TRANSPORTATION PERFORMANCE MANAGEMENT FOR LIVABILITY AND SOCIAL SUSTAINABILITY: DEVELOPING AND APPLYING A CONCEPTUAL FRAMEWORK

A Dissertation
Presented to
The Academic Faculty

By

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In Partial Fulfillment
Of the Requirements for the Degree
Doctor of Philosophy in Civil Engineering

School of Civil and Environmental Engineering
Georgia Institute of Technology

December 2014

TRANSPORTATION PERFORMANCE MANAGEMENT
FOR LIVABILITY AND SOCIAL SUSTAINABILITY:
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ACKNOWLEDGEMENTS

This work has drawn considerably from the collaborative efforts of the Infrastructure Research Group (IRG) at the Georgia Institute of Technology. It has been funded in part by the Georgia Department of Transportation through research grants to the IRG, through the Federal Highway Administration's Dwight D. Eisenhower Graduate Research Fellowship, Women's Transportation Seminar Leadership Legacy Scholarship, Achievement Rewards for College Scientists, and with Federal funding channeled through two University Transportation Centers: the National Center for Transportation Systems Productivity and Management (NCTSPM), and the Southeastern Transportation Research, Innovation, Development, and Education (STRIDE) Center.

I must acknowledge the contributions and advice of my dissertation committee, as well as other colleagues at Georgia Institute of Technology. In particular, my advisor Dr. Adjo Amekudzi Kennedy first assigned me to "become the expert" on how quality of life is measured, and how it is impacted by transportation decisions, shortly after I joined IRG as an undergraduate researcher in 2007. I was delighted at this assignment because, without an understanding of quality of life impacts, why would the work of engineers even matter? Guiding me in class and independent research since that time, she and my other committee members – Drs. Meyer, Rodgers, Ross, Watkins, and Tsai - have helped me to understand how transportation decisions are made and become realized, and how their impacts may be quantified and tracked. Also, several of my peers in the IRG have inspired me and helped me to refine my understanding through collaboration and co-authorship. In particular, these include Dr. Elise Barrella whose follow-through with

developing the *Sustainable Transportation Guidebook* inspired me to press onward with the *Organizational Performance Management Self Diagnostic Tool*; Dr. Mshadoni Smith who first envisioned the need to draw linkages between quality of life and customer satisfaction; Amy Ingles who dedicated countless hours to studying the process of health impact assessment (HIA); Stefanie Brodie also contributed significantly to the "Organizational Performance Management" (OPM) project, helping to organize and beta test the *OPM Self-Diagnostic Tool*; Janille Smith-Colin who spearheaded research in Evidence-Based Decision Making; and Margaret-Avis Akofio-Sowah and Richard Boadi who provided helpful feedback related to asset management processes, and also constant encouragement and constructive criticism as I neared the end of my PhD process.

This work was also supported and encouraged by colleagues at several Atlanta-area transportation agencies, who participated in informational interviews, provided data and feedback, and helped me to refine my understanding of how the Atlanta region is beginning to implement transportation performance management. All of these sources are acknowledged in the body of this dissertation. However, special thanks is due to those who have regularly inquired about my work, and have multiple times provided support or feedback: Rob Goodwin, Valenin Vulov, and Jannine Miller at the Georgia Regional Transportation Authority; David Haynes, John Orr, and Melissa Roberts at the Atlanta Regional Commission; and Tony Giasi, at the Georgia Department of Transportation.

Finally, I have to thank family and friends for encouraging me to be "a very civil engineer" (credit here to my grandfather, Paul Hippmann), and for appreciating that my reclusive behavior during portions of the PhD process was of temporary necessity; it was preparing me to do good work "in the real world" later on. Particular thanks goes to my

parents Audrey and Chris Kemp, and Bob Montague, for often welcoming me at their homes for momentary respites from my work, and for providing many meals that fueled my getting back to work. And, in closing, unending thanks to my husband Josef Fischer for his support and encouragement, for his designer's eye that helped me improve several graphics, and for the voice of reason that saved me many times from letting ambition and perfectionism become the enemies of excellence. Thank you all!

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LIST OF ABBREVIATIONS

3-C – Continuing, cooperative, and comprehensive planning process

AADT – Average Annual Daily Traffic

AASHTO – American Association of State Highway and Transportation Officials

AAWT – Average Annual Weekday Traffic

ABLP – Atlanta BeltLine Partnership

ARC – Atlanta Regional Commission

AQI – Air Quality Index

BCI – Bicycle Compatibility Index

BLOS – Bicycle Level of Service

BRT – Bus Rapid Transit

BTI – Buffer Time Index

CAA – Clean Air Act

CAAA – Clean Air Act Amendments

CalTrans – California Department of Transportation

CIA – Community Impact Assessment

CID – Community Improvement District

CfPT – Citizens for Progressive Transit

CMAQ – Congestion Mitigation and Air Quality

CO – Carbon Monoxide

CS – Customer Satisfaction

CSS – Context Sensitive Solutions

CTOD – Center for Transit Oriented Development

CQGRD – Center for Quality Growth and Regional Development

DOT – Department of Transportation

EB-TAM – Evidence Based Transportation Asset Management

EJ – Environmental Justice

EO – Executive Order

EPA – Environmental Protection Agency

FHWA – Federal Highway Administration

FTA – Federal Transit Administration

GAO – Government Accountability Office

GDOT – Georgia Department of Transportation

GEARS – Georgia Electronic Accident Reporting System

GDC – Governor's Development Council

GHG – Greenhouse Gas

GMP – Gross Metropolitan Product

GPRA – Government Performance Results Act

GRTA – Georgia Regional Transportation Authority

GIS – Geographic Information Systems

HBO – Home Based Other

HBS – Home Based School

HBW – Home Based Work

HFGRS – Human Factors Guidelines for Road Systems

HIA – Health Impact Assessment

HOT – High Occupancy/Toll

HOV – High Occupancy Vehicle

HUD – Housing and Urban Development

IRG – Infrastructure Research Group

KDOT – Kansas Department of Transportation

IDOT – Illinois Department of Transportation

ISTEA – Intermodal Surface Transportation Efficiency Act

IVT – In Vehicle Time

LADOTD – Louisiana Department of Transportation and Development

LOS – Level of Service

LRSTP – Long Range Statewide Transportation Plan

MAP-21 - Moving Ahead for Progress in the 21st Century

MPO – Metropolitan Planning Organization

MPOAC – Florida MPO Advisory Council

MTP – Metropolitan Transportation Plan

NAAQS – National Ambient Air Quality Standards

NARC – National Association of Regional Commissions

NOFA – Notice of Funding Availability

NCHRP – National Cooperative Highway Research Program

NHB – Non-Home Based

NEPA – National Environmental Policy Act

NHS – National Highway System

NO_X – Nitrogen Oxides

OPM – Organizational Performance Management

OR – Operations Research

OVT – Out of Vehicle Time

PEDS – Pedestrians Educating Drivers about Safety

PERI – Political Economy Research Institute

PCI – Pavement Condition Index

PM – Performance Management

$PM_{2.5}$, PM_{10} – Particulate Matter

PLOS – Pedestrian Level of Service

PTI – Planning Time Index

QOL – Quality of Life

RDG – Regional Development Guide

RSTS – Regional Strategic Transportation System

RTC – Regional Transit Committee

RTN – Regional Thoroughfares Network

RTP – Regional Transportation Plan

SAFETEA-LU – Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users

SCDOT – South Carolina Department of Transportation

SOV – Single Occupancy Vehicle

SRTA – State Road and Tollway Authority

SSF – Stacked Systems Framework

SSTP – Strategic Statewide Transportation Plan

STIP – Statewide Transportation Improvement Program

STP – Surface Transportation Program

STRIDE – Southeastern Transportation Research, Innovation, Development, and Education Center, the University Transportation Center for the Southeast.

TAP – Transportation Alternatives Program

TAQC – Transportation and Air Quality Committee

TCC – Transportation Coordinating Committee

TCI – Transportation Competitiveness Initiative

TAM – Transportation Asset Management

TEA-21 – Transportation Equity Act for the 21st Century

TAZ – Transportation Analysis Zone

TIP – Transportation Improvement Program

TOD – Transit Oriented Development

TRACK – Transportation for Regionally Accessible Communities in Kansas

TTI – Travel Time Index

UCLA – University of California, Los Angeles

UNDP – United Nations Development Program

UPWP – Unified Planning Work Program

USC – United States Code

USDOT – United States Department of Transportation

V/C – Volume to Capacity Ratio

VDOT – Virginia Department of Transportation

VMT – Vehicle Miles Traveled

VOC – Volatile Organic Compounds

WalkUPs – Walkable Urban Places

WCED – World Commission on Environment and Development

WFRC – Wasatch Front Regional Council, Utah

WHO – World Health Organization

SUMMARY

The purpose of this research is to help increase the capacity of public-sector transportation agencies (such as state Departments of Transportation, Metropolitan Planning Organizations, and transit providers) to preserve and enhance transportation-related quality of life (QOL) outcomes in their jurisdictions. QOL is a multi-dimensional concept that is closely related to the concepts of livability and social sustainability. Public-sector agencies are charged with promoting the well-being (i.e. QOL) of the public, and they often must work within a complex inter-organizational context, with overlapping and intersecting jurisdictions and responsibilities, in order to influence QOL. Because of their responsibility to promote QOL, many public-sector transportation agencies mention QOL, livability, and/or sustainability in their vision statements, mission statements, and strategic planning documents. Furthermore, U.S. Federal guidance and regulations that govern the practice of transportation planning, engineering, and performance management have begun to refer to issues related to livability and sustainability. However, these complex concepts are still ambiguous in meaning and application for many transportation practitioners. In order to effectively preserve and enhance transportation-related QOL outcomes, practitioners need a clear conceptual framework that links concepts of livability and sustainability to practical performance management tools for an inter-jurisdictional context. The primary objective and contributions of this research are the development of such a conceptual framework – the *stacked systems framework* (SSF) - and a methodology for applying it to enhance transportation performance management in an inter-jurisdictional context. In order to

develop the SSF, this research begins with an extensive literature review that clarifies the relationships among sustainability, livability, and transportation-related QOL outcomes; and integrates the concepts of social sustainability, soft systems methodologies, and the field of transportation performance management. To apply the SSF, this research includes a case study of public-sector transportation performance management processes in metropolitan Atlanta. The case study analyzes the influence of the regional inter-organizational system of public-sector transportation agencies on transportation-related QOL outcomes; identifies gaps in the current set of transportation performance measures used for decision making at the regional scale; and demonstrates the value to decision making of incorporating recommended performance measures that can more appropriately link organizational actions to broader QOL and livability outcomes via changes in transportation service quality. The case study methodology can be extended for future development of transportation performance management practices in metro Atlanta, and reproduced for other regions and geographic scales.

CHAPTER 1: INTRODUCTION

1.1 Project Motivation

The motivation of this project is to increase the capacity of transportation agencies such as state Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and transit providers to improve transportation-related quality of life (QOL) in their jurisdictions, in order to promote social sustainability. Transportation-related QOL issues include access to opportunities, mobility, health and safety, and affordability. Also, social sustainability further requires that transportation-related benefits and burdens are equitably distributed. All of these issues can be significantly affected through strategic transportation investments, programs, and policy decisions aimed at creating more livable and sustainable communities. However, in order to develop such programs and policies, transportation agencies need tools with which to design, track and evaluate the QOL impacts of their decisions. In other words, they need QOL-, livability-, and social-sustainability-oriented performance measures. Furthermore, they need organizational structures and processes which support the generation of performance information, and its use in decision making. Collectively these structures and processes are called performance management.

1.2 Problem and Objectives

Public-sector agencies are charged with the use of public funds to promote the well-being (i.e. QOL) of the public. In order to influence QOL outcomes in their jurisdictions, transportation agencies often must work within a complex inter-

organizational context, with overlapping and intersecting jurisdictions and responsibilities. Because of their responsibility to promote QOL, many public-sector transportation-related agencies mention QOL, livability, and/or sustainability in their vision statements, mission statements and strategic planning documents. However, these complex concepts are still ambiguous in meaning for many practitioners. Moreover, although some of the most common strategic goal areas and performance measures used at such agencies are QOL-oriented; relating to safety, mobility, and customer satisfaction (Pei et al. 2010; Cook and Lawrie 2004); not every metric has equal value for decision making. Depending on the exact definition and application of performance measures used by a transportation agency, the information gleaned from performance measurement may or may not sufficiently indicate the QOL problems and risks experienced by transportation users and other members of the public, or what actions agencies should take to promote QOL in their jurisdictions. Furthermore, although safety and mobility are tracked by most transportation-related agencies, health, affordability, and accessibility indicators are almost entirely absent from the performance measurement information reported by state DOTs (Author's review of Midwest Transportation Knowledge Network State Stats database (MTKN 2011)); they are used by only a small minority of MPOs (Lyons et al. 2012); and while public transit providers often measure accessibility to key resources for routing and funding purposes, they may not track these important indicators on a regular basis (Cook and Lawrie 2004). Finally, due to fragmented or siloed organizational and inter-organizational structures, the more QOL-oriented considerations, and also considerations of equity and distributive justice, are often treated separately from "core" performance measurement practices, and considered the exclusive

realm of agency divisions which deal with civil rights issues or public involvement (Amekudzi et al. 2012). In order to effectively preserve and enhance transportation-related QOL outcomes, practitioners in public-sector transportation agencies need a clear conceptual framework that links concepts of livability and sustainability to practical performance management tools for an inter-jurisdictional context. Therefore, the objectives of this research are as follows.

1. Clarify the relationships among sustainability, livability, and transportation-related QOL;
2. Identify actions that may be taken by transportation agencies to promote QOL and social sustainability in their jurisdictions;
3. Review existing performance measures in use at DOTs, MPOs, and transit, providers that relate to QOL and social sustainability, as well as additional models in the research literature for measuring the QOL-related outcomes of transportation decisions;
4. Develop a conceptual framework that integrates the concepts of social sustainability and performance management in the context of inter-organizational systems;
5. Apply the conceptual framework to a given inter-jurisdictional context in order to recommend new decision making tools (performance measures and organizational/inter-organizational practices) for promoting QOL and sustainability.

1.3. Methodology

The objectives listed above have been accomplished in this dissertation through a combination of in-depth literature review and an applied case study. Chapters 2 provides a literature review of social sustainability and related concepts; Chapter 3 provides a literature review of transportation performance management; and Chapter 4 proposes a new conceptual framework – the *stacked systems framework (SSF)* - that integrates these concepts, cataloguing performance measures and other management tools that can help translate QOL-oriented goals into organizational actions and enhanced QOL outcomes. Chapter 5 develops a methodology for applying the new conceptual framework to an inter-jurisdictional context of transportation performance management through a case study of Metro Atlanta. Finally, Chapter 6 presents conclusions regarding the broader significance and limitations of the SSF, as well as suggestions for future research.

1.3.1 Literature Review and Framework Development

As described by Cronin et al. (2008), literature reviews are of two kinds. A narrative or traditional literature review "critiques and summarizes a body of literature and draws conclusions about the topic in question…It is typically selective in the material it uses, although the criteria for selecting specific sources for review are not always apparent to the reader." In contrast, a systematic literature review uses "a more rigorous and well-defined approach," and it explicitly defines both the time frame within which the literature was selected and criteria for inclusion or exclusion in the review (Cronin et al. 2008). For this study, a narrative literature review approach is used to develop the definitions of social sustainability and related concepts, reported in Chapter 2; a

combination of narrative and systematic literature review methods are used to compile the performance management principles and processes described in Chapter 3; and both narrative and systematic approaches are also used to identify, catalog, and review existing QOL-oriented measures and management strategies that have been used at transportation-related agencies and in the literature in Chapter 4. The literature drawn upon in this review includes and builds upon the results of multiple studies conducted and published by the Infrastructure Research Group (IRG) at Georgia Institute of Technology from 2009-2014, each of which involved substantial contributions from the author of this dissertation. The topics of these IRG studies include:

- Organizational Performance and Risk
- Evidence-Based Transportation Asset Management
- Environmental Justice
- Quality of Life and Customer Satisfaction
- Health Impact Assessment

1.3.2 Case Study

The case study in Chapter 5 analyzes the specific, multi-jurisdictional context of transportation performance management in Metro Atlanta. It references the *stacked systems framework* developed in Chapter 4 to identify the influence pathways through which Metro Atlanta's major public-sector transportation-related agencies (transportation executors) currently affect QOL outcomes in the region; to characterize and conduct a gap analysis of the metrics and other feedback currently collected and used to drive transportation planning and track transportation systems performance at the regional scale in Atlanta; and to demonstrate the value to decision making (especially transportation

planning and programming) of incorporating new performance measures that more appropriately capture QOL and social sustainability considerations. The regional profile and gap analysis draw upon systematic document reviews and targeted interviews with transportation agencies in the Metro Atlanta region. The demonstration (*metric testing*) portion of the case study draws upon exploratory analysis of easily acquired data, which is not yet otherwise being used by Atlanta's transportation executors to systematically track or manage performance.

This case study uses the perspective of the *stacked systems framework* to develop what Leleur (2012) calls "choice intelligence," defined as "an ability to clarify and organise [sic] complex phenomena concerning foresight and related decision making based on constructive circularity." As further explained by Leleur (2012):

> *[T]his clarifying and organising centre [sic] around a process that builds on… unending scoping of a range of 'best possible' choice alternatives and assessment of their consequences and risks, which can point out 'the best' among the alternatives. [T]he process is in principle unending [because] the scoping will frame the assessment and the assessment will frame the scoping.*

Because performance management processes are iterative, as discussed in Chapter 3, they generate more and more choice intelligence over many cycles of decision making, feedback, and adjustment. Clearly an unending cycle of scoping and assessment is impossible to capture in the space of one dissertation. Likewise, comprehensive metric testing to address all of the measurement gaps identified in Chapter 5 could take a team of many modelers and decision makers multiple years of study. Therefore, this case study only aims to demonstrate the value of such a process through a reproducible methodology. Section 5.1 describes the case study methodology in more detail, identifying guiding questions for three tasks: the organizational influence profile,

feedback space profile, performance measurement gap analysis, and metric testing. The case study methodology itself was developed through a process of constructive circularity, through which subsequent guiding questions and tasks became clear as previous tasks were completed.

1.4 Study Significance

The primary contribution of this study is the development of a new conceptual framework - the stacked systems framework (SSF) - and a methodology for applying it to enhance transportation performance management in an inter-jurisdictional context. The SSF represents a new conceptual link between two developing fields of research: socially sustainable transportation systems and transportation performance management. To fully develop the SSF, this research clarifies and characterizes relationships among the challenging concepts of social sustainability, livability, quality of life, performance management, and soft-systems analysis. To fully express the value of the SSF, this research also catalogs a wide range of performance measures and management strategies that can be used by public-sector transportation agencies to influence transportation-related QOL outcomes in their jurisdictions.

Each of the preliminary research tasks (provided in Chapters 2-4) that inform and express the SSF can (of themselves) help better equip transportation professionals to strategically influence the QOL-related and other outcomes of transportation decisions. The methodology (developed in Chapter 5) for applying SSF to an inter-jurisdictional context can be extended to inform future development of the transportation performance management practices in Metro Atlanta, and it can be reproduced for other regions and geographic scales. In summary, the results of this research can be immediately applied in

public-sector transportation agencies to help enhance their QOL-, livability-, and sustainability-oriented performance management practices. This is especially useful in the United States as DOTs, MPOs, and public transit providers grapple with the new performance-based planning and other performance management requirements of MAP-21 (FHWA 2012), which now stand in parallel to recent federal guidance from the Partnership for Sustainable Communities (USDOT 2011) that focuses on integrating livability concepts into transportation decision making.

As transportation agencies use the tools provided in this dissertation to enhance their performance management practices, their work will identify additional research needs to help develop their choice intelligence. Building on the conceptual foundation provided in the SSF, future research will necessarily include longitudinal studies and statistical experiments that link organizational actions, transportation service quality outcomes, and broader QOL and livability outcomes in various contexts. Beyond application to the immediate contexts of particular inter-jurisdictional contexts at the regional scale, the results of this future research can build the body of evidence necessary to inform national policy discussions around transportation performance management, livability, and sustainability.

CHAPTER 2: SOCIAL SUSTAINABILITY AND RELATED CONCEPTS

2.1 Differentiation of Terms: Sustainability and Sustainable Development

Sustainability has become such a buzzword that its root meaning seems to be lost in many applications. To clarify the meaning of sustainability, it is helpful to return to the root of the word. In an etymological sense, something is characterized by "sustainability" if it is able to be sustained, or better yet, able to sustain itself. 'To sustain' means to maintain, perpetuate, or continue. From this etymological perspective, the sustainability of an activity simply means that the activity is able to continue. Sustainable marketing is marketing that can continue, and sustainable transportation is transportation that can continue. However, in the popular sense, and among many researchers, "sustainability" is a concept now inextricably linked to the concept of sustainable development (that is development, specifically of human civilization, which can be sustained). In other words, the phrase "sustainable marketing" might be used to mean "marketing which evokes concepts of sustainable development," and "sustainable transportation" might refer to "transportation which supports a sustainable human civilization." One example of this, which is drawn from extensively in this dissertation, is the 2008 paper by Boschmann and Kwan "Toward Socially Sustainable Urban Transportation: Progress and Potentials." If this title is interpreted from the etymological perspective, it implies that the paper (Boschmann and Kwan 2008) will discuss urban transportation that can continue while relying on some social resource (since the adverb "socially" describes sustainable). However, the paper actually discusses how transportation systems can contribute to social sustainability, which refers to the preservation and enhancement or social resources.

