina	"Connecting people and places in North Carolina – safely and efficiently, with accountability and environmental sensitivity."
Ohio	"To provide a world-class transportation system that links Ohio to a global economy while preserving the state's unique character and enhancing its quality of life."
Oregon (Sep. 21, 2007)	"To provide a safe and efficient transportation system that supports economic opportunity and livable communities for Oregonians"
Rhode Island (Sep. 21, 2007)	"To maintain and provide a safe, efficient, environmentally, aesthetically and culturally sensitive intermodal transportation network that offers a variety of convenient, cost-effective mobility opportunities for people and the movement of goods supporting economic development and improved quality of life."

South Dakota (Sep. 21, 2007)	"We provide a transportation system to satisfy diverse mobility needs in a cost effective manner while retaining concern for safety and the environment."
Texas	"To work cooperatively to provide safe, effective, and efficient movement of people and goods."
Utah	"Quality Transportation Today, Better Transportation Tomorrow."
Vermont (Updated, Sep. 21, 2007)	"To provide for the movement of people and commerce in a safe, reliable, cost-effective and environmentally responsible manner."
West Virginia (Sep. 21, 2007)	"To create and maintain for the people of West Virginia, the United States and the world a multi-modal and inter-modal transportation system that supports the safe, effective and efficient movement of people, information and goods that enhances the opportunity for people and communities to enjoy environmentally sensitive and economically sound development."

2.1 Integrating Sustainability Concepts into Transportation Planning

First and foremost, the concept of sustainability has to be clearly understood. Few could disagree that attainment of a sustainable transportation system is desirable despite many challenges. The state DOT's have enhanced the quality of life which has not been achieved without costs. The negative impacts of the transportation system include congestion, fatalities and injuries, noise, air, and water pollution, greenhouse gas emissions, diminishing energy resources, and biological and ecosystem damage. The challenge of a sustainable transportation system lies in minimizing these costs while offering strong transportation benefits. The following best describe the various unsustainable impacts:

2.1.1 Non-renewable Fuel Depletion and Energy Insecurity

The current transportation system depends on non-renewable resources, and the rate of consumption is gradually increasing. The challenge is in finding more renewable resources to satisfy the definition of sustainability.

2.1.2 Greenhouse gas emissions

The burning of fossil fuels and petroleum products to run vehicles emit greenhouse gases contributes to global warming. Improved fuel efficiency and use of alternative fuels reduce the greenhouse effect.

2.1.3 Global Climate Change

Increased emission of greenhouse gases will have significant impacts on sea level, climate, and agriculture. Rise in the sea level causes flooding of the land. It appears to be too late to prevent or completely reverse the climate change.

2.1.4 Local Air Quality

The vehicles emit carbon dioxide which significantly contributes to local air pollution. Poor air quality has various health impacts. Therefore, air quality regulations should be made for substantial air quality improvements.

2.1.5 Fatalities and Injuries

Gruesome fatalities and injuries occur on the highways. Sustainability argues for a decrease in fatalities and injuries.

2.1.6 Congestion

Congestion is a great sustainability issue because it worsens motorized mobility. It negatively affects the economic and social health of the nation, but it also has some positive implications for sustainability because congested highways cause some people to choose alternative modes of transportation.

2.1.7 Noise Pollution

The transportation system is a significant source of noise. Despite the progress that has been made, new methods, technologies and policies to reduce noise pollution are required.

2.1.7 Low Mobility

A reasonable level of mobility is an essential characteristic of a sustainable transportation system. Transportation must be available to all members of the community, including people with low income, physically challenged, the elderly, and children.

2.1.8 Ecosystem Damage

Transportation activities can cause biological damage. With the increase in population and travel volume, very little care is taken towards endangered species. A continuous effort should be made to maintain and improve on areas of wildlife habitat.

2.1.9 Lack of equity

Intergenerational and social equity are the overarching aims of a sustainable transportation system. Properly planned transportation systems can play a central role in promoting sustainability.

2.2 Sustainability Performance Measures by other DOT's

Another application of sustainability performance measures in the transportation sector involves the use of rating systems for sustainability. In general, a rating system for transportation sustainability provides a framework for scoring and evaluating various projects or alternatives that contain a checklist of potentially sustainable practices.

The following lists selected transportation sustainability rating systems that were reviewed as part of this research:

2.2.1 Federal Highway Administration's (FHWA's) Sustainable Highways

FHWA developed INVEST (Infrastructure Voluntary Evaluation Sustainability Tool) as a tool, called criteria, to help transportation agencies integrate sustainability into their programs. There are 60 criteria within INVEST organized into three modules – System Planning, Project Development, and Operations and Maintenance. There is a scorecard for each module, and the scorecard for Project Development is shown in Table 2-2.