For the remainder of this literature review, the term "sustainability," will carry the popular meaning, which was clarified by Chambers et al. (2000): sustainability is the state which is achieved through sustainable development. However, the adjective "sustainable" will carry only the etymological meaning. Therefore, this dissertation makes an important distinction between two closely linked concepts:

- "Socially sustainable transportation decision making," means transportation decision making that can continue because decision makers have access to the necessary social resources.
- "Transportation decision making for social sustainability," means transportation decision making that aims to preserve and enhance social resources.

  Sections 1.2-1.6 below further deconstruct the components of these two concepts.

2.2 Sustainable Development as Stewardship of Resources

The most popular definition for sustainable development is from the World Commission on Environment and Development's (WCED) 1987 report *Our Common Future:* "Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs." Implicit in this definition is the concept of resource conservation for *inter*generational equity (Stavins et al 2002). A less commonly cited definition - which actually comes earlier in *Our Common Future* - is that "Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life" (WCED 1987). This definition evokes the concept of improvement, enhancement or betterment, and *intra*generational equity. Together, these definitions imply the importance of maintaining "access to the resources needed for a

decent standard of living" (UNDP 1990). In short, the discussion of sustainable development from *Our Common Future* (WCED 1987) can be summarized in terms of resource stewardship, meaning both conservation and enhancement, for three kinds of resources: environmental, economic and social (Fischer 2011).

Environmental or "natural" resources include water quality, air quality, natural vegetation, minerals, fossil resources that occur in the earth, and so forth. As Fischer and Amekudzi (2011) state, "sustainable development requires that natural assets are preserved and are not consumed more quickly than they are replenished (through natural or technological means)." According to the "Russian Doll" model of sustainability (O'Riordan and Voisey 1998), the stewardship of natural resources is the most fundamental aspect of sustainable development, since neither economic nor social resources can exist or be developed in the absence of natural resources.

Economic resources include money and financial markets and what Fischer and Amekudzi (2011) call "capital assets": "goods that are consumed, as well as more permanent goods such as infrastructure systems." For example, transport infrastructure systems are very important economic assets since they enable trade and access to employment.

Social resources (or social capital), "include the skills, knowledge, work, culture and interactions between human beings" (Fischer 2011). In the words of Axhausen (2008), "social capital is the joint skilled ability of the members of a [social] network to perform, act, and enjoy each other's company as a result of their joint history, commitments, references, and understandings… [which] enables both productive and hedonic aspects of human interaction." The stewardship of social resources depends on

both protecting the existing rights and well-being of people and enabling them to improve the condition and productivity of their lives and institutions.

The imperative of social stewardship is summarized by the World Commission on Environment and Development (WCED 1987) when it says that "Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life." This statement of the WCED in 1987 evokes two concepts, each of which has been posited as representing the primary social components of sustainability: social equity (Campbell 1996) and quality of life (QOL) (Chambers et al. 2000). For example, Campbell (1996) discusses "three e's" of sustainability: environment, economy, and *intra*generational equity. On the other hand, Chambers, Wackernagel and Rees (2000) describe sustainable development as the generation of QOL for human beings through sustainable use of natural resources; in this way, QOL subsumes both economic and social resources. Furthermore, in some representations of the "three legged stool" model of sustainability, *intra*generational equity is identified separately from social and economic resources; in this model, the economy, the society, and the environment are each represented as a legs of a stool, and crossbars labeled "equity" exist between each pair of the legs, providing additional stability.

In the "Russian doll" or "nested dependencies" model of sustainability, the economy is the innermost nest of sustainable development, entirely reliant on society, which is in turn entirely reliant on the environment. Other models of sustainability such as the "three-legged-stool" and the "triple bottom line", however, treat the relationships between society, economy, and the environment, as more interdependent and/or

overlapping, indicating that a balanced approach to addressing all three is necessary for achieving sustainability. The three-legged stool model illustrates that social, economic, and environmental resources all equally support sustainability, and if any of these categories is neglected, then sustainability becomes unstable. Likewise, the triple bottom line model provides a framework of resource accounting that stipulates that development not cause any sort of environmental, economic or social deficit. Such interdependence is especially important to acknowledge with social and economic resources since (a) the economy is essentially a construct of society, but (b) social processes and social resources are often dependent upon economic means. Furthermore, feedback does exist between socio-economic processes and environmental processes, since human activities can both deplete and restore environmental resources.

In order to acknowledge the primacy of environmental resources, as well as the interdependence of economic, social and environmental processes, a hybridized "bicycle model" of sustainable development and sustainability may be proposed (Fischer 2013). In this conception, illustrated in (Figure 1),

> *The rider represents human civilization, and the continued experience of the bicycle ride represents human quality of life. Human beings want this journey to continue indefinitely. This journey is supported [most fundamentally] by the quality of the path, which represents the built and natural environment. The front wheel of the bicycle, which steers the ride, represents social processes. The back wheel, which powers the ride, represents economic processes. Like the two wheels of a bicycle, social and economic processes are linked inextricably, and defects in either one can slow progress. (Fischer 2013)*

In the bicycle model, if either wheel is compromised, directly due to some action taken by the cycler or due to roughness in the terrain, then the journey is impeded and possibly stopped altogether. Furthermore, both social and economic processes depend upon and interact with the built and natural environment. If the terrain is fragile, it can be

further damaged by the motion of the wheels. Intragenerational equity may be represented by the bicycle frame and gears, which together distribute power between the wheels and provide stability.

Figure 1: Bicycle Model of Sustainable Development (Informed by Fischer 2013)

2.3 Equity and Justice

Equity and justice are both often used as synonyms for "fairness." In this dissertation, the term "equity" is meant to relate to results whereas "justice" relates to processes. For example, in Amekudzi and Dixon's (2001) discussion of "environmental justice" and "environmental equity," just processes and procedures that include a broad and representative sample of the general public in decision making are more likely (although not guaranteed) to result in equitable results, such that benefits and burdens of development are shared fairly among individuals and groups.

Equity is an important component of sustainable development; however, there are many ways that it can be conceptualized. Using the example of a hypothetical bus

routing problem, Khisty (1996) demonstrates that the configuration of an "equitable" transit network could look drastically different depending on the concept of equity being used. Part of the problem in defining equity involves the competing concepts of rights, deserts, and needs. Rights are based on "publicly acknowledged rules or established practices" for treating people fairly. The United Nations (1948) has outlined such human rights as the right to work and choice of employment, the right to "a standard of living adequate for the health and well-being" of self and family, and the right to education. Likewise, the U.S. Declaration of Independence declares that all men (now interpreted as all people) have the "inalienable rights" to "life, liberty, and the pursuit of happiness." In contrast, deserts are based on merit. For instance, an excellent worker deserves more compensation than a mediocre worker. Or, as another example, someone who contributes more effort or payment toward some goal may deserve more of the benefits when that goal is achieved. Finally, needs include the necessary prerequisites of a minimum acceptable standard of living. For example, Maslow's (1943) hierarchy of needs includes physiological needs, safety, love/belonging, esteem and self-actualization. The needs criterion of justice dictates that disadvantaged or needy people should receive more benefits than advantaged people who have their needs met (Khisty 1996).

Perceptions of equity may also vary depending on what type of benefit or burden is being considered. For instance, market equity, opportunity equity, and outcome equity may all be considered by transportation professionals (Taylor, 2010). Market equity relates to the concept of deserts; it demands that people get what they pay for. For example, the Safe, Accountable, Flexible, Efficient, Transportation Equity Act- A Legacy for Users (SAFETEA-LU), passed in 2005 included a market-equity approach by

guaranteeing that all states receive allocations from the U.S. Highway Trust Fund equal to at least 90% of their federal gas tax contributions (USDOT 2005). Contrastingly, opportunity equity and outcome equity relate to what Khisty (1996) calls "equal shares distribution." Using the Highway Trust Fund as an example, a consideration of opportunity equity would demand that every state receive equal funding. Outcome equity would rather demand that, however much money is spent in each state, the result is an equal level of service provided for all citizens. Opportunity and outcome equity both relate to the concepts of rights and needs.

Attempting to lend some objectivity to the nature of justice, the American philosopher John Rawls (1985) argued that anyone who was completely impartial (that is, enveloped in a "veil of ignorance" (Rawls 1971) that made one unaware of one's position in the social and economic strata) would promote providing the most support to the least advantaged members of society. With this in mind, needs-based distribution of resources, for opportunities and outcomes equity, may be seen as most fundamental. Rawls (1985) further suggests, however, that inequalities among members society can be acceptable so long as those inequalities lead to an increase in benefits for all members of society. For example, it may be justified for jobs that provide critical services to society (e.g. medical doctor, school teacher, and civil engineer) to receive higher pay than some other jobs, since all members of society benefit when such jobs are highly attractive to high-quality workers. This indicates that once a minimum acceptable outcome or opportunity level is provided for all members of society, remaining resources may be allocated based on market equity.

2.4 Quality of Life

For an individual and for a community, QOL is a fundamentally "multidimensional construct," which depends on both internal and external conditions (Felce and Perry 1995; Boschmann and Kwan 2008; Fischer and Amekudzi 2011). Internal, endogenous conditions include *subjective well-being* (Diener 2000), which includes "people's cognitive and affective evaluations of their lives" based on personal expectations, values and priorities; and *personal satisfaction* (Felce and Perry 1995), which represents a comparison between expected or desired and perceived conditions in one's life. External, exogenous conditions are often outside of the control of, and possibly outside the understanding of, the people experiencing life (Fischer and Amekudzi 2011); they include various components of the built and natural environments and social and economic conditions, for example air quality, access to health care, educational attainment, and income.

A complete view of QOL for any individual or population must include information about both endogenous and exogenous factors that affect well-being, as shown in Figure 2. The use of endogenous factors "acknowledges that 'quality' is inherently a context-sensitive term" while the use of exogenous factors "acknowledges that most people are not aware of all the factors that affect their well-being. However, most existing models for quantifying or otherwise amalgamating QOL "tend to focus on either objective or subjective indicators, not an integration of both" (Fisher 2011). Fischer and Amekudzi (2011) criticize these models as insufficient for understanding QOL in the context of sustainability:

- The compensating differentials model of QOL is based on objectively observable conditions, calculating an "implicit price" for each to explain how people choose locations. Compensating differential "ignores social values that cannot be economized and it treats phenomena such as economic stratification as socially insignificant."
- Revealed preference models for QOL focus on behavior, something which is objectively measurable but meant to identify preferences, ignoring "those people who cannot make choices based on preference" and those situations "when an ideally preferred option… is unavailable."
- Models of QOL that rely entirely on survey data, although they "are useful for understanding the values and attitudes held by a community and for capturing differences between the values held by different communities," are insufficient because they "do not capture the objective and exterior conditions that constrain choice, such as characteristics of the natural and built environments or prevailing societal trends."

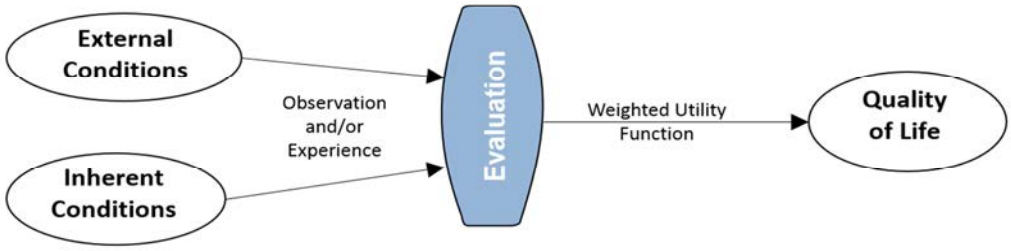


Figure 2: Conceptual Construction of Quality of Life (Adapted from Felce and Perry 1995; Fischer et al. 2014)

The conceptual model for QOL shown in Figure 2 may be understood as a weighted utility model, which combines endogenous and exogenous indicators.

Individual human beings may be understood to subconsciously develop such models, constructing a particular perception of their holistic QOL based on personal (predominantly subjective) evaluations of their observed life conditions and experiences. Social science researchers (e.g. Papageorgiou 1976, Doi et al.2008) have developed more explicit weighted utility functions to produce QOL indices. In best practice, the weighting system designed for such a model, indicated in Figure 2 by the "evaluation" lens, should reflect (a) the values and priorities of the people whose QOL is being assessed and (b) the critical trade-offs that may only be observable by professional experts.

"External conditions," shown in Figure 2, include the livability of the built and natural environment, plus the social and economic context. "Inherent conditions" are endogenous attributes of a human being or community, which may exist as they are regardless of any external conditions. On the other hand, changes to external conditions, for example air quality, could cause changes in inherent conditions; and, based on evaluations of their life experiences, people often make choices which can influence the conditions in which they live (Daub and Erzinger 2005; Fischer and Amekudzi 2011). After their living conditions change, these people may well become more or less satisfied with life, contributing to a change in their subjective well-being.

2.5 Livability

Researchers have long acknowledged that QOL is in part a function of the "environmental, physical, both natural and man-made… conditions" experienced by people (Papageorgiou 1976). In this context, *livability* may be understood as the composite characteristic of a place or environment that allows inhabitants to experience QOL. Historically, most livability-oriented efforts in the United States have been

"citizen-organized, in response to local and regional issues" (Miller et al. 2013); however, the concept of livability was federally institutionalized in 2009 through the Partnership for Sustainable Communities, which defined six "principles of livability" (USDOT 2011):

1. Provide more transportation choices to decrease household transportation costs, reduce our dependence on oil, improve air quality and promote public health.
2. Expand location- and energy-efficient housing choices for people of all ages, incomes, races and ethnicities to increase mobility and lower the combined cost of housing and transportation.
3. Improve economic competitiveness of neighborhoods by giving people reliable access to employment centers, educational opportunities, services and other basic needs.
4. Target federal funding toward existing communities – through transit-oriented and land recycling – to revitalize communities, reduce public works costs, and safeguard rural landscapes.
5. Align federal policies and funding to remove barriers to collaboration, leverage funding and increase the effectiveness of programs to plan for future growth.
6. Enhance the unique characteristics of all communities by investing in healthy, safe and walkable neighborhoods, whether rural, urban or suburban.

These principles of livability – jointly endorsed by the EPA, HUD and USDOT, and later adopted by the National Association of Regional Councils (Young and Hermanson 2012) – "are not a conceptualization of livability: rather, they are objectives that underlie a deeper but unstated definition that spans economic, social and

environmental dimensions" (Miller et al. 2013). Furthermore, the principles highlight that livability depends on an integrated transport-land use system that provides access to important opportunities and accommodates a variety of personal preferences and abilities. Especially in urban contexts, the complex land use system includes residences, employment centers, education, healthcare, social and recreational spaces, and other opportunities that are important for QOL. Transportation systems can provide access to important opportunities by promoting short travel distance and efficient operations for a variety of travel modes in order to accommodate a wide range of personal values and preferences, physical abilities and economic capacities. However, transportation systems can also constrain accessibility for some people. Accessibility is constrained and QOL is diminished when transportation choices are limited, existing transportation options are over-expensive, and/or the transportation system degrades the environment, detracting from sustainability and adversely affecting human health (Fischer and Amekudzi 2011). The specific pathways through which transportation and land-use decisions impact livability and QOL are discussed in more depth in Chapter 4.

The term "livability" has "emerged as a way to describe tactics that local governments and regional planning organizations use to achieve…sustainability goals" (Young and Hermanson 2012). However, as Godschalk (2004) points out with his "sustainability-livability prism" (Figure 3), "attempts to implement these popular visions can encounter a host of conflicts." Campbell (1996) identified three conflicts as obstacles to implementing sustainable development:

- A “property conflict” may arise when actions taken by a property owner within the boundaries of his or her property interfere with the ability of other people to achieve high QOL.
- A “resource conflict” may arise when high rates of economic growth, meant to rapidly increase QOL, have the simultaneous effect of rapid environmental degradation, jeopardizing sustainability.
- A “development conflict… arises from competing needs to improve the lot of poor people through economic growth while protecting the environment through growth management” (Godschalk 2004); intergenerational equity can be threatened when ecological resources are used faster than they can be renewed, and intragenerational equity can be threatened when affluent populations unjustly import natural resources and export wastes.

Godschalk (2004) went on to identify three more conflicts arising between the goals of sustainability and livability, as follows:

- A “growth management conflict” arises between livability and economic growth due to “competing beliefs in the extent to which un-managed development, beholden only to market principles, can provide high-quality living environments.”
- A “green cities conflict” occurs between livability and ecology due to “competing beliefs in the primacy of the natural versus the built environment.”
- A “gentrification conflict” arises between livability and equity due to “competing beliefs in preserving poorer urban neighborhoods for the benefit of their present

populations versus their redevelopment and upgrading in order to attract middle- and upper-class populations back to the central city.

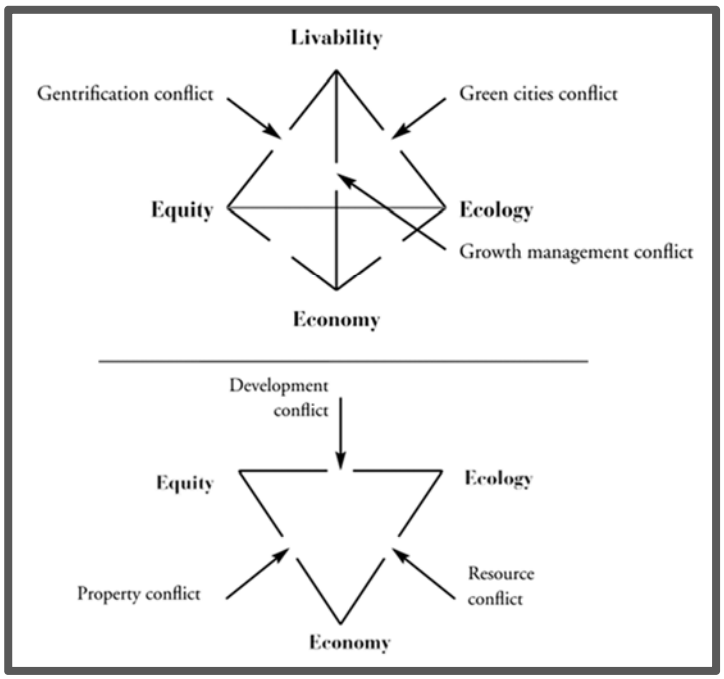


Figure 3: The Sustainability/Livability Prism showing conflicts that arise for built-environment professionals (Adapted from Godschalk 2004)

Multiple paradigms such as New Urbanism, Smart Growth, and Slow Cities recognize the importance of incorporating a livability element into built environment planning, but they do not in and of themselves address all of the conflicts that arise between environmental, economic, social equity, and livability concerns (Godchalk 2004). New Urbanism and Smart Growth promote limiting sprawl through urban growth boundaries and other incentives for compact, especially infill development, and the attempted shift of travel patterns from automobile use to bicycling and walking. As Godschalk (2004) points out, these paradigms highly value livability, secondarily value

the economic and environmental components of sustainability, without placing a priority on equity. New Urbanism addresses the growth management conflict; Smart Growth addresses both growth management and green cities conflicts; but neither paradigm tackles the gentrification conflict (Godschalk 2004). The Slow Cities development paradigm, on the other hand addresses the gentrification conflict as it values and seeks to protect "distinct local context" by utilizing the environmental and cultural assets that are unique to a particular place and supporting localized economies (Mayer and Knox 2004). While the Slow Cities movement focuses on cities with less than 50,000 population, similarly context-sensitive strategies can also be applicable to places within larger, more complex urban areas; Panero and Botha (2011) identify the key to success as being intensive stakeholder involvement and broad inclusion in the decision-making process. In general, Godschalk (2004) recommends that built environment professionals carefully examine each potential conflict at regional, urban and small-area (e.g. neighborhood and corridor) levels, attempting to resolve them through a system of inter-dependent policies, effective at different scales.

2.6 Inclusion and Satisfaction

The concept of inclusion, in processes and outcomes, helps to tie together many of the other concepts presented in this chapter. Inclusive decision-making processes are more likely to produce inclusive outcomes. Inclusive processes are those that engage all relevant stakeholders. Inclusion is an important element of socially sustainable processes because different stakeholders are likely to have different perspectives on a particular issue (thereby increasing the knowledge base available for decision making). These differing perspectives often include different abilities, preferences (priorities) and values.

Abilities are objectively measureable attributes of a person or group, which may be totally or partially outside of the person or group's control; for example, the ability to drive may be hampered or enhanced by physical attributes, age, income, legal status, etc. Preferences and values are subjective and endogenous attributes of a person, but they may also be influenced by (or necessitated) by ability, or by forces such as media, religion, culture, economic stratification and so forth. Preferences are situation specific and represent the order in which a person would choose among multiple alternatives. Values, on the other hand, transcend the moment and reflect "underlying personal or societal principles, standards, goals, or ideals," corresponding to "modes of behavior (bravery, loyalty) and end states (freedom, happiness)" (Doi et al. 2008).

In attempting to promote sustainability and livability, built-environment professionals such as planners and engineers cannot control the abilities, preferences, or values of various stakeholders. However, these various perspectives may be accommodated by context sensitive designs, if they are well understood. The built environment can provide opportunities as well as constraints, making certain choices more or less feasible. A good example is found in transportation mode choice: a person who may prefer to use transit more than driving based on comfort is less likely to choose a travel mode based on preference if there is not a transit service available to the traveler, or if the available transit has greater time cost than driving (Sanchez 1996; Feng and Hsieh 2009). Therefore, projects that promote mobility, for instance by mitigating congestion or expanding mode choice, can directly improve the social sustainability of a transportation system. Such projects enable more people to make choices regarding their travel behaviors that reflect their true preferences.

Whether or not a person is able to make choices based on preference relates closely with that person's satisfaction or dissatisfaction with the system. Personal satisfaction - specifically satisfaction with important life domains where importance is based on the values of an individual or community – makes up a large part of quality of life (QOL) (Felce and Perry 1995; Diener 2000; Doi et al. 2008). The phenomenon of customer satisfaction, as has been found in economic and marketing literature, and often re-cast in terms of stakeholder satisfaction in the public-sector, is directly related to *disconfirmation.* Disconfirmation is the state in which someone's expectations for a product or service are not what he or she actually receives or experiences. Disconfirmation can either be negative or positive, depending on whether the product or service performance falls short of or exceeds the customer's expectations. Low performance leads to dissatisfaction, whereas high performance may lead to delight. Furthermore, for every customer or stakeholder, the *zone of tolerance* is the "difference between the level of service desired and the level of service accepted by the customer [or other stakeholder]" (Smith and Leonard 2009).

Customer satisfaction (CS) data is often gathered for marketing purposes in the private sector, to gauge the likelihood of repeat-purchase behavior and to inform product improvements that will attract customers. Likewise, in the public sector, high satisfaction ratings can indicate that a public agency "has earned or is earning the trust and respect of its customers" – meaning those people who use its services (Fischer et al. 2014). For transportation agencies (which are among the public agencies responsible for developing and managing the built environment, and therefore have a great influence on QOL through livability), CS has been termed "perhaps the most important outcome for DOTs"

(TransTech Management 2003) and “the most relevant [perspective] for evaluating transit performance” (Eboli and Mazzulla 2011).

As Fischer et al. (2014) describe, customer satisfaction is best understood “in the broader context of customer opinions and subjective well-being.” Public agencies can collect a variety of opinions from their customers (i.e. the public) including satisfaction ratings, service evaluations, and importance ratings that reveal customer values and preferences. Collecting information about public opinion, through surveys or other methods of public involvement, is the foundation of inclusivity for public decision making processes. Amekudzi and Dixon (2001) also posit this inclusion of public opinion as the foundation of just decision making processes. Figure 4 illustrates how, since a broad base of public opinion information can lead agencies to make more informed decisions about how to develop inclusive built-environment (or other) systems, which enable quality of life and promote customer satisfaction, inclusivity is also a fundamental element of social sustainability for public agencies.

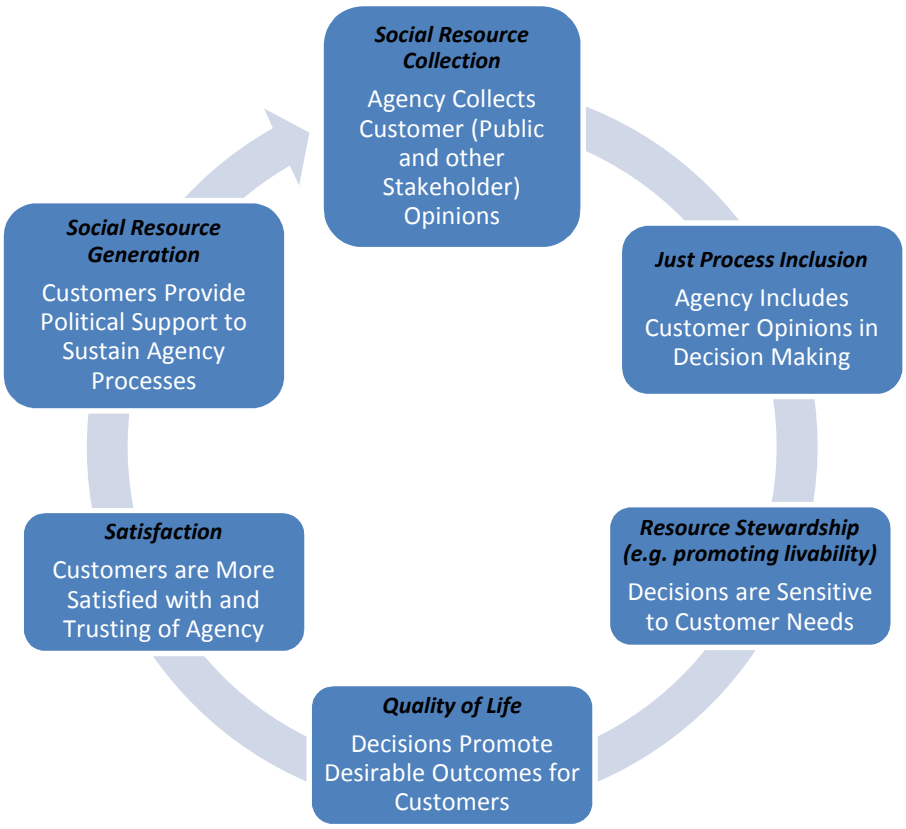


Figure 4: Cycle of inclusive decision making at socially-sustainable public agencies

CHAPTER 3: TRANSPORTATION PERFORMANCE MANAGEMENT

3.1 Transportation as a Sociotechnical System

Transportation infrastructure makes up a large portion of the built environment. Beyond that, transportation infrastructure "may be viewed as part of a socio-technical system, in continuous relationship with the human and natural environments" (Fischer and Amekudzi 2011). The concept of a socio-technical system is especially appropriate for transportation, perhaps more so than many other engineered systems, because system operations often depend upon the participation of many human beings. For example, as stated in *NCHRP Report 600: Human Factors Guidelines for Road Systems (HFGRS), Second Edition:*

> *Highway systems have three major components: the road, traffic control, and users with or without a vehicle… For the highway system to operate efficiently and safely, each of these components must work together as a combined unit. This task is not easy, largely because of the wide range of roadway environments, vehicles, and users (Campbell et al. 2012).*

Examples of roadway users include car and bus drivers and passengers, truck drivers, pedestrians and bicyclists. As system components, roadway users can influence system operations through their behaviors. User behaviors are themselves influenced across the system boundary, as each user enters the system with his or her own background knowledge, abilities, preferences, and expectations. Other human factors also influence the system across its boundary, as transportation professionals make decisions about design, operations, maintenance, and management. The preservation and enhancement of social resources such as the knowledge and work of these human beings,

and the organizational, social, and political structures and processes in which they participate, all contribute to the development of a socially sustainable (or unsustainable) roadway system. Aside from roads, similar observations may be made of other transportation modes; rail, air, and water transportation systems each include human participation, and they are formed through the knowledge and work of human beings.

As important components of the built environment, transportation systems have significant impacts on social sustainability via quality of life, livability, and equity. This impact is partly due to the experiences of the human transportation users, and partly due to the experiences of other members of the public, who do not use a particular transportation facility but are nonetheless influenced by it. To a large extent, the impact of transportation systems on broader social sustainability is moderated by public (government) and semi-public decision-making institutions. Currently in United States, "state, regional, and local governments have wide-ranging legal and financial powers to influence transportation…including:

- "directly supplying or regulating the supply of most transportation infrastructure (roadways, transit, sidewalks, bike paths, …parking [and ancillary infrastructure assets]);
- "controlling access to roadways, influencing the price of parking and fuel, and the price of purchasing and licensing privately owned vehicles; and
- "affecting the design of cars and trucks through regulations intended to make vehicles safer, cleaner, or more fuel-efficient." (Moore 2007)

Because of their use of public funds, governmental and semi-public institutions have the responsibility to promote the well-being of the public; in other words to promote

social sustainability, with attention to both quality of life and equity. In order to make decisions and take actions that preserve and, where possible, improve social sustainability in their jurisdictions, transportation-related institutions must themselves be socially sustainable. This means that they must have the necessary social resources, including organizational structures and processes, to be able to evolve and adapt in response to changing external conditions. The ability to evolve, adapt, and make strategic decisions is summarized in the concept that Leleur (2012) describes as *choice intelligence*:

> *An ability to clarify and organise [sic] complex phenomena concerning foresight and related decision making based on constructive circularity… in principle unending scoping of a range of 'best possible' choice alternatives and assessment of their consequences and risks, which can which can point out 'the best' among the alternatives.*

The remainder of this chapter reviews the concept of *performance management*, which includes organizational structures and processes that can allow public institutions to iteratively develop higher and higher levels of choice intelligence, thus developing internal social resources and becoming socially sustainable. The last section of this chapter also introduces other complementary processes undertaken by transportation-related agencies that support social sustainability and socially sustainable transportation systems. These processes (such as health impact assessment, community impact assessment, and environmental justice assessment) may be considered complementary to performance management because many of their internal elements may link to or correspond with the internal elements of performance management.

3.2 Performance Management Defined

Simply put, *performance management* is a business process through which an organization monitors, maintains, and (as necessary) improves its efficiency and effectiveness. The term is defined more comprehensively by the American Association of State Highway and Transportation Officials (AASHTO) as "an ongoing, systematic approach to improving results through evidence-based decision making, continuous organizational learning, and a focus on accountability for performance" (Kane 2010). The National Cooperative Highway Research Program (NCHRP Report 660) further identifies four components of the performance management process: selecting measures, setting targets, using measures in decision making, and reporting achievement. Collectively, these components of performance management should help develop "a culture of performance" within an organization (NCHRP Report 660). A report developed for Georgia Department of Transportation (GDOT) [hereafter referred to as the GDOT OPM Study[1]] also points out that effective performance management also depends upon the constraints and opportunities of a particular organizational context (Kennedy et al. In Press). Figure 5 summarizes the process of performance management for a public or semi-public agency, such as a state DOT, an MPO, or a public transit provider.

[1] OPM stands for "Organizational Performance Management," and was the internal acronym used by the study developers; the author of this dissertation contributed significantly to the GDOT OPM Study as a member of the Infrastructure Research Group at Georgia Institute of Technology.

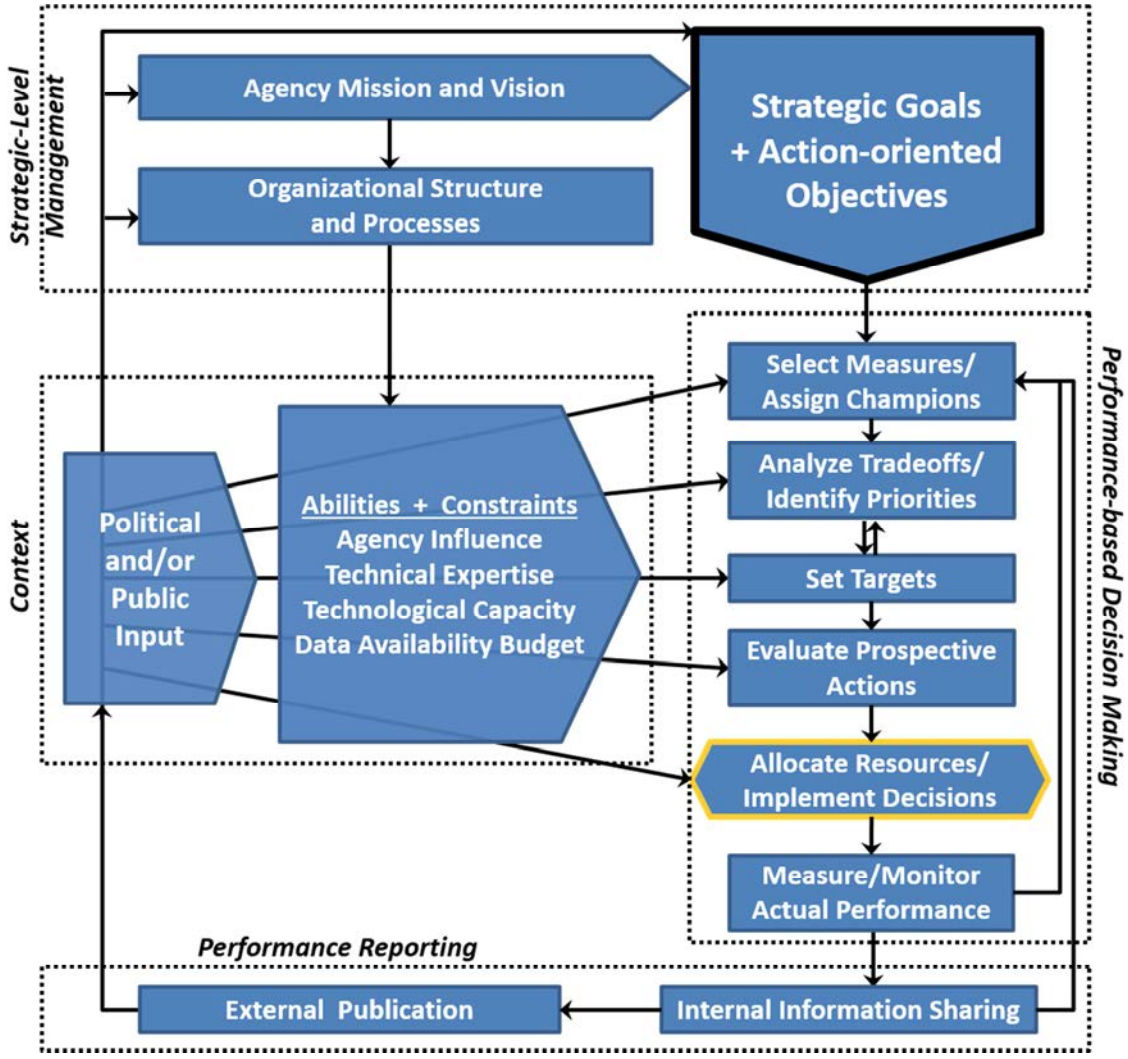


Figure 5: Public Agency Performance Management (Adapted from Kennedy et al. In Press)

As shown in Figure 5, public agency performance management is a complex, iterative process, with multiple pathways to performance-based decision making. Although it should ultimately be conceptualized as a cycle, the beginning of performance management in an agency may be thought of emerging from strategic goals and objectives (upper right corner of Figure 5). Likewise, the culminating step, "why it all matters" may be identified as the allocation of resources and implementation of

performance-based decisions (highlighted hexagon in rightmost column of Figure 5), which lead to outcomes in the agency's jurisdiction.

Strategic goals and objectives are informed by an agency's vision and mission statements, which also inform organizational structure and processes for the agency. Collectively, defining an agency's vision and mission, designing its organizational structures and processes, and setting strategic goals and objectives may be called *strategic-level management* (informed by Kennedy et al. In Press). Strategic-level management leads into the internal activities of performance-based decision making (rightmost column of Figure 5), which includes three of the four activities previously identified as the core of performance management (NCHRP 600): identifying performance measures, setting performance targets, and using performance information in decisions. Performance-based decision making can be conducted as an iterative process within an agency, (as illustrated by the returning arrows on the right side of Figure 5), or within an individual division of an agency. Internal performance-based decision making may also be enhanced by information sharing across the divisions of an agency, so that various divisions can learn from each other's experience. The result of cross-divisional information sharing is often called "horizontal integration" within an organization (Kennedy et al. In Press).

The internal activities of performance management, which are carried out within an organization, as well as the organizational structure and processes that support them, are discussed in more detail in section 2.3 of this dissertation. Beyond its internal components the performance management process is also strongly influenced by the input of external stakeholders (represented by "political and/or public input" in Figure 5).

Input from external stakeholders can include laws and regulations (discussed in section 2.4), inter-organizational relationships (discussed in section 2.5), and customer feedback (discussed in-depth in section 3.6). As illustrated by the leftmost upward arrow in Figure 5, an agency is likely to receive stakeholder input in reaction to its published performance reports. Such input is likely to change the abilities and constraints experienced by the agency. For example, new legislation or executive orders, or a change in political will from the public could affect the kinds of projects under consideration, the funding available to implement projects, or the performance criteria that must be used to evaluate alternative options. Changes to abilities and constraints could necessitate changes to one or multiple elements of the performance-based decision-making process. Alternatively, public and political input could directly influence the strategic-level management structures and processes that set the overall performance management process in motion.

3.3 The Practice of Performance Management

Based on a detailed review of the literature and case studies of performance management practices at 21 state DOTs in the GDOT OPM Study, Kennedy et al. (In Press) identify several important elements of effective strategic-level management and performance management for transportation-oriented public agencies. A follow-up study conducted by the same research group, documented by Smith-Colin et al. (In Press) [hereafter referred to as the GDOT EB-TAM study[2]], clarifies that an evidence-oriented approach to performance measurement and management is necessary for effective

[2] EB-TAM stands for "Evidence-based Transportation Asset Management," and was the internal acronym used by the study developers; the author of this dissertation contributed significantly to the GDOT EB-TAM Study as a member of the Infrastructure Research Group at Georgia Institute of Technology.

transportation decision making. This section draws from and expands upon the observations in these two studies to describe effective organizational structure, selection of performance measures, setting of performance targets, use of performance information in decisions, and reporting of performance information.

3.3.1 Organizational Structure

Effective performance management must be supported by a robust organizational structure. Effective structures will promote ownership and accountability for performance management processes and outcomes, often by identifying "champions" (also called "owners" or "drivers"), staff members who take responsibility for particular performance measures or measurement areas. According to the GDOT OPM study, each performance measure used by a transportation agency is often "owned by the specific division or office to which the measure is most relevant." However, some measurement areas may be shared by multiple divisions or offices; for example, Missouri DOT separately assigns a "measurement driver" responsible for data collection and analysis, and a "results driver" responsible for performance-based decision making (Kennedy et al. In Press).

Another important element of robust organizational structure is balance and coordination among decentralized and centralized performance management function. Several transportation agencies have a specific functional unit, or centralized office, that focuses on monitoring and reporting performance. In order for a transportation agency to function as an integrated whole, it is important for such a functional unit to be in close contact and regular communication with all other units. These centralized offices can also help facilitate communication among functional units that typically work separately but share responsibility for certain performance outcomes; for example, the centralized office

could set up face-to-face meetings for performance review, manage an internal database, and/or prepare performance reports to circulate within the organization, supplementary to any external reports.

3.3.2 Selecting Performance Measures

Carefully selected performance measures allow an organization to translate its strategic goals into action items, which aim to improve performance. Also, in the iterative process of performance management, the monitoring and reporting of performance measures can develop a body of evidence that indicates whether previous actions have contributed to desired outcomes. Thus, as discussed in the GDOT EB-TAM study, performance-based decision making is closely related to the concept of evidence-based decision making (Smith-Colin et al. In Press).

When selecting metrics for performance-based decision making, it is important to differentiate between performance measures, which "can be directly linked to and influenced by actions taken by an agency" and "context measures" such as population growth or funding receipts, which "influence decisions in transportation systems performance [but] do not necessarily reflect agency performance" (Kennedy et al. In Press). Often context measures are important analysis inputs for performance measurement. For example, VMT growth is a context measure. However, an agency might segment VMT growth by vehicle occupancy in order to track the effectiveness of an effort to promote carpooling. As another example, the number of roadway miles managed by an agency is simply a context measure related to asset management inventories. However, this measure can help to calculate the percent of pavement miles in good condition to inform maintenance and rehabilitation activities.

Another important differentiation is between input, output, outcome, and productivity measures (Hatry and Wholey 2007). *Inputs* are the resources used by an organization, such as dollars spent or gallons of fuel used. *Outputs* include products and services delivered by an organization, or work tasks accomplished such as the number of miles of roadway repaired or number of passenger miles operated; but outputs can also be undesirable or unintended, such as greenhouse gas emissions from an organization's activities. *Outcomes* relate to conditions that arise beyond the direct action of an organization, for example fatalities on a roadway network. In order for outcomes to be effective performance measures, they must be attributable, at least in part, to the outputs or other actions taken by an organization. Finally, *productivity* metrics relate to the development of inputs into outputs and outcomes. Productivity may sometimes be expressed in terms of ratios or percentages to indicate efficiency, for example dollars per roadway mile, or percent of right of way acquired on schedule.

A third important distinction, in the context of transportation performance measurement, is between organizational and systems performance measures. Organizational performance measures may relate to human resources, fiscal efficiency, work processes, and other elements internal to an agency, whereas systems performance measures relate to elements of the transportation system that are observed by the agency (often through instruments) and experienced by system users.

Overall, the GDOT OPM Study summarizes four principles for designing a suite of performance measures:

1. "*Meaningfulness* – Measures should be clearly defined and understandable to technical and non-technical audiences, as appropriate. Whether more relevant to

an agency's internal functions or to the experience of system users, measures should also relate directly to the agency's goals and objectives.

2. "*Practical Measurability* – Measures should be easily tracked and evaluated and have associated data that are readily available. Measures should be numeric; however the underlying data need not always be quantitative as qualitative data can often be quantified.
3. "*Comprehensiveness and Balance* – An effective suite of performance measures will provide a balanced picture of the agency's effectiveness, including leading measures related to inputs and outputs (which can be predictive in nature), and lagging measures related to outcomes, and efficiency. An effective suite of performance measures will also show synergies among multiple measures; for example, outputs (which are entirely attributable to the agency's actions) should be linked with outcomes (which are important and meaningful to external stakeholders).
4. "*Conciseness* – A suite of measures should not be overly large or complex because this can lead to difficulties in communication and can complicate the decision-making process." (Amekudzi et al. 2012)

Together, these four principles of performance measurement may be summarized by what Little (2008) describes as *clinicality.* A clinical set of measures will not waste time with meaningless data for its own sake, but it will rather provide the most important information necessary to diagnose problems and identify potential solutions. Little (2008) gives the analogy of a physician conducting triage in an emergency room: it is desirable to gain more information from less data, saving time and cost and expediting treatment.