Table 2-2[19]: Project Development by criteria scorecard by FHWA's

	Paving	Basic Rural	Basic Urban	Extended Rural	Extended Urban	Custom
PD-01: Economic Analyses		X	X	X	X	
PD-02: Life-Cycle Cost Analyses	X	X	X	X	X	X
PD-03: Context Sensitive Project Development	X	X	X	X	X	X
PD-04: Highway and	X	X	X	X	X	X

Traffic Safety						
PD-05: Educational Outreach	X	X	X	X		X
PD-06: Tracking Environmental Commitments		X	X	X		
PD-07: Habitat Restoration	X	X	X	X	X	
PD-08: Stormwater		X	X	X	X	X
PD-09: Ecological Connectivity	X	X	X	X	X	X
PD-10: Pedestrian Access			X		X	X
PD-11: Bicycle Access	X	X	X		X	X
PD-12: Transit & HOV Access			X	X	X	X
PD-13: Freight Mobility		X	X	X	X	X
PD-14: ITS for System Operations	X		X	X	X	
PD-15: Historical, Archaeological, and Cultural Preservation	X		X	X	X	X
PD-16: Scenic, Natural, or Recreational Qualities		X	X		X	X
PD-17: Energy Efficiency		X	X		X	X
PD-18: Site Vegetation	X	X	X	X	X	

PD-19: Reduce and Reuse Materials	X	X	X	X	X	
PD-20: Recycle Materials		X	X	X	X	X
PD-21: Earthwork Balance		X	X	X	X	
PD-22: Long-Life Pavement Design		X	X	X	X	X
PD-23: Reduced Energy and Emissions in Pavement Materials	X		X	X	X	X
PD-24: Contractor Warranty		X	X	X		
PD-25: Construction Environmental Training		X	X			X
PD-26: Construction Equipment Emission Reduction		X	X		X	
PD-27: Construction Noise Mitigation		X	X		X	
PD-28: Construction Quality Control Plan		X	X	X	X	X
PD-29: Construction Waste Management		X	X			
Total number of criteria in Scorecard	**12**	**24**	**29**	**21**	**25**	**19**

2.2.2 Sustainable Transportation Access Rating System (STARS)

Framework applies 29 credits organized into six categories: integrated process, access, climate and energy, ecological function, cost effectiveness analysis, and innovation as shown in Table 2-3 below.

Table 2-3[6]**:** Credit Scorecard (Complete List of Credits)

Integrated Process	
IP1	Establish Project Framework and Goals (Required)
IP2	Multi-Discipline Project Team
IP3	Public Stakeholder Engagement
Access	
A1	Establish Access Goals and Objectives (required)
A2	Evaluate Expanded Transportation Demand Management Strategies
A3	Evaluate Expanded Transportation System Management Strategies
A4	Evaluate Expanded Land Use Strategies
A5	Evaluate Expanded Transportation Supply and Service
A6	Select Preferred Strategies from A2-A5
A7	Implement Selected Strategies
A8	Assess Performance Over Time
Climate and Energy	
CE1	Establish Climate and Energy Goals and Objectives (Required)
CE2	Evaluate Vehicle Mile Reduction Strategies
CE3	Evaluate Improving Vehicle Flow
CE4	Evaluate Construction Materials and Methods
CE5	Evaluate Renewable Energy and Energy Efficiency
CE6	Cleaner Vehicles and Fuels Goal and Evaluation
CE7	Maintenance and Preservation Goal and Evaluation
CE8	Carbon Offset Evaluation
CE9	Implement Climate and Energy Strategies
CE10	Climate and Energy Performance

Ecological Function	
EF1	Identify and Quantify Ecological Resources (Required)
EF2	Protect and Restore Ecological Functions
EF3	Stormwater Quantity and Quality Management
EF4	Integrated Stormwater Management
Cost Effective Analysis	
CEA1	Cost Estimation and Cost-Effective Calculations
CEA2	Selecting Cost-Effective Projects and Programs
Innovation	
IV1	Additional Actions Resulting in More Access and/or GHG Reductions
IV2	Actions Improving STARS Effectiveness

2.2.3 Greenroads

Greenroads is a project-based sustainability rating system. Performance metric awards points for more sustainable practices during the design and construction phases of roadway projects as shown in Table 2-4.

Table 2-4[7]**:** Greenroads Listing by Category

No.	Title	Pts.	Description
Project Requirements (PR)			
PR-1	NEPA Compliance or Equivalent	Req	Conform to NEPA or equivalent
PR-2	Life Cycle Cost Analysis (LCCA)	Req	Perform LCCA for pavement section
PR-3	Life Cycle Inventory (LCI)	Req	Perform LCI of pavement section
PR-4	Quality Control Plan	Req	Have a formal contractor quality control plan
PR-5	Noise Mitigation Plan	Req	Have construction noise mitigation plan
PR-6	Waste Management Plan	Req	Have a plan to divert C&D waste from landfill
PR-7	Pollution Prevention Plan	Req	Have a TESC/SWPPP
PR-8	Low-Impact Development (LID)	Req	Use LID stormwater management where applicable