Similarly, in Little's (2008) discussion of infrastructure asset management, "The desire is, of course, to avoid spending more than necessary while at the same time, avoiding excessive frugality that could bring on calamitous outcomes (e.g. major reconstruction, road closure, catastrophic failure, etc.)." However, Little (2008) goes on to lament that "despite improved models and streams of real-time data," infrastructure asset management practice is far behind medicine in its choice of performance metrics. Agencies responsible for the performance of assets such as pavements, bridges, and pipelines tend to base their maintenance and rehabilitation investment decisions "primarily on the physical condition of the asset, not its actual performance in terms of service delivery," even when the "actual nature of the relationship [between condition and performance] has proved elusive"; however, physicians conducting medical triage have multivariate statistical tools at their disposal, informed by robust research indicating the linkages between physical condition and medical risks (Little 2008).

The Role of Research and Evidence

As described in the GDOT EB-TAM study, the development and availability of quality evidence for decision making in medicine has evolved and accumulated over time. The now accepted concepts of evidence-based practice in healthcare incorporate "conscientious, explicit, judicious use of current best evidence… through integrating clinical expertise with the best available external clinical evidence from systematic research" (Pati 2011). The GDOT EB-TAM study also cites discussions of evidence-based approaches to social policy and education, which similarly emphasize the necessity of accumulating evidence over time through systematic research in order to relate and attribute particular outcomes to particular actions in a variety of contexts (Smith-Colin et

al. In Press). Since attribution is necessary for performance measures to be relevant to resource allocation, a truly clinical set of performance measures in any context will have to be based on rigorous research.

Rigorous research may look different depending on the opportunities and limitations of different contexts; for example, the complex sociotechnical context of transportation systems poses different challenges to researchers than the relatively comparable and predictable systems of a human body. However, according to a systematic literature review related to the GDOT EB-TAM study (Smith-Colin et al. 2014), a growing body of evidence is associating transportation system interventions with particular outcomes, especially in the realms of safety and injury prevention. As this body of evidence continues to grow and diversify, and systematic reviews become more feasible, transportation agencies may come to rely more and more on research literature to inform their selection of performance measures. The authors of the GDOT EB-TAM study propose a standardized format for reporting case studies in transportation asset management, and have built a pilot database to demonstrate the benefit of accumulating a body of evidence for this field. (Smith-Colin et al. In Press) As agencies improve their processes for reporting the results of their own performance monitoring, they can also contribute to this growing body of evidence for the benefit of peers and partners.

That the “evidence based” transportation research literature focuses most dominantly on safety and injury prevention implies the importance of protecting and promoting quality of life for human beings through transportation performance management. Chapter 3 of this dissertation reviews transportation research literature related to safety and physical health (section 3.5) as well as several other quality-of-life

related outcomes, and other factors related to social sustainability, in order to chart and evaluate the universe of performance measures in this area.

3.3.3 Setting Performance Targets

Performance targets are defined values for particular performance measures, which an organization plans to achieve by a particular point in time. For example, a transportation agency may set the performance target of achieving a 50% reduction in crashes at intersections by 2050. For targets to be meaningful and achievable they must be set for performance measures – never context measures- with associated action items that the best available evidence suggests will influence performance outcomes (Kennedy et al. In Press, Smith-Colin et al. In Press). If evidence linking particular actions to quantifiable outcomes is not available for some performance measures, those measures may not be well-suited to numerical targets. This may also be true if the policy context is unclear, funding levels are uncertain, or other ambiguities exist. In such cases, an agency may instead express desired achievement in terms of an "aspirational target" or general trend direction, such as "toward zero fatalities" (Kennedy et al. In Press).

Important distinctions exist among the similar concepts of *targets*, *standards*, and *guidelines*, all of which can designate specific numerical values for specific performance measures, relating to the design or operation of programs or projects. Targets represent desired levels of performance, which an agency seeks to achieve through ambitious strategies that improve performance. If an agency fails to achieve its targets, repercussions could include a loss of credibility with stakeholders, and the realization of a need to revise future targets and/or strategies. The primary functions of targets are to (a) motivate improvement in performance through ambitious strategies, and (b) track the

effectiveness of agency strategies in achieving desired performance levels. Standards, on the other hand, represent mandatory levels of performance that must be achieved. Set by external or internal stakeholders, if standards are not achieved, the agency (or sub-unit within the agency) may suffer legislatively or regulatory defined sanctions such as lessened funding, or increased oversight of mandatory reporting on corrective actions. Finally, guidelines are decision tools that an agency may use to develop and/or implement its strategies for achieving performance. Guidelines may be framed as decision rules – "if this, then that" - that trigger specific actions by the agency; for example, "if a bus route is performing below *x* service standards, then it should be eliminated or rerouted to improve performance." Alternatively, guidelines may be framed as desired levels of projected performance, such as "routes serving business centers should operate with a maximum headway of *x* minutes," or "right of way should be cleared to provide *x* sight distance at intersections." It is often desirable that the same performance measure be used to define multiple of these three related quantities; however, depending on the context, the related target, standard, and/or guideline may not always be designated at the same numerical value.

NCHRP Report 666: Target-Setting Methods and Data Management to support Performance-Based Resource Allocation by Transportation Agencies offers an excellent review of the state of the practice, and recommendations for target setting at transportation agencies. According to that report (Cambridge Systematics et al. 2010), the robustness of a target-setting approach depends largely on three factors: (1) whether or not targets are internally developed or stakeholder input is considered, (2) the amount

of time available for target setting, and (3) support from agency managers and staff to conduct relevant analyses.

Stakeholder orientation is important to target setting because both internal and external stakeholders will ultimately have a role in achieving targets. Internal stakeholders, including management and front-lines employees, will have to do the actual work of implementing strategies for achieving desired performance. External stakeholders, such as elected officials, partner organizations, or the general public, can influence the context in which performance strategies are implemented, thereby creating or removing obstacles for achievement.

Time is important because there are many factors to consider and questions to ask in order to inform robust and achievable targets. *NCHRP Report 666* mentions six successive areas of questioning to support the target-setting process at a public agency:

1. *Why is the target needed?* Is there a need within the agency? Is there a real or perceived need expressed by elected officials, the public, or other stakeholders? Will the target help to implement a particular strategic goal or objective? Can target-setting break down a large, longer-term goal into smaller surmountable pieces?
2. *Who will be using the target?* Internal users in the agency, or external stakeholders?
3. *How will the target be used?* To what activities will this target be relevant: project evaluation and selection, systems-level review, project design, project delivery, performance monitoring, or communication to internal or external stakeholders?

How could the use of this target affect the agency's abilities, constraints, and achieved performance?

4. *When should the target be attained?* What timeframe is desirable for reporting achievement, given time horizons related to known resources and resource limitations, stakeholder expectations, agency jurisdiction and influence, support and championship within the agency, and the greater multi-organizational and political context?
5. *How will the target be calculated and achieved?* What combination of strategies will be relevant to achieving the target? What level of change in the chosen performance metric are these strategies likely to achieve, considering existing resources?
6. *What is the target?* What is the numerical value that the agency aims to achieve, in the defined timeframe?

Support for analysis is especially necessary when defining the timeframe for achievement, the method for achievement, and the numerical target. Full answers to the questions in these areas can be supported by in-house research using technical tools for forecasting the results of long-term programs. Also, as with choosing performance measures, target-setting practices benefit from frequent and systematic reviews of the best available evidence, which link actions to outcomes. As an agency iterates through and matures the cycle of performance management, performance targets may be adjusted over time based on first-hand experience and accumulated evidence from other contexts.

In the current state of the practice, there is wide variation among transportation-related agencies in their ability and desire to set evidence-based performance targets, and

many agencies struggle with setting and achieving performance targets due to attribution issues (Kennedy et al. In Press). Where targets are set, different methods may be used to set different targets within the same agency (Cambridge Systematics et al.2010).

Table 1 shows five common methods of setting targets (columns) and how different contextual factors (rows) play into the target-setting practice at various agencies that implement each method. Target setting methods "range from unilateral executive edicts based primarily on experience to collaborative senior staff decisions guided by relatively sophisticated modeling techniques" (Cambridge Systematics et al. 2010). From a social sustainability standpoint, the target-setting methods that prioritize customer service, stakeholder expectations, and internal support are more likely to support the social resources necessary for long-term achievement. Table 1 also supports the converse, as it shows that setting performance targets by edict (which places low priority on social resources) only tends to be practiced at agencies with shorter histories of performance based resource allocation. It is also notable that target-setting by edict is not a method that necessarily relies on evidence; whereas the four other methods collect some sort of evidence to support the target-setting process, either from recognized experts, customers, peer agencies, or technical analysis. This accumulation of evidence depends upon the strength of social resources such as inter-organizational relationships, and the skills of employees.

Table 1: Contextual factors (rows) for different target-setting approaches (columns) used by transportation agencies (adapted from NCHRP Report 666: Cambridge Systematics et al. 2010)

	Edict	Expert Opinion	Customer Feedback	Benchmarking	Modeling
Political / Legislative Influence	Varied	Strong	Strong	Varied	Varied
Customer Service Focus	Low Priority	High Priority	Highest Priority	Priority	Priority
History of Performance-based Resource Allocation	Shorter History	Varied	Longer History	Varied	Longer History
Commitment to Regular Communication & Reporting	Low Priority	High Priority	High Priority	Priority	Priority
Span of Control / Agency Jurisdiction	Limited/ Focused	Broad	Broad	Any	Limited Modes
Financial Resource Level	Few	Few	Strong	Medium	Strong
Timeframe for Targets	Varied	Varied	Varied	Short	Varied
Technical Resources for Planning and Forecasting	Low	Low	Low	Medium	Strong
Organizational Structure	Vary Centralized	Varied	Varied	Varied	Varied
Stakeholder Expectations	Low Priority	High Priority	High Priority	Priority	Priority
Internal Support	Low Priority	High Priority	Priority	High Priority	Priority
Types of Resources to be Allocated	Internal Funds And Staff	Funding For Projects and Programs	Funding For Projects and Programs	Varied	Funding For Projects and Programs
Agency Culture	Less Oriented to Performance Management	Stakeholder-Oriented	Customer-Oriented	Competitive	Technical

3.3.4 Performance-Based Decision Making

If transportation decision-makers regularly receive updated performance information, this may be used in many types of decisions. These range from day-to-day resource allocation (such as assigning work tasks) and systems management (for example in traffic operations) to periodic decisions in planning and programming that affect the organization at a strategic level or the transportation system at a network level (Cambridge Systematics 2010). The GDOT OPM study found that flexibility is key to successful performance-based decision making at all levels: decision makers must adopt "an attitude of learning" which allows the agency "to adapt its actions" and "address any [new] needs and priorities identified by performance information" (Kennedy et al. In Press). Drawing on the GDOT OPM (Kennedy et al. In Press) and EB-TAM (Smith-Colin et al. In Press) studies, and *NCHRP Report 666* (Cambridge Systematics 2010), some principles of this "attitude of learning" include:

- *Multi-purpose metrics*: some metrics that are used in a variety of day-to-day agency functions should also inform periodic investment decisions, define standards, or be used as guidelines
- *Future orientation*: resource allocation should consider existing and forecasted performance, taking into account the potential effects of multiple alternatives
- *Broad economic consideration:* decision makers should investigate the accumulated economic ramifications of past investments using the best available evidence and tools (rather than relying solely on benefit-cost analysis, for example).

- *Multiple time scales*: investments should be made that, according to the best available evidence, are likely to contribute progress toward short-term and long-term targets
- *Data availability:* performance data should be housed and shared using efficient database structures, which can be regularly updated, and to which decision makers have regular access

3.3.5 Reporting and Communication

There are multiple audiences that can make use of performance information, both within and outside of a transportation agency. Depending on the particular audience, performance information may be appropriately reported on internal or external interactive websites; as documents that can be downloaded, printed, and shared; and/or using news and social media outlets. According to the GDOT OPM study, it is common for internal and external DOT performance reports to include graphics such as "time series charts that show actual performance alongside numerical targets and desirable trend directions," dashboard-style dials that illustrate actual achievement and target values, and sometimes "photographs, maps and diagrams… to highlight programs, projects, and other initiatives that are tangible and appealing" to the particular audience.

As described in the GDOT OPM study, reporting to external audiences, such as external government agencies, the public, and system users, "improves the accountability of the agency and builds credibility and trust" between the agency and its external stakeholders. To demonstrate accountability and credibility, it is important for an agency's reports to communicate both "its accomplishments in areas of high performance as well as its risks in areas of concern." Although an agency may track certain

performance measures only for an internal audience at first, when it "can comfortably include performance information that [reports] less than desirable [outcomes] in external reports, it gains the opportunity to outline strategies for improving performance, and to identify the resources needed to improve" (Kennedy et al. In Press).

Another important function of external performance reporting is to inform the decisions of those stakeholders who shape the context in which a transportation agency operates. For example, real-time performance reporting about the transportation system (through websites, mobile applications, and social media) can enable system users to adapt their behavior in ways that improve efficiency (Ferris et al. 2013). Likewise, periodic performance information that attributes performance outcomes to agency actions can demonstrate an agency's abilities and constraints to legislators and other officials who set budgets and define jurisdictions.

Internal stakeholders, such as technical staff and managers, will often need access to performance information more frequently, and in more detail, than is released to external audiences. This can be accomplished through "localized" reporting or data sharing in an individual division or office, and/or through agency-wide internal reports. Internal communication of performance information across an agency's functional units can enable these functional units to collaborate on creating performance outcomes, or to learn from each other in implementing transferrable effective practices. (Amekudzi et al., In Press)

No matter the audience, performance reporting is a critical component of the performance management cycle. If strategic-level management may be seen as an originator for the performance-based decision making; performance reporting may be

seen as the pump or engine that propels the process from one cycle of decision making to the next. Reporting enables evidence to be accumulated and analyzed over time, strengthening the basis for future performance-based decisions both within and outside a transportation agency.

3.4 Evolution of Transportation Performance Management in the United States

In the United States, the more comprehensive process of transportation performance management has recently begun to evolve out of a much longer-standing practice of transportation performance measurement. The use of performance measures related to the transportation system has been spurred on at the national level many times. As described in the GDOT OPM study, "the 2nd (1965) edition of the Highway Capacity Manual first introduced the grading concept for level of service (LOS A-F) (Kittelson 2000); measures of bridge health became widely used after Congress established the National Bridge Inspection Program in response to the deadly collapse of the Silver Bridge in 1967 (Herr 2010); and the pavement condition index (PCI) was formulated by the U.S. Army Corps of Engineers in 1978 (Shahin 1978)." While apparently resulting in technical metrics, it is important to note that the evolution of transportation performance measurement through each of these examples relates closely to the outcomes experienced by human beings and social and economic systems. That is, LOS relates to mobility, bridge health was directly motivated by concerns about safety and loss of life, and PCI is linked to ride quality and comfort. Evidently, although not termed as such, early transportation performance measures in the United States were motivated by QOL (and therefore social sustainability) concerns.

In parallel to the gradual increase in the widespread use of performance measures for the transportation system itself, U.S. federal law explicitly linked transportation actions to outcomes in the natural and human environments and instituted procedural elements that have, over time, merged with and contributed to the evolution of transportation performance management. A major landmark is the National Environmental Policy Act (NEPA) of 1969, which mandated environmental impact analysis for all federally funded actions, including transportation projects, to ensure that impacts on the human and natural environments would be considered in decision making. The purpose of NEPA, with is subsequent amendments (most recently 1982), is clearly associated with concerns for social sustainability and quality of life. The law describes its concerns to "stimulate the health and welfare of man" (42 USC §4321), to "assure for all Americans safe, healthful . . . surroundings," to avoid "risk to health or safety," and to "preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice" (42 USC §4331).

Another transformative federal law was the Clean Air Act (CAA) of 1970, which established metrics, standards, and protocols for regular air quality monitoring and control due to the observed health effects of air pollution in vulnerable populations. CAA regulations associated with the National Ambient Air Quality Standards (NAAQS) required metropolitan planners and to consider the air quality, and public health, ramifications of transportation systems as early 1971 (EPA 1971). The CAA amendments (CAAA) of 1990 strengthened the procedural linkage between managing air quality (maintaining or striving to achieve NAAQS) and choosing transportation investments. As

Howitt and Moore (1999) point out, these amendments were enacted, in part, in reaction to two perceived failings of NEPA:

> First, although [NEPA] establishes procedural requirements for environmental analysis, the law did not provide substantive guidelines for determining which projects should proceed. Therefore, it did not prevent decision makers from moving ahead with projects that have adverse environmental impacts, as long as these were considered in the environmental analysis. Second, NEPA's project-by-project focus did not sufficiently address cumulative air quality effects – for example, how transportation projects would affect regional emissions of pollutants. (Howitt and Moore 1999)

The legacy of the CAAA of 1990 includes a more robust procedural framework that relies on performance measurement and stakeholder involvement. Specifically, MPOs use computer simulations to forecast transportation demand trends and resultant emissions for regulated pollutants; these are compared to permissible emission levels defined in the state implementation plan; and participating agencies collaboratively develop transportation plans and programs that can meet air quality conformity standards (Howitt and Moore 1999).

The link between transportation investment and environmental protection was reinforced by the 1991 passage of the Intermodal Surface Transportation Efficiency Act (ISTEA), which required that federal funding flow only to those transportation projects from plans or programs that are in conformity with the CAA (Howitt and Moore 1999. Other elements of ISTEA reinforced the importance of public involvement and social context in the transportation decision making process, which was earlier introduced

through NEPA. As described in *A Guide to Metropolitan Transportation Planning under ISTEA – How the Pieces Fit Together*:

> *…ISTEA places significant emphasis on broadening participation in transportation planning to include key stakeholders who have not traditionally been involved, including the business community, members of the public, community groups, and other governmental agencies. This challenges transportation professionals and elected officials because meaningful engagement of diverse interests can be difficult. However, broader participation should ensure that decisions will be more responsive to local needs (FHWA/FTA 1994).*

As Ward (2005) describes, transportation agencies across the United States "took an increasing interest in considering the social impacts of their actions on communities" throughout the 1990s, largely due to leadership at the federal level. In the wake of ISTEA, FHWA and FTA took leadership by issuing an interim policy on public involvement that endorsed "evaluating public involvement processes and procedures to assess their success at meeting... performance requirements," and by publishing reference guides on community impact assessment and mitigation (Ward 2005). The next federal transportation reauthorization bill, the Transportation Equity Act for the 21st Century (TEA-21), passed in 1997, "continued the emphasis on public involvement" and sought to streamline federal processes associated with related "crosscutting issues" such as equity, environmental justice, civil rights, and the cumulative environmental and social effects of transportation decisions (Ward 2005). The inclusivity of federally required stakeholder involvement expanded further with the Safe Accountable Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) of 2005, which required MPOs to "consult with State and local agencies responsible for land use management, natural resources, environmental protection, conservation, and historic preservation" during the development of long range transportation plans (FHWA 2013).

ISTEA, TEA-21, and SAFETEA-LU were not explicitly based in performance measurement or management, however they were "clearly motivating changes in the [transportation] planning process" (Niemeier 1996) that collectively indicated emerging goals such as accountability, performance monitoring, project prioritization, and expanded communication with a broad base of stakeholders. For example, the FHWA (2013) summarizes that these bills require transportation plans to contain "operational and management strategies to improve the performance of existing transportation facilities," and that they placed responsibilities in public officials for collaboratively "determining the best transportation investments to meet… transportation needs." The performance orientation of these transportation bills was strengthened by the Government Performance and Results Act (GPRA) of 1993, and the GPRA Modernization of 2010, which encouraged performance-based decision making in all U.S. governmental agencies. Understandably, during the period from 1990-2012, the transportation research literature also began to more and more reflect this performance focus, as evidenced by numerous federally funded publications. Figure 6 summarizes the evolution of transportation performance management during this period. The four generations shown were identified by the GDOT OPM study, expanding upon work by Bremmer et al. (2005).

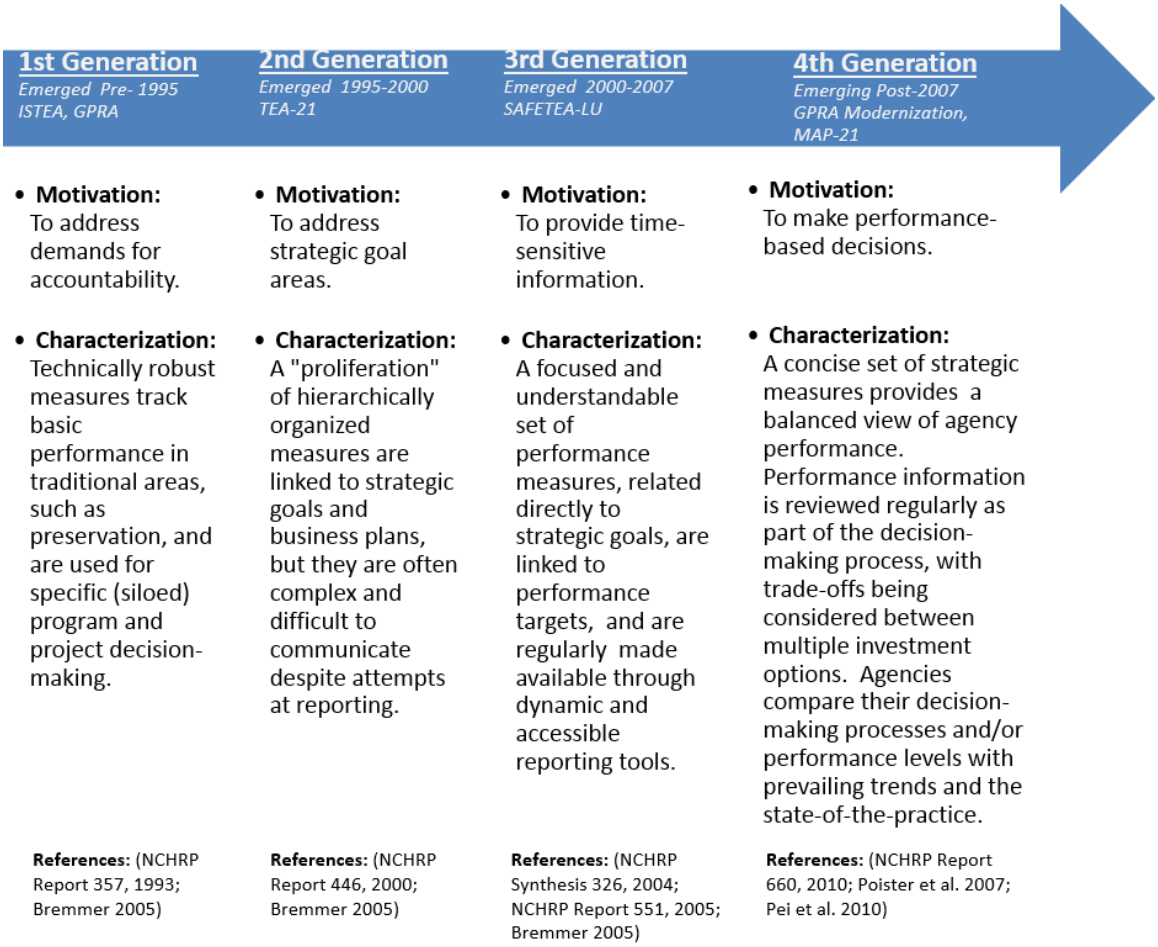


Figure 6: Evolution of transportation performance management in the United States from approximately 1990 to 2014, showing important federal legislation and research. (Adapted from Kennedy et al. In Press)

Figure 6 cites the motivating federal legislation that led transportation performance management practice during this period, as well as the National Cooperative Highway Research Program (NCHRP) reports that document and provide guidance for the evolution of the field. As cited in Figure 6, the federal motivation for performance management moved to the strategic level when the new surface transportation funding bill was passed in 2012: Moving Ahead for Progress in the 21st Century (MAP-21). MAP-21 explicitly established seven national performance goals for federal highway

programs and mandated specific roles for state and metropolitan transportation agencies in a national approach to transportation performance management. The seven national performance goals established by MAP-21 are:

- **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 (FHWA 2012).

These national performance goals were informed, in part, by the experience of state transportation agencies across the United States, through the involvement of

AASHTO in the development of MAP-21. Understandably, the national performance goals reflect goal areas that had already risen to the forefront of the state of the practice; as reported by Pei et al. (2010), the top five most-often used goal areas at state DOTs – just before MAP-21 was developed - included safety and security, asset management and preservation, transportation systems efficiency, organizational development, and customer satisfaction. At the time of Pei et al.'s (2010) study- a survey of stated DOTs with 39 states responding, an estimated 92% of state DOTs developed strategic plans most of which with goals in these areas. According to the study, other elements of performance management were also at different levels of implementation among U.S. state DOTs in 2010:

- 68% of respondents reported using performance metrics in association with their strategic goals, but the number and use of performance metrics varied widely among agencies;
- 78% reported a regular review of their performance measurement frameworks by top management, and 82% reported a regular review of performance data, but the frequency of this review varied widely;
- 76% reported the use of performance measures to engage with stakeholders outside of their agencies;
- 79% reported some attempts at setting performance targets, mostly through deliberation among decision makers rather than a scientific process. (Pei et al. 2010)

The passage of MAP-21 was largely meant to elevate transportation performance management processes across the United States, so that at least all DOTs and MPOs, and

transit agencies that receive federal funds, would meet a minimum level of performance management practice. The law requires that FHWA mandate specific performance measures for each of the seven highway-oriented goals – to be used by DOTs and MPOs, and that FTA establish national measures for transit state of good repair, planning, and safety. At the date of this dissertation, USDOT had released only two of at least eight expected Notices of Proposed Rulemakings to implement the performance measurement requirement of MAP-21. (CalTrans 2014)

3.5 Performance Management across Organizations, Jurisdictions, and Scales

The performance management concept can be applied to many types of decisions, including transportation planning, design, and operations, as well as organizational decisions related to human resources, organizational structure, and customer service. In U.S. states and metropolitan regions, many transportation-related decisions involve multiple stakeholders and actors. Transportation planning, in particular, is broadly recognized as an inter-organizational process. In fact, federal legislation created Metropolitan Planning Organizations (MPOs) in the 1970s specifically "to ensure that existing and future expenditures for transportation projects and programs were based on a continuing, cooperative, and comprehensive (3-C) planning process" (FHWA and FTA 2007). Now, transportation planning is meant to be "a cooperative process designed to foster involvement by all users of the system, such as the business community, community groups, environmental organizations, the traveling public, freight operators, and the general public, through a proactive public participation process conducted by the Metropolitan Planning Organization (MPO), state Department of Transportation (state DOT), and transit operators" (FHWA and FTA 2007). Furthermore, as described by the

US DOT, "[t]ransportation planning must be cooperative because no single agency has responsibility for the entire transportation system" (FHWA and FTA 2007).

Government agencies that are responsible for developing and managing the transportation system can be understood as public-sector transportation executors. Typical transportation planning and implementation functions are carried out by MPOs, State DOTs and other transportation executors (FHWA and FTA 2007):

- MPOs, which are "transportation policy-making bod[ies] made up of representatives from local government and transportation agencies with authority and responsibility in metropolitan planning areas", establish the setting for a continuing, cooperative, and comprehensive (3-C) planning process. They also conduct planning studies and evaluate alternative transportation improvement options, as reported in a Unified Planning Work Program (UPWP); prepare and maintain a long-range (20-year horizon) Metropolitan Transportation Plan (MTP); and develop a short-term (four-year) Transportation Improvement Program (TIP). MPOs must take care to involve the general public and other stakeholders in each of their other planning functions. Typically, MPOs do not provide engineering or operations functions for project implementation, but they will "provide an overall coordination role," by approving the allocation of funds for multiple phases of project implementation. In air quality nonattainment areas, MPOs are also responsible for coordinating the State Implementation Plan for air quality. Some states also allot their MPOs additional powers for allocating funding, or managing land use and urban growth.

- State DOTs' transportation planning functions include preparing and maintaining a Long-Range Statewide Transportation Plan (LRSTP), with a minimum 20-year planning horizon, and developing a short-term (4-year) Statewide Transportation Improvement Program (STIP). The DOTs must take care to include the general public in these two processes, and to coordinate with other stakeholders. For example, the STIP incorporates the TIP(s) developed by any MPOs in the state. Beyond transportation planning, DOTs are often responsible for the design, construction, operation, and maintenance of state-owned transportation facilities and services. State-owned transportation facilities typically include roads, highways, and bridges, but they can also include air, water, and surface public transit modes.
- Other public and semi-public organizations directly involved in planning and implementing transportation systems and services include tolling authorities, ports, local governments, special districts, and public transit providers. Each of these types of agencies may own, operate, or maintain different portions of a regional transportation network.

In general, the planning and implementation of regional transportation infrastructure and services span a multi-organizational context. Therefore, it is also important for performance management structures and processes to be coordinated across the multiple relevant organizations. MAP-21 requires MPOs and state DOTs to integrate each other's (and public transit providers') goals, objectives, performance measures, and targets – at least by reference - into each of their own transportation planning processes.

As described by FHWA's (2013b) *Performance-based Planning and Programming Guidebook*:

> *This does not mean that each agency must use the same goals, objectives, and measures. Unique local circumstances, agency-specific issues, and differences between urban and rural areas can all spur variations among agencies in the emphasis placed on different performance areas. However, it is important that goals and objectives of various transportation agencies working in the same areas are supportive of each other.*

Transportation executors often have overlapping or intersecting jurisdictions at different spatial scales. For example, a state DOT will typically interact with multiple MPOs within the state, each of which may interact with multiple transit agencies and multiple local governments whose jurisdictions lie completely within an MPO boundary. Part of the challenge of performance management in such a context is to develop goals, objectives, and measures that appropriately address the transportation needs and priorities at each spatial scale. The sociotechnical transportation system crosses political boundaries, and transportation executors who make decisions at larger spatial scales face the challenge of choosing performance metrics that are relevant to all of the sociotechnical contexts at smaller scales within their jurisdictions.

The challenge of performance management across multiple spatial scales is presented by the requirements of MAP-21. MAP-21 requires USDOT to define performance measures in several categories, which will be regularly reported on by state DOTs, MPOs, and transit agencies that receive federal funds. At minimum, safety-related measures for all agencies will include injuries and fatalities; infrastructure condition measures will address pavements, bridges, and transit state-of-good repair; traffic congestion measures will be formulated to support congestion reduction and system reliability; freight movement on the Interstate System will be tracked to support

economic vitality; and environmental sustainability measures will address mobile emissions. To be effective, the performance measures defined by USDOT must be ubiquitously relevant to all states and metropolitan regions, which MAP-21 then requires to set contextually appropriate performance targets for each federally defined performance measure. It is so that they can appropriately support performance management within various contexts at multiple spatial scales that MAP-21 performance measures are to be developed "in consultation with States, MPOs, and other stakeholders" (FHWA 2012). State DOTs, MPOs, and transit agencies that receive federal funds will then report progress toward their targets on an annual basis. If a performance report shows inadequate progress, particularly infrastructure condition or safety measures, the reporting agency must identify corrective actions and develop an annual improvement plan. Performance measures and targets, and the strategies for making progress, must also be described in long-range planning documents; and transportation improvement programs. (FHWA 2012)

Federal requirements for performance reporting associated with national performance goals does not preclude state DOTs and MPOs from setting and using additional performance measures beyond the mandatory measures defined by USDOT. In fact, due to the context-sensitivity of transportation impacts on quality of life and livability at the local level, it is highly unlikely that federally mandated performance measures will meet all of the performance management needs of transportation executors working at smaller spatial scales. Figure 7 indicates how, as spatial scale becomes smaller from the federal to the local level, the definition of "performance" in terms of goals, objectives, and performance measures, must become more specific and context-

sensitive. Effective performance management by transportation executors at each smaller scale will likely require a larger set of performance measures than what is actually reported to external stakeholders. Performance measures at the federal scale are, in part, meant for drawing comparisons among states and regions for the purpose of allocating federal dollars. In order to be useful in comparison, these federal metrics must be few and focused enough to effectively apply across a wide variety of state and regional contexts. Within a particular region, however, characteristics that distinguish it from other regions may delineate needs that require additional performance measures to guide decision making. Therefore, any given region or locality will likely find uses for performance measures that are mandated from multiple levels of a geographical hierarchy.

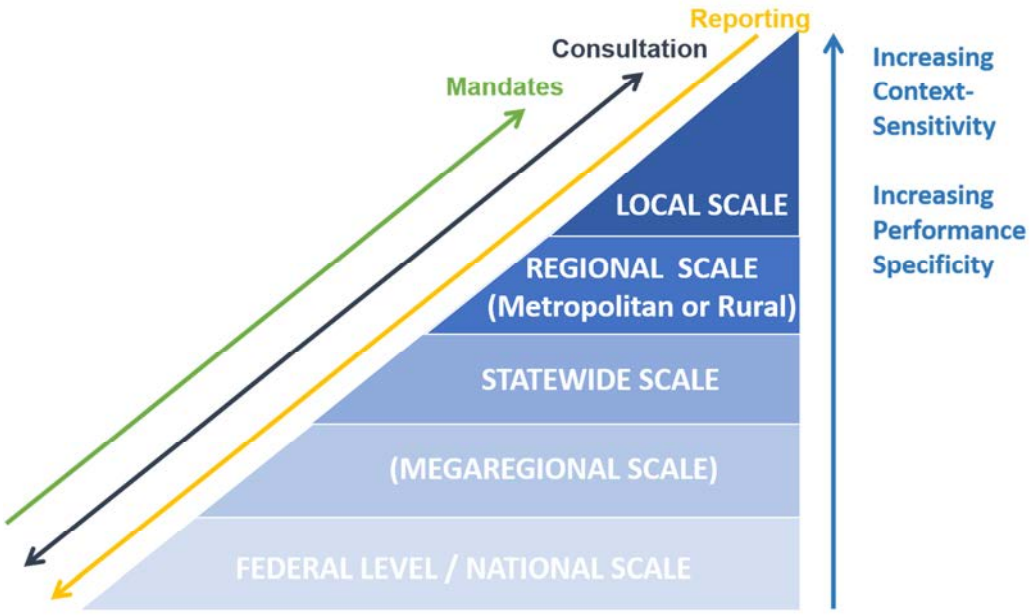


Figure 7: Lines of Communication along Jurisdictional Hierarchy for Transportation Performance Management

Figure 7 is organized according to a geographical hierarchy of jurisdictional perspectives. Transportation executors operating at larger geographic scales may mandate performance measures to those operating at smaller geographic scales, and the smaller-scale executors are in turn required to report performance results. At the same time, performance-based perspectives of the sociotechnical transportation system operating at larger scales must be the most basic, general and flexible enough to encompass and allow comparisons to be drawn among all of the various perspectives at smaller spatial scales. Just as federal executors are designing MAP-21 performance measures "in consultation with" (FHWA 2012) stakeholders that operate at smaller spatial scales, state and regional agencies can likewise use similar methods. It is important to note that hierarchical and consultative models of inter-organizational performance management are not mutually exclusive, at any spatial scale. For example, the U.S. Government Accountability Office reported two notable hybrids of hierarchy and consultation in the relationships between transportation-focused agencies, based on a survey of MPOs and interviews with federal and state transportation representatives in 2009:

- MPOs and federal agencies both view "informal interactions— such as regular meetings, technical assistance, and review of air quality conformity analyses— as an important aspect of oversight."
- A large majority of MPOs (about 80% of the survey respondents) report that state DOT officials are involved in their boards and committees, and federal officials are involved in over 55 percent and 70 percent of MPO boards and committees, respectively. (GAO 2009).

As U.S. transportation executors in various regions strive to meet the requirements of MAP-21 and advance performance management more broadly in their jurisdictions, some performance management functions will be appropriately undertaken independently, within individual agencies, whereas others should be undertaken through close collaboration among two or more agencies. Different regions are likely to develop different mixes of hierarchical and consultative relationships to meet the needs of transportation decision making, depending upon the specific intersections of jurisdictional responsibility. Depending upon the geographic scale, and the particular strategic goals involved, it may also be appropriate for more traditional transportation-oriented agencies to partner with a variety of other entities. As described by the *Performance-based Planning and Programming Guidebook:*

> *In relation to many goals (e.g., safety, economic vitality, asset preservation, health, and environment), non-transportation decisions and strategies (e.g., driver behavior, vehicle technologies, and land use patterns) play an important role in determining and achieving desired outcomes. Therefore, setting goals and objectives may highlight the important role of collaboration between transportation agencies and other partners, such as local governments, the business community, freight communities, law enforcement, housing agencies, economic development organizations, and others. (FHWA 2013)*

For example, a 2014 performance measurement workshop hosted by Broward MPO in Fort Lauderdale, Florida (Lane et al. unpublished report[3]) included stakeholders from several transportation executors in the South Florida region (Broward MPO, Florida

[3] The workshop was facilitated by the author of this dissertation on August 14, 2014, as part of a technology exchange project for FHWA's Community Vision Metrics searchable database tool (temporarily hosted at http://www.planningcommunities.com/communityvisionmetrics/), funded by the Southeastern Transportation Research Innovation, Development, and Education (STRIDE) Consortium, the federally funded University Transportation Center for the Southeastern region. The technology exchange project was led by Leigh B. Lane at the Center for the Environment at North Carolina State University, and the author of this dissertation facilitated two of the five workshops sponsored by the project, on behalf of the IRG at GA Tech. The project was being conducted concurrently with the writing of this dissertation, and the full report is expected to be published by STRIDE in December, 2014.

DOT, Broward County Transit, Broward County Traffic Engineering, South Florida Regional Transportation Authority) as well as non-traditional collaborators representing the public health field, such as the Florida Department of Health (DOH) and public health research consultants. DOH representatives are collaborators in the Broward Complete Streets Initiative, which is working to develop performance measures and policy guidelines that link investments in multimodal transportation infrastructure. Transportation executors who participated in the workshop benefitted from input from the public health representatives, who have access to data and experience with data collection methods that can add value to livability-oriented transportation performance measurement.

Focusing on shared goals and objectives across multiple transportation executors and other partners can help to establish common motivations for team-oriented decision making. As described by Gilboa, (2011), "Groups that differ in their motivation may find it hard to make coherent decisions, and if they do, the decisions may be very conservative, and may also be swayed by charismatic personalities." This challenge can be compounded when participants in group decision making may be operating upon both conscious and unconscious motivations. For this reason, Leleur (2012) points out that "working in groups should be… carefully designed and prepared" in order to develop an explicit common motivation which can facilitate group decision making. As with the various stakeholders represented in Broward MPO's (2014) performance measurement workshop, livability and quality of life (QOL) are implicitly common goals for all public (governmental) agencies because of their responsibility to use public funds to support the well-being of the public. The goals of livability and QOL may also resonate well with

other stakeholders, such as certain business communities and public interest groups. Therefore, focusing on this common motivation to improve livability and QOL through "carefully designed and prepared" collaboration among a variety of stakeholders may be more likely to support coherent decision making.

Performance management can be seen as a process of building social sustainability within organizations, and among organizations in a multi-jurisdictional context. This is because performance management builds social capital that can be leveraged for decision making. The social sustainability built within and among public agency transportation executors, and their other partners, can help these agencies make better decisions that ultimately lead to better livability and QOL outcomes for their constituents. Better livability and QOL outcomes support social sustainability in the broader sense of sustainable development. Section 3.6 discusses additional processes that can be augmented by performance management principles to promote livability and QOL outcomes. The design of organizational structures and processes, including interactions among multiple organizations in an inter-organizational context, constitutes a major component of "strategic-level management" in the performance management cycle. Additional concrete examples of inter-organizational relationships and structures at different scales of transportation decision making include:

- Kansas DOT (KDOT) has a hierarchical relationship with the "approximately 180 transit providers covering 99 of the state's 105 counties," which receive state financial support. KDOT's Transit Management Office monitors the performance of these transit providers using the Transportation for Regionally Accessible Communities in Kansas (TRACK) weighted scorecard. The TRACK Scorecard

includes performance metrics in the areas of Safety (30%), Customer Satisfaction (30%), and Fiscal Efficiency (30%), and context metrics related to Customer and Operations Information (weighted 10%). (KDOT 2014)

- The Active Transportation Committee established by Wasatch Front Regional Council (WFRC) is a consultative working group comprised of elected officials, Utah DOT, Utah Transit Authority, and the Utah Department of Health. The group's purpose is to ensure that public health is considered when establishing transportation performance measures. (WFRC 2014)
- The Virginia 2012-2016 Strategic Highway Safety Plan was developed under the guidance of an inter-agency steering committee including the Virginia DOT, Department of Motor Vehicles, State Police, Department of Health, Department of Education, Department of Fire Programs, and representatives to provide local perspectives from the Association of Chiefs of Police and the Hampton Roads Transportation Planning Organization. Together, these agencies set a long-term goal (with supporting strategies) to reduce deaths and severe injuries on Virginia's highways in half by 2030. (VDOT 2014)
- 22 of the 26 MPOs in the state of Florida have "entered into formal arrangements to coordinate regional transportation planning activities with one or more neighboring MPOs" (Center for Urban Transportation Research 2010). Supporting this effort, the Florida legislature established a statewide Florida MPO Advisory Council (MPOAC) "to augment the role of individual MPOs in cooperative transportation planning." (FHWA 2011) This case represents an

emerging trend of multi-jurisdictional planning in mega regions, which can exist within or across state boundaries.

3.6 Performance Management in other Sustainability-Oriented Processes

Performance management can help public agencies to become more socially sustainable by strengthening the logic and systematization of institutions, and by developing and preserving institutional knowledge. As public agencies become more socially sustainable, within and among themselves, their ability to promote social sustainability in a broader sense can also be strengthened. Several notable processes, currently used by transportation agencies to advance the goals of social sustainability for the wider society, can be strengthened by integrating performance management concepts into their operation. Some of these processes are currently mandated, or supported, at the federal level in the United States, whereas others have just begun to emerge at the frontiers of practice. This section discusses the potential for integrating performance management concepts into four important and related processes/perspectives, all of which have been used by transportation practitioners to advance social sustainability goals in wider society: environmental justice, community impact assessment, context sensitive solutions, and health impact assessment. These are not the only important perspectives that can be used to implement livability; the National Association of Regional Councils (NARC) *Livability Literature Review: A Synthesis of Current Practice* describes many other relevant perspectives including as smart growth, complete streets, lifelong communities, safe routes to school, new urbanism, transit-oriented development, and placemaking (Young and Hermanson 2012). However, unlike these other perspectives, which focus more on design principles, the four focus perspectives of this section are

process-oriented, with steps that can be linked and integrated with performance management.