PR-9	Pavement Maintenance	Req	Have a pavement preservation system
PR-10	Site Maintenance	Req	Have a roadside maintenance plan
PR-11	Educational Outreach	Req	Publicize sustainability information for project
Voluntary Credits			
Environment & Water (EW)			
EW-1	Environmental Management System	2	ISO 14001 certification for general contractor
EW-2	Runoff Quantity	3	Reduce runoff quantity
EW-3	Runoff Quality	3	Treat stormwater to a higher level of quality
EW-4	Stormwater LID/BMP Cost Analysis	1	Conduct an LCCA for stormwater BMP/LID selection
EW-5	Native Re-vegetation	3	Use native low/no water vegetation
EW-6	Habitat Restoration	3	Create new habitat beyond what is required
EW-7	Ecological Connectivity	3	Connect habitat across roadways
EW-8	Light Pollution	3	Discourage light pollution
EW Subtotal		21	
Access & Equity (AE)			
AE-1	Safety Audit	2	Perform roadway safety audit
AE-2	Intelligent Transportation Systems (ITS)	5	Implement ITS solutions
AE-3	Single-Occupant Vehicle (SOV) Reduction	5	Reduce SOV use through quantifiable methods
AE-4	Context Sensitive Planning	5	Plan for context sensitive solutions
AE-5	Pedestrian Access	2	Provide/improve pedestrian accessibility
AE-6	Bicycle Access	2	Provide/improve bicycle accessibility
AE-7	Transit Access	5	Provide/improve transit accessibility
AE-8	Scenic Views	2	Provide views of scenery or vistas
AE-9	Cultural Outreach	2	Promote art/culture/community values
AE Subtotal		30	
Construction Activities (CA)			

CA-1	Quality Process Management	2	ISO 9001 certification for general contractor
CA-2	Environmental Awareness Training	1	Provide environmental training
CA-3	On-Site Recycling Plan	1	Provide on-site recycling and trash collection
CA-4	Fossil Fuel Use Reduction	2	Use alternative fuels in construction equipment
CA-5	Equipment Emission Reduction	2	Meet EPA Tier 4 standards for non-load equip.
CA-6	Paving Emission Reduction	1	Use pavers that meet NIOSH requirements
CA-7	Water Use Monitoring	2	Develop data on water use in construction
CA-8	Performance-Based Warranty	3	Warranty on the constructed pavement
	CA Subtotal	14	
Materials & Resources (MR)			
MR-1	Full Life Cycle Assessment (LCA)	2	Conduct a detailed LCA of the entire project
MR-2	Pavement Reuse	5	Reuse existing pavement sections
MR-3	Soil Rehabilitation	1	Use native soil rather than import fill
MR-4	Recycled Materials	5	Use recycled materials for new pavement
MR-5	Regional Materials	5	Use regional materials to reduce transportation
MR-6	Energy Efficiency	5	Improve energy efficiency of operational systems
	MR Subtotal	23	
Pavement Technologies (PT)			
PT-1	Long-Life Pavement	5	Design pavements for long-life
PT-2	Permeable Pavement	3	Use permeable pavement as a LID technique
PT-3	Warm Mix Asphalt (WMA)	3	Use WMA in place of HMA
PT-4	Cool Pavement	5	Contribute less to urban heat island effect (UHI)

PT-5	Quiet Pavement	3	Use a quiet pavement to reduce noise
PT-6	Pavement Performance Monitoring	1	Relate construction to performance data
	PT Subtotal	20	
Voluntary Credit Total			
Custom Credits (CC)			
CC-1	Custom Credits	10	Design your own credit
	CC Subtotal	10	
	Greenroads Total	118	

2.2.4 GreenLITES

The GreenLITES program includes rating systems (Table 2-5), spreadsheets, and other metrics to assess projects, plans, operations and maintenance programs, and regional programs.

Table 2-5[8]: GreenLITES Project Environmental Sustainability Rating System Scorecard

Category		ID	Description	Points	
				Available	Scored
Sustainable Sites(s)	S-1 Alignment Section	S-1a	Avoidance of previously undeveloped lands(open spaces or "Greenfields")	2	
		S-1b	Selecting an alignment that establishes a minimum 100-foot buffer zone between the edge of the pavement and the natural water course or significantly sized natural wetland to serve the purpose of stormwater filtration	2	
		S-1c	Alignments which minimize overall construction "footprint". Examples: Use of retaining walls, selecting design option with minimal footprint.	2	
		S-1d	Design vertical alignments which minimize total earth work.	1	
		S-1e	Adjust alignment to avoid or minimize impacts to social or environmental resources (avoidance of park lands, wet lands, historic sites, farm lands, residential and commercial buildings, etc.)	1	
		S-1f	Alignments that optimize benefits among competing constraints (the goal is not	1	

			always the minimum length alignment, but the one with the best benefit overall).		
		S-1g	Micro-adjustments that do not compromise safely or operation but that might make the difference in providing sufficient clear area for free planting.	1	
		S-1h	Clear zones seeded with seed mixtures that help to reduce maintenance needs and increase carbon sequestration.	1	
		S-1i	Provide a depressed roadway alignment.	1	
		S-1j	Use of launched soil nails as a more cost effective option to stabilize a slope rather than, for example, closing a road to construct a retaining wall which may negatively affect traffic flow and neighboring properties.	1	
	S-2 Context Sensitive Solutions	S-2a	Adjust or incorporate highway features to respond to the unique character or a sense of place (both natural and built) of the area ("Unique character" means whatever identifiable elements makes a place distinctly, memorable, important to the community, etc. - landmarks, views, historic bridges and buildings, parkways, characteristic use of material, a notable stand of trees, etc.	2	
		S-2b	Incorporate local or natural materials for substantial visual elements (e.g., bridge fascia, retaining walls).	2	
		S-2c	Visual enhancements (screening objectionable views, strategic placement of vegetation, enhancing scenic views, burying utilities, etc.).	2	
		S-2d	Period street furniture/lighting/appurtenances.	1	
		S-2e	Inclusion of visually-contrasting (colored and/or textured) pedestrian crosswalk treatments.	1	
		S-2g	Follow the NYS Bridge Manual, Section 23 – Aesthetics.	1	

		S-2h	Site material selection & detailing to reduce overall urban "heat island" effect.	1	
		S-2i	Permanently protect view sheds via environmental or conversation easements.	1	
		S-2j	Color anodizing of aluminum elements (ITS cabinets, non-decorative light poles, etc.)	1	
		S-2k	Decorative bridge fencing (in lieu of standard chain link).	1	
		S-2l	Use of concrete from liners (for bridge approach barriers, parapet walls, retaining walls, noise walls, bridge piers & abutments, etc.)	1	
		S-2m	Imprinted concrete/asphalt mow strips, gores and/or snow storage areas.	1	

2.2.5 Illinois Livable and Sustainable Transportation System and Guide (I-LAST)

I-LAST is a checklist of potentially sustainable practices followed by a description of the intent of each category in the checklist and the rationale and measures of effectiveness for each item as shown in Table 2-6. Lists of source materials and additional background resources for each item assist in understanding and applying the practices.

Table 2-6[9]: I-LAST Project Environmental Sustainability Rating System Scorecard

Category		ID	Description	Points	
				Available	Scored
Planning	P-1 Context Sensitive Solutions	P-1a	Identify Stakeholders and develop Stakeholders Involvement Plan	2	
		P-1b	Engage Stakeholders to conduct Context Audit and develop project purpose	2	
		P-1c	Involve Stakeholders to develop and evaluate alternatives	2	
		P-1d	Employ Stakeholder involvement	2	

			techniques to achieve consensus for Preferred Project Alternative		
	P-2 Land Use / Community Planning	P-2a	Promote reduction in vehicle trips by accommodating increased use of public transit	2	
		P-2b	Accommodate multi-modal transportation uses (e.g. transit riders, pedestrians, and bicyclists)	2	
		P-2c	Increase transportation efficiencies for moving freight through features such as dedicated rail or intermodal facilities	2	
		P-2d	Partnerships that provide environmental or technological advancements while promoting environmental stewardship	2	
		P-2e	Project is consistent with regional plans and local managed growth-based Master or Comprehensive Plans	2	
		P-2f	Project is compatible with local efforts for Transit Oriented Design	1	
Design	D-1 Alignment Selection	D-1a	Avoid impacts to high quality undeveloped lands		
			D-1a-1 Avoid all impacts	2	
			D-1a-2 Avoid significant impacts	1	
		D-1b	Provide buffer between highway and high quality wetlands/water resources		
			D-1b-1 Provide 100 foot buffer to resources	2	
			D-1b-2 Avoid resource with less than 100 foot buffer	1	
		D-1c	Avoid impacts to environmental resources, such as INAI sites and sites with threatened or endangered species		

			D-1c-1	Avoid all impacts	2	
			D-1c-2	Avoid significant impacts	1	
		D-1d	Avoid impacts to socioeconomic resources			
			D-1d-1	Avoid all impacts	2	
			D-1d-2	Avoid significant impacts	1	
		D-1e	Cross section minimizes overall construction "footprint" to eliminate R.O.W. takes		2	
		D-1f	Minimize total earthwork by matching proposed vertical alignments as closely as possible to existing grades		1	
		D-1g	Utilize brownfield locations		2	
	D-2 Context Sensitive Design	D-2a	Adjust highway features using design flexibility		2	
		D-2b	Incorporate locally produced or native materials			
			D-2b-1	Over 95% of materials sourced in US	1	
			D-2b-2	Over 60% of materials sourced in metro area	2	
		D-2c	Visual enhancements		2	
		D-2d	Items fit context of surroundings		1	
		D-2e	Bridge aesthetics		1	
		D-2f	Reduce urban “heat island” effect		1	
Environmental	E-1 Protect, Enhance/ Restore	E-1a	Avoid habitat fragmentation		3	
		E-1b	Minimize habitat fragmentation		2	
		E-1c	Mitigate habitat fragmentation		1	
		E-1d	Wetland restoration/mitigation		1 to 3	
		E-1e	Provide nesting locations		2	
		E-1f	Provide wildlife crossings		2	
		E-1g	Provide fish passage		2	
		E-1h	Provide mussel relocation prior to		2	

	Wildlife and its Habitat		construction			
		E-1i	Provide right-of-way wildlife barriers		1	
		E-1j	Provide mowing markers		1	
		E-1k	Schedule construction to avoid wildlife disruption		1	
		E-2a	Avoidance/protection of individual and contiguous stands of specimen trees and localized areas of established, desirable vegetation		2	
	E-2 Trees and Plant Communities	E-2b	Designs which demonstrate an anticipated ultimate net increase in tree species			
			E-2b-1	Increase tree species through preservation and new planting	2	
			E-2b-2	Coordination with local stakeholders to create a plant palette in context with community	2	
			E-2b-3	Historic native plantings are re-established	1	
		E-2c	Re-establish/expand native vegetation in reclaimed work areas or abandoned old alignments		2	
		E-2d	Use of plant material in lieu of or enhance structural such as living snow fences, sight screens (viburnum, dogwood, etc.)		1	
		E-2e	Use of native species for plugs, seed mixes, perennial and other plantings		2	
		E-2f	Planting trees, shrubs and/or native plant material in highway right-of-way		2	