3.6.1 Environmental Justice Analysis

Environmental Justice (EJ) is a federally mandated perspective, formalized by President Clinton's 1994 executive order (EO) 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Amekudzi et al. (2012) explain that the EO required that all federally funded agencies "identify and address disproportionately high and adverse human health and environmental effects of their programs, policies, and activities on minority and low-income populations." In this way, the EO combined the foci of "two previous regulations: Title VI of the 1964 Civil Rights Act, which focuses on nondiscrimination, and the 1969 National Environmental Policy Act (NEPA)" (Amekudzi et al 2012). However, the legislative legacy leading to a formal mandate for EJ is actually much deeper, involving "many statutes, regulations, and policies" McDonough-Bragg (2003):

> *[In] 1964, Title VI of the Civil Rights Act was passed by Congress, stating that, "No person in the United States shall, on the basis of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." The National Environmental Policy Act of 1969 (NEPA) stated the following objectives: "…Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings…Maintain…an environment which supports diversity, and variety of individual choice…achieve a balance…which will permit high standards of living and a wide sharing of life's amenities." Although many agencies have carried out these objectives with a slant toward the natural environment, the statutes and regulations themselves clearly state that both natural and human environment issues are to be considered equally. The Federal-Aid Highway Act of 1970 states that the following issues must be taken into account as part of decisionmaking:*
>
> • *Community cohesion.*

- *Availability of public facilities and services.*
- *Adverse employment effects.*
- *Tax and property value losses.*
- *Injurious displacement of people, businesses, and farms.*
- *Disruption of desirable community and regional growth.*

Formal integration of EJ considerations into transportation policy followed Clinton's executive order. The U.S. DOT Order 5610.2 in 1997 "established the process for the DOT and its operating administrations to integrate [EJ] goals … within the framework of existing requirements." Based on this Order and subsequent regulations, the FHWA and FTA definition of EJ can be summarized as having three fundamental principles (Amekudzi et al. 2012):

> *1. To avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations (burdens);*
>
> *2. To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process (process); and*
>
> *3. To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low-income populations (benefits).*
>
> *These principles are applicable for all phases of project development for any agency receiving federal funds, whether the improvement is federally funded or not.*

These principles speak to the establishment of just, inclusive processes (ensuring full and fair participation of stakeholders in decision-making), and the accomplishment of equitable outcomes with regard to the distribution of benefits and burdens. As discussed in section 2.6 of this dissertation and illustrated in Figure 4, inclusive processes at a public agency can increase the social resources available to that agency, and lead to an increase of social sustainability in the wider society. Robust (i.e. "full and fair")

stakeholder inclusion is a critical component of effective performance management because it formalizes the feedback loop through which an agency can consider its context (as introduced in section 3.2 and Figure 5) in performance-based decision making.

Because EJ is federally mandated for federally funded entities, it is becoming institutionalized at many transportation agencies. Amekudzi et al. (2012) describe the state of EJ practice at state DOTs along a continuum of three phases of maturity:

- Phase I is "activity based," characterized by the formalization of guidelines and procedures for public involvement and technical analysis to identify the distribution of benefits and burdens of the transportation system.
- Phase II is "performance-based," characterized by the development of quantitative performance measures and public opinion surveys related to EJ.
- Phase III strengthens the linkage – or feedback loop - between performance measures, customer opinions, and revised EJ guidelines and procedures, completing the cycle of performance management.

Based on a literature review and targeted survey, Amekudzi et al. (2012) found that "common elements of EJ programs and initiatives [included] public involvement programs, project analyses to determine burdens and identify disproportionately high impacts, and documentation. Less common elements include formalized EJ policies; before-and-after studies to determine whether EJ outcomes are being met … and linking EJ analysis results with decision making." In other words, the state of the practice shows "most DOTs are in the Phase I stage of the maturity scale." Based on this study, the researchers identified that "the next step" for developing maturity "is to measure EJ outcomes of transportation projects"; that is, to incorporate performance measurement

into EJ processes, with the aim of integrating these performance measures into a complete cycle of performance management (Amekudzi et al. 2012). Amekudzi et al. (2012) catalogued 28 performance measures in 8 goal areas related to EJ; these and other metrics will be discussed in detail in Chapter 4 of this dissertation.

3.6.2 Community Impact Assessment

Community Impact Assessment (CIA), "is an iterative process of understanding potential impacts of proposed transportation activities on affected communities and their sub-populations throughout transportation decision making" (Kragh 2003). Like EJ, the evolution of CIA practice in the United States came out of the joint legacy of NEPA and Title VI of the Civil Rights Act. Also like EJ, CIA keeps public involvement at the center of decision making. As Mary McDonough-Bragg described at the third national workshop on CIA:

> *Public involvement is a tool to be used to make better decisions; gain data and information not available elsewhere; understand and respond to the needs, values, and concerns of the public; inform the public of plans, activities, and decisions; and encourage public understanding.*

CIA uses a holistic approach and considers "a community as a whole entity"; robust public involvement allows a CIA practitioner to "become an advocate, a champion, an ombudsman" on behalf of each community served, and its subgroups (Kragh 2003). Public involvement is meant to be infused into every step of a CIA process, which also includes:

- Define the project area and impact area for study
- Develop a community profile considering multiple question: "Where are the neighborhoods? How do people get around? Are there children, elderly, disabled,

low-income, or transit-dependent persons in the community? Is there access to the downtown? What is the community's vision for itself?" (Toth 2003)

- Analyze impacts including "safety; mobility/access; community cohesion; displacement of people, businesses, and farms; adverse employment effects; tax and property value losses; noise; access to public facilities and services; aesthetic values; destruction or disruption of man-made and natural resources; disruption of desirable community growth; nondiscrimination; and other community issues" (Kragh 2003)
- Identify solutions, considering the anticipated impacts of all alternatives
- Document the process, findings, commitments, and outcomes

Through this process, CIA practitioners see themselves as part of a movement within the transportation field, focused on becoming "stewards of transportation dollars" (Kragh 2003) in order to better promote quality of life in the communities they serve. This perspective incorporates EJ considerations, and is closely aligned with the desire to promote livability and social sustainability.

The CIA perspective is relevant at all stages of transportation decision making, including planning, project development, operation, and maintenance (McDonough-Bragg 2003). Many of the CIA process elements parallel the cycle of performance management, with the documentation element being akin to performance reporting. As performance-based decision making has become more of a recognized priority in transportation, some work has been done to collect community-oriented performance measures, which can be used in CIA processes. In one significant effort in 2011-2012, FHWA funded the development of the Community Vision Metrics searchable database

tool[4]. The database includes more than 1700 metrics, categorized and searchable according to community and livability-related themes (e.g. accessibility, community engagement, safety, etc.), geographic scale (e.g. census block, neighborhood, corridor, region, etc.), setting/density (e.g. rural, downtown, etc.), and transportation mode. Many of the performance measures contained in the database are discussed in Chapter 4 of this dissertation, with a focus on the metropolitan context. Parallel with the writing of this dissertation, the author engaged in a technology exchange project, in partnership with the Center for Transportation and the Environment at North Carolina State University and funded by the Southeastern Transportation Research, Innovation, Development, and Education (STRIDE) Center, focused on introducing this database to potential users at transportation agencies. One agency involved in the project, the Atlanta Regional Commission, is featured prominently in the case study presented in Part II of this dissertation.

3.6.3 Context Sensitive Solutions/Design

The Federal Highway Administration Primer on Context Sensitive Solutions (CSS) provides a helpful summary of this process/perspective (FHWA nd):

> *The CSS process is a collaborative, interdisciplinary, holistic approach to the development of transportation projects… It involves all stakeholders, including community members, elected officials, interest groups, and affected local, state, and federal agencies. It puts project needs and both agency and community values on a level playing field and considers all trade-offs in decision making.*
>
> *The process differs from traditional processes in that it considers a range of goals that extends beyond the transportation problem. It includes goals related to community livability and sustainability, and*

[4] Temporarily hosted at http://www.planningcommunities.com/communityvisionmetrics/. As of the date of this dissertation, FHWA expected to launch a permanent website during 2014.

> *seeks to identify and evaluate diverse objectives earlier in the process and with greater participation by those affected. The result is greater consensus and a streamlined project during later stages of project development and delivery.*

Like CIA, CSS processes "are often associated with design," but "the approach is most effective when used during each step of planning and project development" (FHWA nd). While CIA takes care to define "community" holistically, CSS extends this perspective to define a "context" including:

- The natural environment,
- The social environment, community characteristics, perceptions, values, and culture
- Function and design of transportation infrastructure
- Transportation behavior
- Economic environment, including land uses and dependence of businesses and residents on transportation infrastructure

As FHWA further describes:

> *Some aspects of context might be viewed positively by one stakeholder group and negatively by another. For example, substantial regional traffic might be a positive for the owner of an auto oriented business and a negative for the area's residents. Descriptions of the context should use objective, value-–neutral language to reflect the perspectives of all stakeholders without judging which aspects are good or bad.*

This approach of using objective language allows for consensus to be built among diverse stakeholders with (potentially) differing values and priorities. Like EJ and CIA processes, CSS relies heavily on stakeholder involvement, but it extends beyond these processes by focusing more heavily on building consensus among diverse stakeholders.

According to FHWA (nd), consensus should be developed around several issues before identifying solutions:

- The project context,
- Problem to be addressed,
- The implementation plan, decision-making process and roles,
- Vision, goals, and evaluation factors.

This focus on consensus building allows the decision making process to become "less contentious as the design becomes more complex" (FHWA nd). In other words the number of unresolved issues decreases more rapidly over time for CSS processes, as illustrated in Figure 8. While CSS practitioners may take more time on public and stakeholder involvement as "a primary activity early in the project," this proactive inclusivity can ultimately lead to more effective and more easily implementable decisions (FHWA nd).

Several components of CSS directly link with the cycle of performance management introduced in Section 3.2: defining a vision, goals, and evaluation criteria (i.e. metrics), analyzing tradeoffs, and considering the context and community values. A performance measurement framework for CSS has been identified as including balance between project-level and organization-wide measures, as well as balance between process-oriented and outcome-oriented measures.

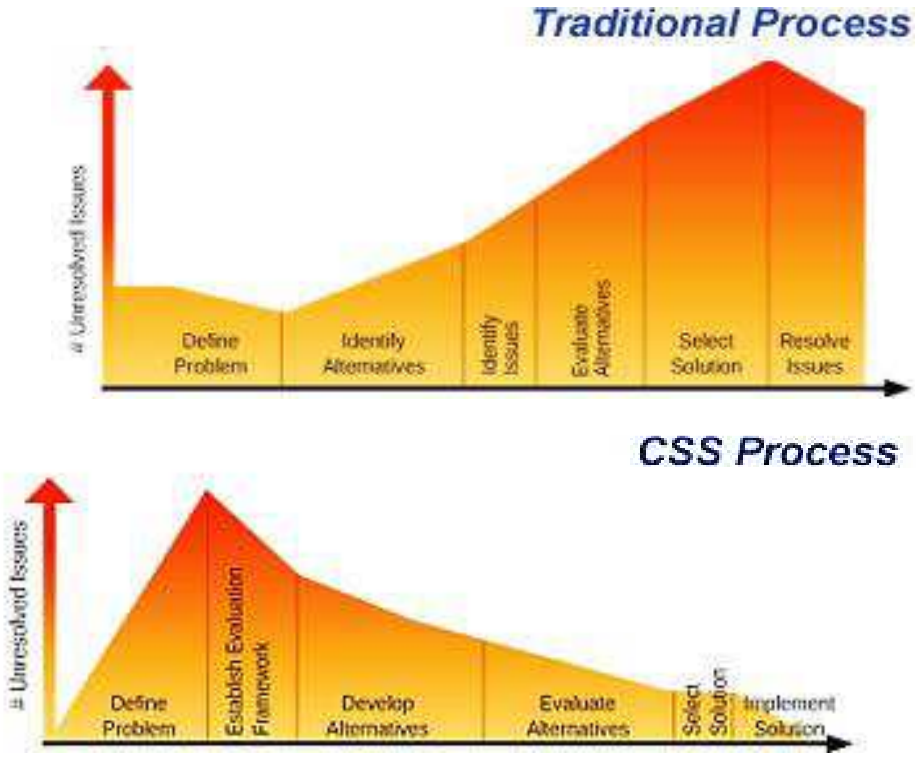


Figure 8: Comparison of the unresolved political issues (value conflicts) over time throughout the life of a traditional transportation decision making process and a CSS process (adapted from FHWA nd)

This balance is important because each measure type complements its partner. While the success of CSS can ultimately be seen through measuring the effectiveness of individual projects, organization-wide measures are important to capture trends across multiple projects. These complementary categories can together inform the development of agency-wide training, project development manuals, and project management strategies. With respect to processes and outcomes, "CSS-related processes… are closely linked to CSS policy goals" (TransTech Management et al. 2004). In other words more desirable outcomes are linked to more effective processes. Processes such as stakeholder involvement, the use of multi-disciplinary teams, alternatives analysis, consensus building, and implementation often "can be measured in a timely fashion, without

imposing unrealistic staff burdens." In comparison, outcomes "may require a greater investment in collection of new data, and are often harder to track over time", but "agencies should ideally seek a balance between both categories" due to the strong linkage between them. When both process and outcome measures are tracked, problems in an agency's decision making process may be diagnosed, and improved process may be manifested in improved outcomes. (TransTech Management et al. 2004) Specific measures for processes and outcomes at the project and organization levels are discussed more in Chapter 4.

3.6.4 Health Impact Assessment

Health Impact Assessment (HIA) is defined as "a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" (European Centre for Health Policy 1999). This definition implicitly incorporates both quality of life and equity outcomes, each of which is a central aspect of social sustainability. Within the context of HIA, *health* is defined as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO 1948). This comprehensive, or holistic view, of health impacts, the outcomes of concern for HIA may often overlap with those of EJ and CIA. As described by Ingles (2013[5]), "a few transportation projects in the United States… have been analyzed for their potential impacts on public health, [but] this is not the norm." When

[5] Amy Ingles' (2013) Master's Thesis makes reference to a yet-unpublished work, "Incorporating Health Considerations into Collaborative Transportation Decision Making," which at the time of the writing of this dissertation was still in preparation for publication by co-authors (Ingles, Fischer, Barrella, and Kennedy), including the author of this dissertation. Quotations and findings citing Ingles (2013) in this dissertation may also appear in the yet unpublished, jointly-authored work. Some findings have also been presented at the American Planning Association Annual Meeting in 2013.

such analysis is conducted, it is typically done by public health professionals rather than transportation professionals. However, the importance of multidisciplinary collaboration between transportation agencies and public health agencies in this area is becoming more recognized (National Research Council 2011, Lyons et al. 2012).

A complete HIA process includes five stages (UCLA 2013, Harris et al. 2007, National Research Council 2011), as listed in Table 2. In practice, however, most HIAs tend to stop at the point of making recommendations; monitoring and evaluation is often neglected due to funding limitations. This means that HIA processes have not been linked with an ongoing cycle of performance management within the agencies that perform them. Even if both HIA and performance management perspectives have been adopted by a particular agency, the current practice has kept them out of phase with each other, despite the concepts showing many logical linkages. As described by Ingles (2013):

> *The goal of both HIA and performance management is to utilize the analysis of performance data, whether projected or actual, as an input to feed back into the system and improve outcomes of a project, program, or policy. The difference is that, with traditional performance management, the analysis takes place after implementation; while the bulk of HIA takes place before implementation, except for the monitoring and evaluation of outcomes.*

So long as health is understood according to the WHO's (1948) holistic definition, the process of HIA is conceptually very similar to CIA, which has a somewhat longer history in transportation. Both HIA and CIA assess the impacts of programs and projects on the wellbeing of a community, and both emphasize the input of the community as an important information source to guide the assessment. Also, both have the potential to become more effective tools for promoting social sustainability by integrating a performance-based approach. Table 2 shows parallels between the stages and activities of HIA and PM, which could allow transportation agencies to draw

linkages that strengthen the effectiveness of HIA, as it becomes a more prominently used tool.

Table 2: Linkages of health impact assessment (HIA) stages linkages to performance management (PM)

HIA Stage	Activity Description	Linkage to PM
Screening	Determine if HIA is necessary and feasible	Requires evaluation of agency context, especially abilities and limitations
Scoping	Determine what level of analysis is appropriate given the community/project context and agency context	Requires a clear vision of desired HIA outcomes, health related goals to guide analysis, an initial set of performance measures, and an organizational plan for conducting the remaining analysis
Assessment	Collect and analyze quantitative and qualitative data and input from stakeholders to identify and prioritize impacts, and develop initial recommendations	Requires performance measures, tradeoff analysis, and evaluation of prospective actions
Decision Making & Recommendations	Recommend actions to promote desirable (and mitigate undesirable) health outcomes	This is the "allocate resources/implement decisions" step
Monitoring & Evaluation	• Monitor actual health outcomes after decisions are implemented, and compare them with the projected outcomes from analysis • Evaluate the HIA process and identify the impacts of process elements on recommendations and outcomes	This is the "measure & monitor actual results" step. It should lead into reporting performance, internally and externally, and therefore generate evidence that can be used for future applications of HIA.

CHAPTER 4: APPLYING PERFORMANCE MEASURES IN A COMPLEX SOCIOTECHNICAL CONTEXT

4.1 Introducing the Stacked Systems Framework

Transportation - that is, the multimodal network of transportation infrastructure and services - can be viewed as a sociotechnical system (Fischer and Amekudzi 2011) because it includes both human/social and infrastructure/technological components (Campbell et al. 2012; Moore 2007). Building upon the discussion of sustainability and sustainable development in section 2.2 of this dissertation, it is important to acknowledge that transportation systems exist within a broader, more complex context including environmental, economic, social elements. Also, transportation is just one example of *socio-technical operations* that leverage natural and built environmental resources to generate social and economic capital. In the *bicycle model* for sustainable development, introduced in section 2.2 of this dissertation, socio-technical operations are represented "where the rubber meets the road."

4.1.1 Adapting the Bicycle Model to a Systems Management Context

The *bicycle model* is a useful conceptualization for understanding the relationship between social, economic, and environmental processes; but it is not particularly useful for applying performance measurement in a complex sociotechnical context such as transportation systems management. In order to apply the bicycle model to this context, the role of the socio-technical transportation system must be discretely characterized

apart from, but in interaction with, the rest of the built and natural environment, and the rest of socioeconomic situations. In the words of Checkland (1999):

> *Cursory inspection of the world suggests it is a giant complex with dense connections between its parts. We cannot cope with it in that form and are forced to reduce it to some separate areas which we can examine separately.*

Reducing the "giant complex… to separate areas" allows us to more systematically analyze, and thereby to some extent systematize, situations in the real world that may not be inherently systematic (Checkland 1999). This is part of the foundation of operational research (OR). As described by Blackett (1962):

> *Operational Research is the application of the methods of science to complex problems arising in the direction and management of large systems of men, machines, materials and money in industry, business, government and defence [sic]. The distinctive approach is to develop a scientific model of the system, incorporating measurements of factors such as chance and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls.*

Therefore to adapt the bicycle model, which illustrates dense connections and interactions, to support the management of the socio-technical transportation system, a new conceptual framework may be proposed: the *stacked systems framework* (SSF), illustrated in Figure 9. In the SSF, the bicycle is abstracted as a layer of "socio-economic situations," which are complex and dynamic, and encompass human quality of life. The natural and built environment are unpacked in the lower layers of the stack, while the layer of sociotechnical operations is called out explicitly as a mediator between the built environment and socio-economic situations. The SSF reflects what Checkland (1999) identifies as two fundamental pairs of ideas for systems thinking: *emergence and hierarchy*, and *communication and control."* As further described by Checkland (1999):

> *[T]he architecture of complexity is hierarchical… the time required for a complex system to evolve is much reduced if the system is itself*

comprised of one or more layers of stable component sub-systems… Hierarchy theory is concerned with the fundamental differences between one level of complexity and another… what generates the levels, what separates them, what links them? … [E]mergent properties associated with a set of elements at one level in a hierarchy are associated with what we may look upon as constraints [imposed upon] a higher level… [This] is an example of regulatory or control action. Hierarchies are characterized by processes of control operating at the interfaces between levels.

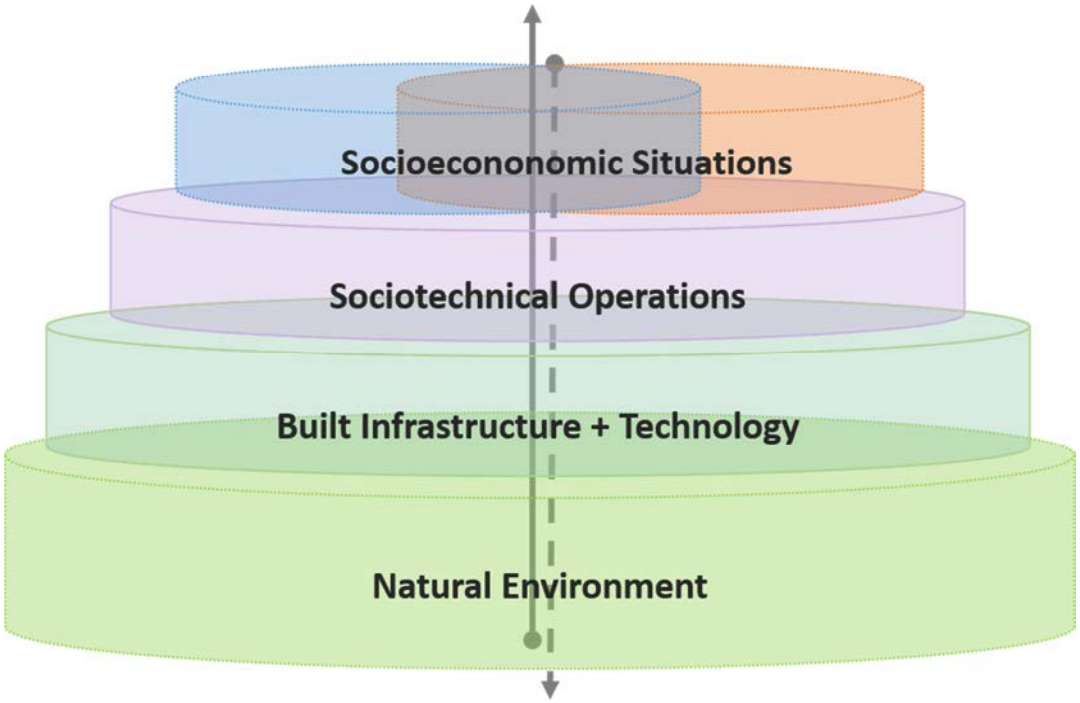


Figure 9: Stacked Systems Framework

Each layer of the SSF for sustainable development in Figure 9 can be thought of as categories of systems. Within each layer, it is possible to draw system boundaries in different ways, and to distill subsystems of larger systems. Also, joint-subsets of multiple layers may be conceptualized within a single system boundary. Systems higher in the stack depend upon resources generated lower in the stack in order to sustain themselves.