		E-2g	Tree replacement ratios at greater than 1:1		2	
		E-2h	Minimize potential salt splash impacts through use of berms or vegetative screening		2	
		E-2i	Removal of undesirable plant species, removal of invasive species		1	
		E-2j	Topsoil preservation		2	
	E-3 Noise Abatement	E-3a	Construction of noise barriers			
			E-3a-1	Specialized noise barrier construction	2	
			E-3a-2	Typical noise barrier	1	
		E-3b	Incorporate traffic system management techniques to reduce existing noise levels		2	
		E-3c	Provide a buffer zone for adjacent receptors		2	
		E-3d	Provide sound insulation to public or non-profit institutional structures		1	
		E-3e	Tining of pavement to reduce noise levels		1	
		E-3f	Provide plantings or sight screen to separate receptors from roadway			
Water Quality	W-1 Reduce Impervious Area	W-1a	Use of ditches		2	
		W-1b	Replacement of paved median		2	
		W-1c	Reduction of paved shoulder areas		2	
		W-1d	Reduction of paved shoulder areas		2	
		W-1e	Replacement of paved bike paths with permeable pavement or permeable material		2	
		W-2a	Use of bioretention cells		2	

	W-2 Stormwater Treatment	W-2b	Use of constructed wetlands		2	
		W-2c	Use of bioswales		2	
		W-2d	Use of mechanical stormwater treatment systems		2	
		W-2e	Use of catch basins		1	
		W-2f	Use of infiltration trenches		1	
		W-2g	Use of rain gardens		1	
		W-2h	Use of sand filters		1	
		W-2i	Use of ditch checks		1	
		W-2j	Use of sediment traps and forebays		1	
	W-3 Construction Practices to Protect Water Quality	W-3a	Analysis of pollutants in stormwater		1	
		W-3b	Stream bank restoration		2	
		W-3c	Practices to protect highly erodible soils			
			W-3c-1	Special provisions for soil erosion control at stream crossings	2	
			W-3c-2	Meet NPDES requirements	1	
		W-3d	Implementation of erosion control practices		1	
		W-3e	Staging construction to minimize soil exposure		1	
		W-3f	Provide stormwater detention		1	
		W-3g	Reduce use of fertilizers and herbicides		1	
		W-3h	Protection from materials entering waterway on bridge demolition and construction		1	
Transportation		T-1a	Special use lane: High Occupancy Vehicle, reversible		2	
		T-1b	Innovative intersection/interchange design		2	
		T-1c	Expansion of or connection to a Traffic		2	

			Management Center (TMC)			
	T-1 Traffic Operations	T-1d	Installation of coordinated signal system			
			T-1d-1	Installation of closed-loop system	1	
			T-1d-2	Timing plans developed for weekend or special events	1	
			T-1d-3	Advanced logic system such as adaptive control	1	
			T-1d-4	Inclusion of transit vehicle priority	1	
		T-1e	Limiting or consolidating access points along highway		1	
		T-1f	Bus turnouts		1	
	T-2 Transit	T-2a	Provide new Park-and-Ride lots			
			T-2a-1	Evaluate demand and effectiveness of potential Park-and-Ride lots	1	
			T-2a-2	Construction of Park-and-Ride lots	1	
		T-2b	Operational improvements of an existing Park-and-Ride lot		1	
		T-2c	Provide bike accommodations at Park-and-Ride lots & transit stations		1	
		T-2d	Improved shading through vegetation at Park-and-Ride lots		1	
		T-2e	Provide new multi-modal connections		1	
		T-2f	Include bus stops with shelters or pads and pedestrian access		1	
		T-2g	Installation of a transit express system		3	
		T-3a	Assess Conditions –Perform bicycle		1	

			and pedestrian Level of Service analysis within the roadway corridor			
		T-3b	Improved intersection designs for pedestrians		1 to 2	
		T-3c	Provide new or rehabilitate existing sidewalks or bikeways			
			T-3c-1	Provide new sidewalks or bikeways	2	
			T-3c-2	Rehabilitate sidewalks or bikeways	1	
	T-3 Improve Bicycle and Pedestrian Facilities	T-3d	Sidewalk or bikeway widening			
			T-3d-1	Widen sidewalk or bikeway	1	
			T-3d-2	Provide parkway separation	1	
		T-3e	Designated space for cyclists (shared lanes)		1	
		T-3f	Striped bike lanes within roadway		2	
		T-3g	Restore or pave shoulders for bicycling		2	
		T-3h	Create parallel bike routes		1	
		T-3i	Align the roadway to facilitate the development of future multi-use paths and facilities		1	
		T-3j	Provide new grade-separated (bridge or underpass) bike/pedestrian crossing structure		3	
		T-3k	Install bikeway signs		1	
		T-3l	Install bicycle racks		1	
Lighting		L-1a	Use of alternative energy source to power street lighting, warning signs, and remote Intelligent Transportation Systems (ITS) components		2	

	L-1 Reduce Electrical Consumption	L-1b	Retrofit existing street lighting with high efficiency types		2	
		L-1c	Replace signs with retro reflective signs to eliminate sign lighting		2	
		L-1d	Retrofit existing sign lighting with high efficiency types		1	
		L-1e	Use of high efficiency street lighting on new installations		2	
		L-1f	Use of alternative energy source for bus stops		2	
		L-1g	Use of high efficiency (such as LED) traffic signals		1	
	L-2 Stray light Reduction	L-2a	Retrofit existing roadway lighting fixtures using cut off or full cut off fixtures		2	
		L-2b	New roadway lighting using cut off or full cut off fixtures		2	
Materials	M-1 Materials	M-1a	Reuse of top soil		1	
		M-1b	Balance cuts and fills			
			M-1b-1	Balance cuts and fills for the project	1	
			M-1b-2	Balance cuts and fills per stage	1	
		M-1c	Reuse spoils within project corridor to minimize material in and out of site		2	
		M-1d	Allow rubblization of concrete shoulder and concrete pavements		1	
		M-1e	Allow flexibility in design with the use of recycled or salvaged non-hazardous material			
			M-1e-1	Allow the processing of	1	

				demolished concrete to reclaim scrap metals to create useable aggregate.		
			M-1e-2	Allow the use of milled HMA pavements for capping stone.	1	
			M-1e-3	Allow the use of recycled crushed pavements for temporary aggregate for areas like driveways or access roads	1	
			M-1e-4	Allow the use of recycled crushed pavements for shoulder stone	1	
			M-1e-5	Allow the use of recycled crushed pavements as aggregate for subgrade, sub-base, or base lifts	1	
			M-1e-6	Allow reclaiming sub-base granular material	1	
			M-1e-7	Provide for optional reuse of reclaimed scrap materials for various items (sheeting, guard rail, etc.)	1	
		M-1f	Allow locally produced byproducts to be reused in the construction of embankments, hot mix asphalt and Portland cement concrete mixtures			
			M-1f-1	Allow the use of fly ash, ground granulated blast furnace slag cement, and micro silica in concrete mixtures	1	

			M-1f-2	Allow the use of ternary concrete mixtures in the construction of concrete pavements, shoulders and various structural items	1	
			M-1f-3	Allow the use of foundry sand or bottom ash as part of a material in the construction of embankments	1	
			M-1f-4	Allow the use of slag aggregate in the production of HMA mixtures (SMA Designs and "F" Mix).	1	
			M-1f-5	Allow the use of Recycled Asphalt Shingles (RAS) in the production of Stone Matrix Asphalt Mixtures (SMA)	1	
			M-1f-6	Obtain and implement a project specific use for the innovative reuse of waste materials other than the ones listed above.	1	
		M-1g	Allow the use of recycled asphalt pavement (RAP) in the construction of new hot mix asphalt pavements			
			M-1g-1	Allow the use of recycled asphalt pavement (RAP) in hot mix asphalt (HMA)	1	
			M-1g-2	Allow the use of fractionated recycled	1	

				asphalt pavement (FRAP) at a higher percentage in the manufacturing of hot mix asphalt.		
		M-1h	Allow inclusion of environmentally acceptable and permitted sites in the contract documents for the disposal of surplus excavated material to an off-site location		1 to 2	
		M-1i	Allow the salvage / moving of buildings		2	
		M-1j	Soil stabilization with geosynthetics		1	
		M-1k	Soil stabilization with cementitious and recycled materials		2	
		M-1l	Consider locally available materials (such as local seed stock and plants) in developing specifications for the project		1	
		M-1m	Extended pavement life; design and rehabilitation strategies			
			M-1m-1	Specify the use of perpetual HMA pavement design	3	
			M-1m-2	Specify the use of 30 year design life concrete Pavement	2	
			M-1m-3	Specify the use of 40 year design life concrete Pavement	3	
			M-1m-4	Specify the use of pulverization of HMA pavement for a base	1	
			M-1m-5	Specify the use of various	1	

				pavement preservation processes such as chip seal, seal coat, micro resurfacing, etc.		
			M-1m-6	Selecting hot-in-place or cold-in-place recycling of hot mix asphalt	2	
Innovation	I-1 Innovations	I-1a	Use of Experimental Feature(s) to improve the sustainability of a project		1 to 3	

2.2.6 Green Guide for Roads

The initial framework for Green Guide for Roads includes 13 areas -- Community interface, Valued environmental components and land consumption, Mobility choices, Intersections and driveways, Hard surfaces, Landscaping, Amenities, Drainage, Safety, Energy consumption, Construction, Operations and maintenance, Services and utility -- where sustainability practices can be applied, with a description of requirements and associated best practices or strategies. The Guide applies to all types of roads in urban and rural settings and includes sustainability considerations such as improved compatibility and livability, universal accessibility, modal equity, conservation of resources, affordability on a full life-cycle basis, and environmental protection.

3. Sustainability Performance Measurement Framework

During the last two decades, measurement of sustainability issues by indicators has been widely used by the scientific community and policy-makers. Development of sustainable indicators was first brought up as a political agenda issue at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992.

3.1 Sustainability Indicators

An indicator is a tool that quantifies complex physical and social phenomena and presents them in a way that can inform the decision-making process. The following are the various functions of indicators or performance measures:

1. They can help with the comparison of similar trends across jurisdictions.
2. They can help with the comparison of different phenomena.
3. They can help with the understanding of trends.
4. They can help with evaluating progress towards or away from defined goals or targets.