This is one example of the "control" described by Checkland (1999). In the other direction, higher systems can also impact lower systems through resource consumption (at sustainable or unsustainable levels), waste generation, and decision making that originate from the socioeconomic situations layer. All systems in the SSF are open, with inputs and outputs crossing their system boundaries and influencing outcomes in other systems.

4.1.2 Tracking Organizational Influence and Performance through System Sub-stacks

It is important to bear in mind that any application of the SSF is merely a model of reality, used to systematize the exploration of processes that may or may not be inherently systematic. Checkland (1999) emphasizes that processes involving human beings – especially those found in the socioeconomic situations layer – tend to be unsystematic because of their complexity. However, conceptualizing *human activity systems* within this layer can allow researchers or managers to deal with complex situations a systematic way. The definition of an *organizational system*, or an *inter-organizational system*, with defined structures and processes within and among organizational subunits, allows managers to analyze and direct the influence that organizational actions can have upon sociotechnical operations or the built or natural environment. Organizational action can be seen as a social output of the top layer of the SSF, and a social input to lower layers.

Since performance measurement and management are implemented by organizations, it is helpful to consider the flow of inputs and outputs among the subsets of the SSF from the perspective of organizational influence. Applying this perspective to transportation decision making, three subsets of the overall SSF are worth considering,

each of which generates and makes use of social and other resources in the cyclical relationship illustrated in Figure 10.

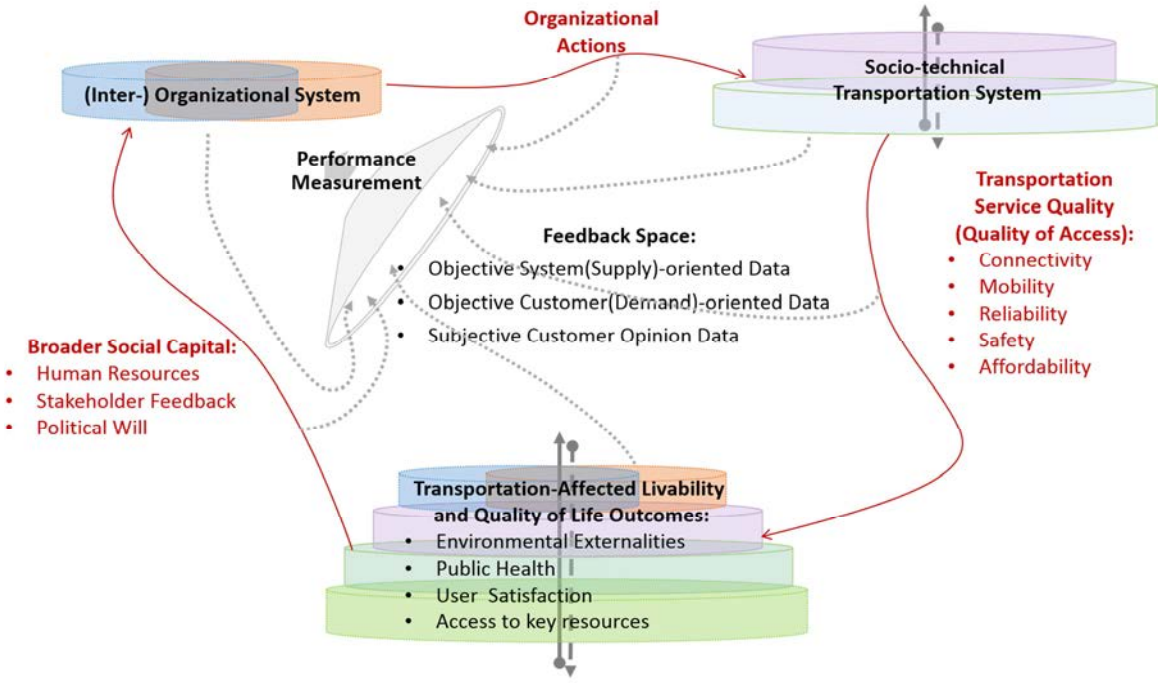


Figure 10: Cycle of social resources among transportation-related systems sub-stacks

Figure 10 illustrates a cycle of three types of social resources (organizational actions, transportation service quality, and broader social capital) flowing among three subsets (or sub-stacks) of the overall SSF. The three sub-stacks may be most usefully considered in the order of decreasing influence from transportation decision makers.

The first sub-stack to be considered for transportation performance management, shown in the top-left of Figure 10, is an inter-organizational system of decision making bodies (transportation executors) such as DOTs, MPOs, modal agencies, and others, who have responsibility for managing the sociotechnical transportation system. This is a subset of the socioeconomic situations layer in Figure 9. Although socioeconomic situations are inherently complex, defined organizational structures and processes can

allow managers to systematize their operations (Checkland 1999). The exact makeup of the inter-organizational system responsible for transportation decision making will vary from region to region; and while modeled as systematic through the lens of the SSF, the reality of this sub-stack may be more or less systematized, depending upon the consistency of interactions among organizational units.

The inter-organizational system shown in Figure 10 generates organizational actions that directly influence the sociotechnical transportation system. The sociotechnical transportation system, shown in the top right of Figure 10, is a joined subset of the built environment and socio-technical operations layers of the SSF. Organizational actions can impact the built environment of physical infrastructure and/or the sociotechnical operations which depend upon the built environment. It is important to acknowledge that transportation infrastructure interacts with land use patterns as part of the larger built environment layer of Figure 9; however, land use considerations have typically been tangential, if not completely external to transportation decision making and vice versa. Nonetheless, as introduced in section 2.5 of this dissertation, the efficiency or inefficiency of the larger transport-land use system generates a quality of access to key resources, which the broader population can leverage to generate quality of life. The sociotechnical transportation system subset itself generates transportation service quality, a multidimensional construct of objectively measureable outcomes related to the ability of transportation system users to access key resources.

Some characteristics listed for transportation service quality in Figure 10 are more directly influenced by organizational actions than others. For example, connectivity involves the physical configuration of transportation infrastructure and services such as

roadways and bus networks. This physical configuration is highly dependent upon organizational actions, with few interceding factors. However, mobility and reliability deal with the ability of transportation users to move around on the physical network. Unlike connectivity, mobility and reliability can be highly influenced by factors such as the number, abilities, and preferences of system users, all of which are outside the direct control of transportation agencies.

Transportation service quality supports broader livability and QOL outcomes in the universal system. The sub-stack shown at the bottom of Figure 10 encompasses broader livability and QOL outcomes such as accessibility to important opportunities (through transportation-land use interactions), health outcomes, customer satisfaction, air quality outcomes, and others. This sub-stack incorporates complex interactions among the natural environment, the rest of the built environment (i.e. the land use systems), and socioeconomic situations involving individuals and communities. All of the layers in this sub-stack may be indirectly influenced by the organizational actions of transportation decision makers, due in part to the mediating effects of transportation service quality.

The complex interactions between various subsets of the universal systems stack can make it difficult to categorize discrete sets of characteristics for the socio-technical transportation system, transportation service quality that flows from that system, and the third sub-stack shown at the bottom of Figure 10: transportation-affected livability and QOL outcomes. For example, safety may arguably be categorized as a characteristic of sociotechnical transportation operations, an attribute of service quality, or a broader social and/or economic QOL outcome. This author draws the line between system characteristics and service quality attributes in terms of the extent to which a particular

characteristic or attribute is directly relevant to user experience (discussed more in section 4.8). However, a precise categorization is not as important as acknowledging the "impact pathway" (Ingles 2013): safety-related outcomes such as injuries and fatalities arise due to transportation operations, and they can have broader effects on livability and QOL. With other outcomes that are more clearly in the third sub-stack, such as respiratory health and obesity, it is equally important to recognize the impact pathways. Focusing on health outcomes, Ingles (2013) acknowledges a "continuum" of more direct to less direct impact pathways, describing that "Direct impacts are those that affect the health of the population by means of interacting with the transportation system itself, while indirect impacts are those that occur due to the transportation system's interaction with the environment and its related health determinants." For example, safety outcomes are often related to direct pathways, "e.g. sidewalks help prevent pedestrian injuries by separating pedestrians from vehicles"; whereas other health outcomes are due to indirect pathways, "e.g., sidewalks help reduce obesity by creating [a safe] opportunity for physical activity" (Ingles 2013).

Because of the indirect pathway between organizational actions and broader livability and QOL outcomes, the latter have traditionally been "externalities" of the transportation decision making discussion. As Ingles (2013) describes, "more direct pathways tend to be those that are conventionally considered in transportation planning". This is understandable from a performance management perspective because performance measures should "be directly linked to and influenced by actions taken by an agency" (Kennedy et al. In Press). However, indirect influence does not equate to lack of influence. If an impact pathway can be identified from organizational actions to a

particular outcome, however mingled that impact pathway may be with interceding factors, transportation-related organizations would do well to at least monitor that outcome; and they could attempt to manage the outcome through cooperation and partnership with other organizations that work in education, public health, public safety and enforcement, etc.

The sub-stack of broader transportation-affected livability and QOL outcomes represents an important link in the cycle of social resources necessary for sustainable transportation systems. Specifically, it generates social, economic, and environmental capital that transportation agencies use in their organizational actions. Social capital generated by this sub-stack includes human resources (i.e. well-educated workers who can perform the duties required within the organizational system), stakeholder feedback (including input from the public and other organizational actors outside of the defined inter-organizational system), and political will (which may provide the organization with access to additional environmental or financial resources such as land, materials, and funding).

4.1.3 Feedback Space

Table 3 provides more detailed descriptions for QOL-related outcomes of transportation and land use decisions. All of these elements may be considered "outcomes" of organizational actions, inasmuch as they are characteristics of or outputs of the two systems sub-stacks in Figure 10, aside from the organizational system. (The difference between inputs, outputs, and outcomes was introduced in Section 3.3.2 of this dissertation, from the perspective of decision makers within organizations.) As illustrated on the interior of Figure 10, data about all of these outcomes, and the inter-

organizational system itself, can be collected and used in performance measures to inform organizational processes and actions. The information available to an organization or inter-organizational system, which may or may not be translated into performance measures, is called the *feedback space*. As discussed in Chapter 3, an organization or inter-organizational system implementing effective performance management will seek data relevant to its own strategic goals and the priorities of its external stakeholders. In other words, organizational systems create their own feedback space by actively seeking data, and then using the tools of performance management to translate data into information, and finally into action. Organizations may *activate* the feedback space by actively collecting data, and by using it in performance reporting, internally and externally. This concept of activated feedback is similar to Little's (2008) concept of clinical performance measurement; regularly seeking out performance information that (a) is relevant to strategic goals and stakeholder priorities, and (b) assesses the consequences of organizational action, allowing decision makers to build up an evidence base, improve their choice intelligence, and make better, more effective decisions as metrics also improve.

As further discussed in Chapter 3, the most important role of performance measurement is to inform future organizational action, which can lead to changes in the sociotechnical transportation system, transportation service quality, or broader QOL outcomes. In order to reflect the broader QOL impact of any particular element of the sociotechnical transportation system, or service quality, the activated feedback space should include both objective and subjective data, each of which are considered in the formulation of performance metrics.

The remainder of this chapter further discusses the influence pathways, three system sub-stacks, and three categories of social resources illustrated in Figure 10, and it provides example performance measures that can be used in transportation decision making for social sustainability. Section 4.2 discusses the organizational system; 4.3 discusses the relationship between physical infrastructure and accessibility; 4.4 discusses mobility and reliability, which arise from sociotechnical operations; 4.5 discusses affordability; 4.6 discusses physical safety; 4.7 discusses public health; and 4.8 discusses customer experience and satisfaction. The performance measures introduced in this chapter are not necessarily a comprehensive list of possible performance measures. However, they provide a basis for comparison, which transportation agencies can use to evaluate and expand their own performance measurement frameworks with the goal of promoting QOL. Section 4.9 introduces the case study provided in Chapter 5.

Table 3: Example QOL-related outcomes of transportation and land use decisions

Objectively Measurable Outcomes	Subjective (Human Perception) Outcomes
Mobility and reliability [b]: the ability to move around freely and with confidence (depends on modal options [a], travel cost [b], congestion patterns [a])	Satisfaction [c]: whether or not the expectations of users and the public are being met (depends upon system characteristics, and personal values and priorities)
Accessibility [b] to employment, goods, services, and other important opportunities (depends on land use patterns [a], connectivity [a])	Positive (or Negative) Experiences [c] as evaluated by system users and the public
Safety [b] effects such as fatalities and injuries, and physical health outcomes [c] such as illnesses (depends on system characteristics [a] and environmental conditions [c])	Personal Values and Priorities [d]: assignments of relative importance to system characteristics
Environmental conditions [c] such as air quality, water quality, noise levels (affects human health, safety, and ecological sustainability)	**a** Characteristics of the transport-land use system **b** Direct effects of transport-land use system, often understood as components of "service quality" **c** Indirectly influenced by transport-land use system **d** Although directly related to, may be independent of transport-land use system

4.2 Organizational (and Inter-Organizational) Structures and Processes

The GDOT OPM Study (Kennedy et al. In Press) discusses three important, interrelated elements of a public agency's organizational processes, which lead to the ability to implement performance management: strong leadership at the executive level, distribution of responsibility throughout the agency, and employee accountability. In terms of leadership, agency top management must "demonstrate that performance-based decision making is a priority in an agency" through participating in the performance management process and providing resources for other staff to participate. At the same time, non-executive staff at multiple levels throughout the agency hierarchy should also take on leadership roles in performance management. This vertical distribution of leadership and responsibility "can encourage wider commitment," and support a greater sense of ownership and acceptance, without which performance management efforts are unlikely to be effective or sustainable. Horizontal distribution (or decentralization) of responsibility across multiple divisions of an agency can also promote effectiveness by taking advantage of the various specializations reflected in the agency's division of labor. For example, DOT staff in a Safety Division would be most suited to tracking safety metrics and recommending actions for improving them; whereas an Asset Management division would be more adept at tracking and managing infrastructure condition. However, the benefits of a division of labor could be squandered if agency divisions become too siloed, neglecting horizontal communication. In the example, it is quite possible that safety issues are in part dependent upon asset management issues. In such a case, it will be important for the two divisions to communicate and work together to recommend solutions. This communication could happen through informal interaction,

but formal organizational procedures, like monthly meetings, can facilitate cross-agency collaboration for performance management. (Kennedy et al. In Press)

Within an organizational structure with performance management-supporting leadership, distribution of responsibility, and internal communication processes in place, further steps can be taken to promote employee accountability (Kennedy et al. In Press):

- Making performance data available, internally, across multiple levels and divisions of the agency can support short-term decision making in and a performance-based culture that relies on data and analysis.
- Providing opportunities to showcase the performance successes of different groups and divisions can "encourage creative problem solving" and strengthen staff buy-in of a performance-based perspective.
- Performance measures focused on outputs, productivity, and attributable outcomes can be integrated into daily routines and used as part of the periodic (e.g. annual) personnel review process. If review measures are mutually agreed upon by employees and management together, and these measures clearly relate to the overarching agency vision and strategic goals, this can "foster teamwork" and cohesion among multiple levels of the agency hierarchy.

In the multijurisdictional context introduced in section 3.5, many of the principles discussed above for a single agency can also strengthen multi-organizational performance management. As with multiple divisions within an agency, the responsibility for tracking and managing different components of the complex transport-land use system may logically fall to different organizations, depending upon their mandated functions and

jurisdictions. And as with a single agency, strong communication and partnership across organizational lines (connecting the siloes) is essential for effective performance management. Interagency communication in a multijurisdictional context is important for multiple reasons, all of which apply among multiple functional units of a single agency, but which may gain complexity when multiple organizations are involved:

- Data sharing – one organization may have data that is relevant to decisions that must be made, and ultimately carried out, by another organization.
- Partnership – many decisions may require the buy-in and cooperation of multiple organizations in order to be implemented successfully; building consensus around such decisions can take time and deliberation, even when a hierarchical relationship exists between the multiple organizations involved.

Inter-organizational contexts often have a similar challenge to that imposed by divisional structures within a single organization. The problem arises when the product or service of one functional unit could be improved by input from others, but little or no opportunity exists for communication and collaboration across functional units. In this respect, divisional siloes can sometimes impede efficiency. Ironically, just as a divisional structure may become more valuable as overall organizational size increases, the risk of communication breakdown between divisional siloes also increases. This can be mitigated by enhanced communication practices, including performance reporting.

In association with the GDOT OPM study, the author of this dissertation and other research team members developed an “Executive Checklist” and spreadsheet-based “Self-Diagnostic Tool” (described in Kennedy et al. In Press, Appendices C and D, respectively) to support DOTs as they strive to enhance their performance management

processes. The checklist and tool lead users through a series of yes-or-no questions, the answers to which can inform an agency about ways to strengthen its performance management processes. Although the checklist and tool were written to inform the perspective of an individual agency, they do also include questions related to inter-organizational relationships, in the context of communication with external stakeholders more broadly. Other questions relate to elements of strategic-level management and performance-based decision making introduced in 3.2 of this dissertation. Many of the yes-or-no questions contained in the checklist and tool imply potential measures of success (i.e. performance metrics) for effective organizational structures and processes. Table 4 catalogues performance metrics related to organizational structures and processes, whereas Table 5 catalogues performance measures related to internal and external stakeholders.

Table 4: Performance Metrics Related to Organizational Structures and Processes (Informed by Kennedy et al. In Press)

Metrics	Notes
Strategic-Level Management Practice	
Levels of organizational hierarchy that are represented in visioning and strategic planning process	Should include executive leadership, middle management, and "front lines" employees.
Percentage of employees at each level of the hierarchy who express an understanding of the value of performance measurement/ management	Should approach 100%. Lower values could indicate a need new training or other information-sharing strategies.
Percentage of functional units that help set the agency's strategic direction (vision, strategic goals)	Should approach 100%. Lower values could indicate a need for more extensive outreach to staff in different functional units.
Existence of formal mechanisms for regular information sharing across functional units and among levels of hierarchy	This is a "check box" type of metric. To satisfy this metric, formal mechanisms could include regular in-person meetings, internal reports, and shared databases. More robust performance management practice may implement multiple mechanisms.
Percentage of functional units, or internal decision makers, that receive the information they need for day-to-day decisions on a regular basis, in a timely way.	Should approach 100%. Lower values could indicate a need for additional, or more formalized mechanisms of information sharing. In order to develop such mechanisms, managers will need to identify which functional units typically need external information, and from where that information comes.
Performance-based Decision Making	
Percentage of strategic goals/objectives that have defined performance measures, changes in which are attributable to agency actions	Should approach 100%. Lower values could indicate a need to re-evaluate certain goals, objectives, or metrics.
Percentage of performance metrics that are supported by accurate, sustainable (technologically and fiscally) data sources	Should approach 100%. Lower values could indicate a need to re-evaluate certain metrics or data sources.
Percentage of identified performance targets that have been met within their defined timeframes in the last decision-making cycle: Project/program delivery targets (e.g. percent of projects completed on schedule) Performance outcome targets	This metric can be evaluated at a divisional, agency-wide, or inter-organizational level, in each case examining only metrics relevant to the particular scale. It is desirable for the value of this metric to approach 100%, except where targets are understood to be purely aspirational. Lower values could indicate a need to re-evaluate targets, timeframes for achievement, or strategies for achievement, including who champions tracking and achievement.

Table 5: Performance Metrics related to Internal and External Stakeholders (Informed by Kennedy et al. In Press)

Metrics	Notes
External Stakeholder Relationships	
Percentage of identified external stakeholder groups for whom formal mechanisms exist to regularly report relevant performance	Should approach 100%. Improving performance in this area may require a sort of "market research" approach to identifying stakeholder groups, their priorities, and preferred/feasible reporting methods. Reporting methods may include report documents, websites, news media, social media, and/or in-person meetings.
Percentage of identified stakeholder groups for whom formal mechanisms exist to regularly collect feedback	Should approach 100%. Improving performance in this area may require training or hiring staff to interact with stakeholders and/or collect and analyze feedback. Feedback mechanisms may include periodic polls or detailed surveys, emails/calls, social media, or in-person meetings.
Percentage of stakeholders who express satisfaction with the agency's priorities, activities, and demonstrated performance	It is desirable that performance in this area approach 100%. Lower values may indicate a need to closely analyze areas of low satisfaction for different stakeholder groups.
Internal Stakeholder / Human Resource Management	
Percent of employees that meet or exceed performance expectations	It is desirable for this to approach 100%. This metric can be segmented by job category or functional unit. For both high and low values of this metric, further analysis may show may be warranted to showcase excellent practices and to identify problem areas.
Percent of employees who express satisfaction with working conditions (e.g. safety, hours, pay, management practices, personal fulfillment etc.) and overall work experience	It is desirable for this to approach 100%. Many types of "working conditions" may be defined for different job categories. Employees may be more inclined to participate in data collection for metrics such as these if surveys responses are anonymous.
Percent compliance with employee guidelines and protocols (e.g. safety, hours, management practices, stakeholder engagement, etc.)	Should approach 100%. Improving performance in this area may involve additional analysis by job category or functional group, as well as additional training.
Number of employee complaints	It is desirable for these metrics to approach 0.
Number of on-the-job accidents or injuries	
Promotion and separation rates	It may not be appropriate to set targets for these metrics, but employee groups may be segmented and tracked by job category and demographic characteristics. Unusually high or low values in one employee group, in comparison with the average, may merit additional analysis and action.
Percent of employees cross-trained in multiple disciplines	It may be appropriate to set targets for these metrics in order to help with succession planning and maintain efficiency when employees leave or join the organization.