Table 3-1: Timeline of Indicator Development

Decade Indicator Work Began	Type of Indicators
1940s – 1950s	Economic
1960s	Social, Quality of Life
1970s	Environmental and Natural Resource, Health and Safety
1980s	Healthy communities
1990s – 2000s	Sustainable Development
2000s – 2010s	Sustainable Development in fields such as the Transportation Sector

There is currently no standard set of sustainable transportation indicators. A variety of indicators are used, some of which are particularly appropriate and useful for planning and policy analysis. It would be highly desirable for transportation professional organizations to develop standardized, "baseline" indicator sets, with consistent definitions and collection

methods, suitable for comparing impacts and trends between different organizations, jurisdictions, and times. This can include some indicators suitable for all situations, and others for specific needs and conditions. Table 3-2 lists various possible sustainable indicators within different categories of sustainable transport planning concern.

Table 3-2[10]**:** Potential Sustainability Indicators in General

Category	Subcategory	Indicator
Travel Activity	Vehicles	Motor Vehicle Ownership
	Mobility	Motor vehicle Travel
	Mode split	Portion of trips by auto, public transit, and non-motorized modes
Air Pollution Emissions	Emissions	Total vehicle emissions
	Air pollution exposure	Number of days of exposure per year
	Climate change	Climate change emissions(CO2, CH4)
	Embodied emissions	Emissions from vehicle and facility construction
Noise Pollution	Traffic noise	People exposed to traffic noise above 55 LAeq,T
	Aircraft noise	People exposed to aircraft noise above 57 LAeq,T
Traffic risk	Crash causalities	Crash deaths and injuries
	Crashes	Police-reported crashes
	Crash Costs	Traffic Crash economic costs
Economic Productivity	Transport Costs	Consumer expenditures on transport
	Commute costs (time and money)	Access to employment
	Transport reliability	Per capita congestion

	Infrastructure costs	Expenditure on roads, public transit, parking, ports, etc.
	Shipping costs	Freight Transport efficiency
Overall Accessibility	Mobility options	Quality of walking, cycling, public transit, driving, taxi, etc/
	Land Use accessibility	Quality of land use accessibility
	Mobility substitutes	Internet access and delivery service quality
Land Use Impacts	Sprawl	Per capita impervious surface area
	Transport Land Consumption	Land devoted to transport facilities
	Ecological and cultural degradation	Habitat and cultural sites degraded by transportation facilities
Equity	Affordability-transportation	Portion of household budgets needed to provide adequate transport
	Affordability-housing	Affordable housing accessibility
	Basic accessibility	Quality of accessibility for people with disabilities
Transport policy and planning	Pricing efficiency	Cost-based pricing
	Strategic planning	Degree to which individual planning decisions support strategic goals
	Planning efficiency	Comprehensive and neutral planning
	User satisfaction	User survey results

3.2 Performance Measures Currently Used By ALDOT

In 2009, Professor Heather Shar, from UAH, was contracted by the ALDOT Planning, Construction, Maintenance, Bridge Design, and Aeronautics Bureaus to collect information on different performance indicators to be used by ALDOT to study the performance of the transportation sector in Alabama (see Appendix A for the Survey). The following are the list of performance indicators used by ALDOT:

- Traffic Count
- Construction Cost
- Number of Safety Incidents
- Vehicle Miles Traveled
- Travel Time
- Speed
- Density (passenger cars per hour per lane)
- Level of Service
- Travel Time Reliability
- Percent of System Congested
- Travel Costs
- Vehicle Occupancy
- Weather- related traffic incidents
- Rail Grade Crossing Incidents
- Duration of Delay Caused by Accidents
- Response time to Incidents
- Commercial Vehicle Safety Violations
- Security for Highway and Transit
- Weather related Road Closures
- Response Time to Weather-related Closures
- Evacuation Times
- Toll Revenue
- Operating Budgets
- Maintenance Funds

Traffic count, construction costs, and number of safety incidents were reported as the primary measures.

3.3 Selection of Performance Measures for Transportation Sustainability

NCHRP 708 [4] defines a set of 11 goals in the framework that serve as guidance for a set of sustainability goals. The performance indicators used by ALDOT don't address sustainability issues. The recommendation of this report is to add the list in Table 3-3 to ALDOT's current list of performance measures.

Although it is not directly tied to determining the system performance level, public opinion is of vital importance to ALDOT's ability to maintain and increase the funding levels and support

necessary to effectively perform their stated mission. In addition, surveys should be conducted to enhance the performance measures.

Table 3-3: Recommended Sustainable Performance Measures to be adopted by ALDOT

Project Requirements	
PR-1	Build Project Framework and Objectives
PR-2	Multi-Discipline Project Team
PR-3	Public Stakeholder Engagement
Transportation	
Safety	
S-1	Reduce the number and severity of crashes.
S-2	Plan road networks that are predictable and recognizable.
S-3	Develop programs that maximize return on safety investment.
S-4	Prioritize projects with explicit safety considerations.
S-5	Reduce crash risk in work zones.
Access & Equity	
AE-1	Ensure accessibility to essential destinations.
AE-2	Minimize travel time delay (by mode) for affected population due to construction and maintenance activities.
AE-3	Improve travel time reliability to jobs and other essential destinations through operational improvements.
AE-4	Ensure comparable transportation system performance for all communities.
AE-5	Program transportation projects that improve transportation infrastructure equitably.
Security	
SEC-1	Prevent incidents within a transportation agency's control and responsibility.
SEC-2	Program projects that enhance the security of freight transportation assets (e.g. ports).

Environmental	
Ecosystems	
E-1	Ensure properly functioning environmental and ecological systems.
E-2	Maintain ecosystem functions and processes.
E-3	Conserve natural resources/capital during project implementation.
E-4	Maintain enterprise-wide habitat connectivity.
E-5	Reduce exposure to pollutants and contaminants during project implementation.
E-6	Apply context sensitive corridor habitat restoration and landscaping during project implementation.
Emissions & Air Quality	
A-1	Reduce activity that generates pollutant emissions.
A-2	Increase land use compactness, density, and balance of interacting uses (compactness, density, balance).
A-3	Increase the use of non-motorized modes.
A-4	Reduce congestion; promote low emissions travel speeds.
A-5	Reduce traffic volumes on major highways within critical distance of sensitive receptors (schools, hospitals, residences, ethnic/racial equity).
Construction Activities	
Resource Consumption	
R-1	Maintain a sustainable fleet.
R-2	Use renewable energy to provide project power.
R-3	Provide electric vehicle infrastructure.
R-4	Encourage the sensible use of recycled materials in project programming.
R-5	Purchase regionally-produced construction materials.
Waste Generation	
W-1	Reduce total waste created.
W-2	Ensure transportation infrastructure (e.g., pavements, bridges, etc.) is designed for long life.
W-3	Clean up existing hazardous waste.

W-4	Change in average design life of infrastructure [by major component] due to program.
Social & Economic	
System Efficiency	
SE-1	Ensure that the transportation system is functional for all users.
SE-2	Ensure that the existing transportation system achieves and maintains a state of good repair.
SE-3	Program projects that maintain or improve the efficiency of the transportation system for all users.
SE-4	Maintain the functionality of the transportation system during construction activities.
Prosperity	
P-1	Support growth in jobs and income by improving travel efficiency/reducing congestion.
P-2	Program projects that reduce freight transportation costs.
Economic Viability	
EV-1	Ensure the expected value of social and economic benefits created by proposed transportation projects exceeds their costs.
EV-2	Ensure the selection of the lowest cost project alternative.
EV-3	Ensure construction costs are within planned budget.
EV-4	Ensure maintenance costs are within planned budget.
EV-5	Ensure operation costs are within planned budget.

4. Conclusion

The research project, carried out over a 12 month period, was designed to establish a baseline understanding of the potential for using sustainability performance measures in the Alabama Department of Transportation. Quite a number of sustainability initiatives have discussed various definitions and performance measures of sustainable transportation systems, but very few regional agencies have developed planning tools that successfully incorporate sustainability in transportation sector. This study develops a framework of sustainability performance measures, and incorporating sustainability considerations into the ALDOT's decision-making process. The recommended performance measures are found in Table 3-3.

The literature review indicates that the present status of addressing sustainability in transportation planning is more focused on the effectiveness and efficiency of transportation systems as well as the resulting environmental impacts, and less on economic and social impacts. The proposed framework should help decision-makers in transportation planning consider sustainability issues by identifying better plans for readily available objectives.

Future Research

Future research should proceed to incorporate broader environmental, economic, social impacts of transportation systems by modeling the interactions among these sustainability dimensions. Public opinion is to be considered and surveys should be conducted to enhance the performance measures. Further development and quantification of sustainability measures will help to incorporate the sustainability considerations more fully.

Acknowledgments

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APPENDIX A

Please return this survey to Heather Shar at the University of Alabama in Huntsville.

Email: sharh@uah.edu
Fax: (256) 824-6970
Address: 301 Sparkman Dr.
VBRH A-4
Huntsville, AL 35899

Name: _____ Title: _____

Bureau: _____

Address: _____

City/State/Zip: _____

Phone: _____

Email: _____

What are the goals your bureau uses to measure success? _____

_____

	Do you use this information? Circle or mark *yes* or *no*	Do you collect this data? Circle or mark *yes* or *no*. If ***no***, write in from whom you receive the data	Do you distribute this information? Circle or mark *yes* or *no*. If ***yes***, write in to whom you distribute the data	How important is this measure to you? On a scale of 1 to 5, with 1 being most important and 5 being least important	How desirable is this measure to you? On a scale of 1 to 5, with 1 being most important and 5 being least important	Other Comments:

Operations

Traffic Count	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Vehicle-miles traveled	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Travel time	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Speed	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					

Level of Service

Density (passenger cars per hour per lane)	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Recurring delay	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Level of service/Highway Capacity Manual	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Duration of congestion	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Travel time reliability	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					
Percent of travel	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5					

System Measures

Percent of system congested	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						
Travel costs	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						
Vehicle occupancy	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						

Safety

Number of incidents	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						
Weather-related traffic incidents	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						
Rail grade crossing incidents	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						
Duration of delay caused	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5						

by incidents																				
Response times to incidents	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Commercial vehicle safety violations	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Security for highway and transit	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				

Environmental

Weather-related road closures	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Response time to weather-related closures	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Evacuation times	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				

Toll

Toll revenue	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Delay from toll collection	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Delay from incidents	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				

Financial

Operating budgets	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				
Maintenance funds	Yes	No	Yes	No	Yes	No	1	2	3	4	5	1	2	3	4	5				

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