4.3 Physical Infrastructure and Accessibility

4.3.1 Transportation Asset Management Practice

The science of managing physical assets in transportation is called "transportation asset management" (TAM). TAM is formally defined by the American Association of State Highway and Transportation Officials (AASHTO, 2011) as a "strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their lifecycle". TAM programs typically consider physical assets including infrastructure and equipment.

Performance measurement is crucial to effective TAM programs. Measures related to asset management and preservation include inventory measures, which list the number of assets belonging to the agency by category, project delivery measures such as the number or percent of scheduled inspections or maintenance tasks completed, and condition ratings, which are often on a qualitative scale, and aggregated by asset type. The most common assets tracked by DOTs are pavements and bridges, but some DOTs have started tracking inventory and condition for other, "ancillary assets" and properties, including signs, pavement markings, culverts, retaining walls, sidewalks, carpool lots, real estate, buildings, equipment and machinery (Akofio-Sowah 2011).

Extensive knowledge of both inventory and condition are both necessary for an agency to manage the performance outcomes to which physical assets contribute. Asset management processes can have significant, attributable, impacts on QOL outcomes due to the types of infrastructure provided and its condition. For example:

- Pavement condition directly impacts ride quality and maneuverability for roadway users, and thereby indirectly impacts user costs related to vehicle wear and tear, and safety or perceived safety through crash risk.
- Ancillary highway assets such as traffic signals, retaining walls, and guardrails all have significant safety consequences.
- The existence or condition of pedestrian infrastructure as a last-mile (or quarter-mile) connector from transit stations and stops into neighborhoods and business centers dramatically impacts the relative inclusion of people who are unable to, or prefer not to drive.
- The condition and performance of transit vehicles may impact passenger comfort, safety, and mobility.
- For some assets, such as rail lines that squeal when the rail-wheel interface is not effectively managed, asset condition can also affect the QOL of non-users by causing noise pollution.

4.3.2 Network Configuration and Multi-Modal Connectivity

Typically, TAM is thought of as an activity that occurs after assets already exist and are owned by a transportation agency. However, the AASHTO (2011) definition's reference to "upgrading and expanding physical assets" implies that TAM can also include – or should at least be closely linked with – project planning, programming, and design. Furthermore, several of the livability principles outlined by the federal Partnership for Sustainable Communities (USDOT 2011) affirm that the particular configuration of physical infrastructure and assets in the transportation network, and transportation infrastructure's physical linkages with land use systems, can have

significant impacts on QOL. Perhaps most notably for QOL, these principles the injunction to "Provide more transportation choices" (USDOT 2011); that is, to increase the availability of different modal options, including motorized and nonmotorized options that system users may choose according to their preferences, abilities, and trip purposes. Fischer and Amekudzi's (2011) cite multiple studies (Gabriel et al. 2003; Frank et al. 2006; Schrank and Lomax 2005) that show how diversity or lack of transportation choices "can influence the health of a population, limit its access to amenities such as free time, and mean the difference between billions of dollars wasted or saved." As Feng and Hsieh (2009) describe, transport diversity is an important QOL indicator that can be used to "assess whether …important needs are satisfied equitably, and monitor whether the transportation system is moving toward sustainability."

Another injunction of the federal Livability Principles is to invest in "walkable neighborhoods" (USDOT 2011). Walkability may be understood as the composite characteristic of a place that makes walking for transportation purposes to be attractive and safe. Characteristics of walkable environments include both physical infrastructure and operational elements including traffic speeds that affect safety. Distilled from the literature, physical infrastructure elements that promote walkability include the following:

- A high level of connectivity- expressed as the density of intersections between transportation links - to minimize both distance and depth between origins and destinations (Litman 2011; Alayo 2001). Depth is expressed as the number of view changes (or corner turns) that a traveler must make between an origin and destinations.

- Well-maintained and easily negotiable pedestrian infrastructure, including sidewalks and cross walks, which is inclusively designed to accommodate people with different physical abilities and other constraints (Coleman et al. 2007).;
- Land use mix that incorporates residences and key services within walkable distances (Sperry et al 2010, Joh et al. 2008); and
- Attractive and interesting scenery along walking routes, including human-scaled development, with caps on parking and store size (Ryan 2003).

Promoting walkability has been touted as one way of creating more efficiency in the transportation system (Litman 2011). Increased transport efficiency may be characterized as a higher level of accessibility to important opportunities, relative to travel distance, travel time and/or user costs. From an infrastructure provision standpoint, an efficient transportation network will be coordinated with an efficient land use system, where important origins and destinations are located in close proximity to each other. Walking as a mode of transportation is especially associated with the presence of residential, retail, office, health, and entertainment land uses within short distances of each other; whereas recreational walking is more strongly associated with the presence public open space and sporting infrastructure (Christian et al. 2011; Duncan et al. 2010). Connectivity is important, as illustrated in Figure 11, because a density of intersections, and especially a gridded network, allows pedestrians to walk shorter distances, and, given a mix of land uses, it helps them to be aware of many opportunities (Litman 2011; Alayo 2001). Alayo (2001) expounds:

> *If the land use mix is critical, the morphology of the network (particularly connectivity and grain) is the one that hat establishes the way potential origins and destinations are linked and the extent of the catchment area for any given location. At the simplest level, the*

network provides the distance between locations, but it can also influence the level of awareness and convenience. … For instance awareness of the location of a shop, for the users of an area, is likely to be higher if that shop happens to be in a location that enjoys good visibility from many other points of the network. … Broadly speaking, spaces that have high levels of integration (the visual depth to other elements is low) tend to be busier than more segregated spaces (those for which reaching other elements require more changes of visual direction).

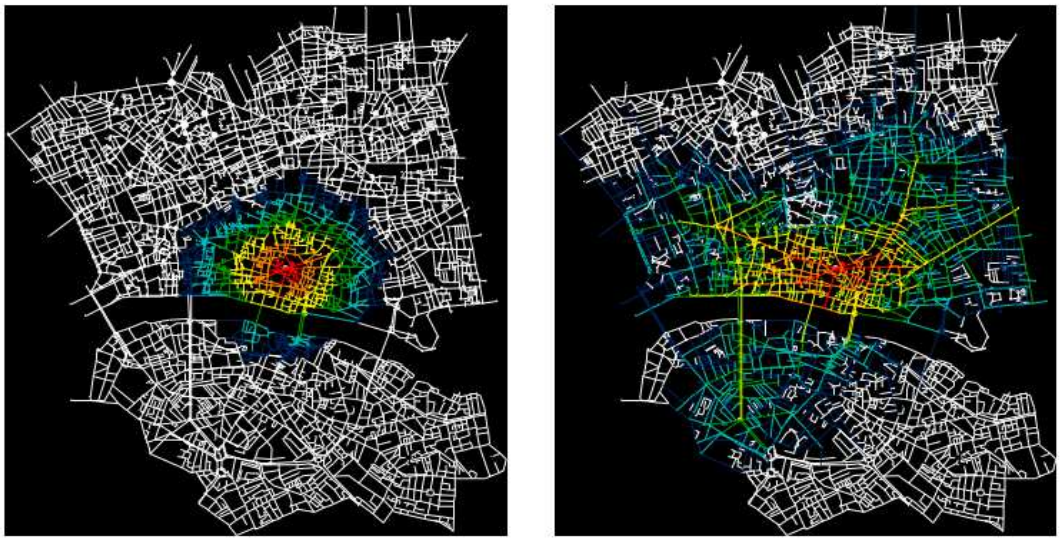


Figure 11: Distance (left) and depth (right) profiles defining the walking catchment area around a location in London. Color gradation is scaled by increases of 200 meters (distance), and single view changes (depth). (Alayo 2001)

Providing more walkable environments can lead to more efficient and inclusive transportation system by improving accessibility for people of all groups. Litman (2011) calls walking "the most basic form of transport, for the following reasons:"

- *It is universal. Virtually everybody walks, and virtually all trips include walking links.*
- *It is very affordable. Economically and socially disadvantaged people tend to rely heavily on walking for transport.*
- *It provides connections between other modes of transport. Automobile, transit and air travel trips all depend on walking.*

- *It provides additional benefits, including exercise and enjoyment.*

Also, Litman (2011) points out, pedestrian infrastructure is less expensive to provide (build and maintain) than infrastructure for other modes, so it is highly desirable from a resource-efficiency standpoint. However, walking is appropriate for all trips. Table 6 describes the user requirements and appropriate uses for eleven transportation modes. In order to accommodate people who may need or prefer each of these modes, a diversity of transportation infrastructure is necessary. Sidewalks or multiuse paths can accommodate walking and wheelchair use. Multiuse paths and bicycle lanes can accommodate cycling, which has been calculated as the most energy efficient transportation mode per passenger mile, on average (Litman 2009). Fixed route transit can be provided via rail, or via bus service on highways; of infrastructure options, light rail has been calculated to be the most energy efficient per passenger mile on average, and the most energy efficient transportation mode overall when filled to maximum capacity (Litman 2009). Highway infrastructure can accommodate automobile users including drivers and passengers. Each type of infrastructure also has its primary and ancillary components. For example, driving networks include pavements, signage, pavement markings, etc.; transit networks may include tracks or dedicated lanes, stations or stops including shelters, signage, and so forth.

Table 6: User Requirements (1 – Physical ability, 2 – Financial ability, 3 – Vehicle Ownership or Equipment, 4 – Social support) and Appropriate Uses for 11 Transportation Modes (Adapted from Litman 2009).

Modes	User Requirements				Most Appropriate Uses
	1	*2*	*3*	*4*	
Walking	•				Short trips by physically able people with little to carry.
Wheelchair		•	•		Short urban trips by people with physical disabilities.
Bicycle		•	•		Short to medium length trips by physically able people with little to carry on suitable routes.
Fixed Route Transit		•	•		Short to medium distance trips along busy corridors; longer trips for express transit service.
Taxi				•	Infrequent trips, short and medium distance trips.
Paratransit				•	Travel for people with disabilities.
Auto driver		•	•		Travel by people who can drive and afford an automobile.
Ridesharing (auto passenger)				•	Trips that the driver would take anyway (ridesharing) Occasional special trips (chauffeuring).
Car sharing (vehicle rental)		•	•		Occasional use by drivers who don't own an automobile.
Motorcycle	•	•	•		Travel by people who can ride and afford a motorcycle
Telework			•	•	Alternative to some types of trips.

4.3.3 Measuring Infrastructure Provision

Table 7 summarizes infrastructure performance metrics related to infrastructure provision and asset management that are directly attributable to both (a) actions that may be taken by a transportation agency, and (b) QOL-related outcomes. Infrastructure provision metrics can be seen as outcomes of transportation agency decisions. Inputs and outputs related to project delivery can also be important tools for making QOL-oriented investments. Also, metrics that associate infrastructure provision with broader social and economic contexts are relevant to infrastructure planning.

Table 7: Performance metrics to inform, track, and measure physical infrastructure provision in the transport-land use system (informed by MTKN 2011, FHWA 2014)

Metrics	Notes
Asset Management Inputs	
Dollars spent on new capacity, inspections, repair and maintenance	These metrics can be segmented and compared by mode to demonstrate and express the level of priority that an agency or region places on each type of modal infrastructure. However, these metrics – especially the dollars spent metrics – will not tell the whole story by themselves. They can be correlated with operational metrics such as person miles traveled by mode, and tracked over time to help identify where more investment and time may be warranted.
Staff hours dedicated to monitoring and managing infrastructure assets	
Project/Program Delivery (Outputs and Process)	
Percentage of new capacity opened according to schedule (or within a target timeframe)	Delivery metrics such as these can help the organizational system fulfill its promises to the public, increase accessibility, and avoid undue operational disruptions. Values for these metrics should approach 100%. Lower values indicate a need to re-evaluate organizational structures and processes for project and program delivery.
Percentage of infrastructure maintenance tasks completed according to schedule	
Network Configuration and Condition	
Percent of right of way that accommodates a particular mode, or multiple modes.	Metrics such as these may have different target levels, or different standards, within different corridors, or areas. Agencies may use design or condition standards set internally or by an outside group or mandate. For example Maryland DOT measures the percentage of state owned roadway centerline miles in urban areas that have sidewalks that meet ADA standards, and a bicycle level of comfort of "D" or better. Similarly, Oregon DOT tracks the percentage of urban streets that have bike lanes and pedestrian facilities in "fair or good condition". Several DOTs track the percent of roadway miles with acceptable ride condition, defined differently for different roadway types, and Missouri DOT tracks the percent of roadway signs and stripes that meet customer expectations, and. (MTKN 2011).
Percent of infrastructure elements, meeting design or condition standards, or customer expectations (Percent of customers satisfied with infrastructure condition, defined for multiple modes)	
Comparative extent of modal networks; expressed as the ratio of, for example, bike path miles or transit service miles to total street miles	This sort of metric is relevant to equity and transport diversity. Similar to the metric type immediately above, this may have different target values for different contexts, such as priority areas or corridors that are identified as "optimal" locations for non-motorized transportation.
Average block length	These metrics may have different target values depending on the context. Shorter blocks, increased intersection density, and increased land use diversity improve walkability, and increased land use density around transit stops can make transit operations more feasible and sustainable, but all these elements decrease automobile efficiency. Agencies may wish to identify target areas – or walkability nodes – for decreased block length and intersection density, especially within a target distance from transit stations.
Intersection density	
Land use diversity	
Land use density	
Socioeconomic Integration	
Number of non-work attractions accessible within a target distance or depth profile of transit stops	
Density of employment opportunities within a target walking distance of transit stations or stops	
Jobs/housing balance	Metrics such as these acknowledge that built environment functions in a broader context, and that its primary purpose is to provide people with access to goods and services. Planning professionals, especially, should take the socioeconomic context into account in order to ensure that the transport-land use combined system
Percent of population (or group) living within a target walking distance of transit stations or stops	
Modal access for disadvantaged groups compared to entire population	

4.4 Mobility and Reliability

While accessibility to important opportunities may be seen as the primary social resource output of the transport-land use system, only the foundation of access is provided by the physical infrastructure system described in Section 4.3. Several other elements of transportation service quality emerge due to sociotechnical system operations, and these can likewise enhance or impede a population's ability to access desired resources in an efficient manner. As Fischer and Amekudzi (2011) describe, "Whether or not resources are available is irrelevant if access to resources is lacking" and "the quality of access … can significantly affect QOL."

Mobility refers to the ability and proclivity of people and goods to move from their origins to their destinations. Perhaps the most basic mobility metric is miles traveled - traditionally tracked on roadway systems as vehicle miles traveled (VMT). Person-miles and ton-miles traveled are more relevant to tracking people and freight mobility, respectively, and they can also be applied to and compared across multiple modes. Miles-traveled metrics express mobility in the sense that more miles mean more movement; however, these metrics are not particularly useful for tracking accessibility. Miles traveled will be highly correlated with population size, job growth, and sprawling development patterns. Rather than considering miles traveled as a performance measure for mobility, in and of itself; it may more appropriately used as a context metric that feeds into performance analysis related to other outcomes, for example safety (number of crashes per vehicle miles traveled).

More appropriate mobility performance metrics will relate directly to mobility-related goals. As described by Lomax (2005), "Goals addressing mobility might include

lower travel times and more reliable travel conditions." One approach to achieving these goals has to do with congestion mitigation. According to the Texas Transportation Institute's Urban Mobility Report, congestion cost the average urban-area commuter 38 hours of delay in 2011; a metric that increases to 52 hours in very large urban areas (over 3 million population) (Schrank et al. 2012). Transportation and development agencies may tackle recurrent congestion problems through initiatives that attract travelers out of their automobiles, especially during the peak commuting period. Such initiatives may include physical infrastructure changes such as increasing land-use diversity and density, which can shortens trip distance and make non-automobile trips more attractive (Joh et al. 2008; McCormack et al. 2001; Christian et al. 2011); providing new capacity for "alternative modes" (other than driving alone), or upgrading existing infrastructure such as bicycle paths, sidewalks, and transit; or improving operations on transit modes by increasing frequency, adding routes, improving on-time performance, or upgrading infrastructure. Transportation agencies may use miles-traveled metrics to track the effectiveness of these sorts of programs to increase multimodal mobility by segmenting and comparing the evolution of person miles traveled by mode over time. However, new capacity for increased travel is likely to cause only temporary traffic due to population and economic growth and the phenomenon of "triple convergence."

As Lomax (2005) indicates, agencies "may have more success in reducing the day-to-day variations in travel time than in reducing average congestion levels." Other literature also indicates that total travel time in and of itself is less concerning to travelers than travel time reliability (Cambridge Systematics, University of Maryland, and Resource Systems Group). Metrics are therefore are needed to inform and track the

success of initiatives aimed at improving travel time *reliability*. Reliability refers to the level of confidence that a traveler can have in the travel time provided by a particular transportation link or network.

Mobility performance measures may be thought of as falling along two continua from more congestion-oriented to more reliability-oriented, and from user-more experience-focused to network-management-focused.

Table 8 lists mobility-related metrics according to both continua.

Table 8: Operations-related performance measures for tracking mobility and reliability (informed by MTKN 2011, FHWA 2014)

	User Experience	Network Management
Congestion/ Capacity/ Operational State	• Average travel time to major employment centers, by time of day (peak and off peak), and by mode • Average commute travel times • Average trip speed on selected corridors or segments (peak and off-peak); • Travel time index (TTI): ratio of the average peak-hour travel time to free-flow travel time • Ratio of out-of-vehicle time (transfer/wait time) to in-vehicle (in-motion) time for transit trips (OVT/IVT)	• Change in annual person miles traveled by mode • mode share by trip purpose • Mobility index: person-miles (or ton miles for freight) divided by vehicle miles traveled • Percent of trips with space-mean speed less than target value • Volume to capacity ratio (V/C) by corridor or segment • Percent of roadway miles with volumes at congested levels
System Reliability	• Cumulative travel time delay per capita, possibly segmented by population group • Planning time index (PTI): ratio of the 95th percentile travel time to the free-flow travel time • Buffer time index (BTI): ratio of the buffer time (difference between the 9th percentile and average congested travel time) to the average congested travel time • Transit headways • On-time performance of transit trips, by route	• Number of employees within target travel time of major employment centers, by mode • Duration of peak-period congestion • Percent of trips with travel times less than 10 or 25 percent higher than the median travel time • Vehicle hours of delay per lane mile

4.5 Affordability

There are two perspectives from which to investigate transportation. From the organizational system perspective, costs are required to create and implement all transportation initiatives including plans, programs, and projects. An affordable initiative will (a) have resources such as funding and staff time available, and (b) will be expected to yield an acceptable return on investment. From the service quality and QOL perspective, all transportation modes include some sort of user investment, and different modes are more affordable than others depending upon personal financial means. From this perspective, an affordable transportation system will "provide a viable option for any modal user" (Blake, 2013).

4.5.1 Agency Investment and Affordability

Return on investment for transportation initiatives implemented by public agencies is often thought of in terms of economic development. A major indicator of economic development impact is jobs creation. The Political Economy Research Institute (PERI) (Garrett-Peltier 2011) studied direct, indirect, and induced jobs creation by the design, construction, and materials procurement of 58 transportation projects in eleven cities across the United States. Results are summarized in Table 9. In the PERI study, "direct jobs… are created in the engineering and construction firms involved in infrastructure projects, [indirect jobs] are created in the supply chain of these industries… such as cement manufacturing, sign manufacturing and truckers, [and induced jobs are created] as workers in the direct and indirect industries spend their earnings, [creating] demand in industries such as food services and retail establishments" (Garrett-Peltier 2011). As shown in Table 9, the study found that bicycling projects create the most jobs

per $1 million of investment, followed by pedestrian-only projects, with roadway (motor-vehicle) –only projects trailing in last place.

Table 9: Jobs created by transportation investment projects in the United States (Garrett-Peltier 2011)

Project Type	Number of Projects	Jobs per $1 Million Invested			
		Direct	Indirect	Induced	Total
Total, all projects	58	4.69	2.12	2.15	8.96
Bicycle infrastructure only	4	6.00	2.40	3.01	11.41
Off-street multi-use trails	9	5.09	2.21	2.27	9.57
On-street bicycle and pedestrian facilities (without road construction)	2	4.20	2.20	2.02	8.42
Pedestrian infrastructure only	10	5.18	2.33	2.40	9.91
Road infrastructure with bicycle and pedestrian facilities	13	4.32	2.21	2.00	8.53
Road infrastructure with pedestrian facilities	9	4.58	1.82	2.01	8.42
Road infrastructure only (no bike or pedestrian component)	11	4.06	1.86	1.83	7.75

Beyond jobs creation due to the construction of bicycle and pedestrian infrastructure, additional economic development impacts are associated with the presence of this infrastructure. For example, Local Government Commission Center for Livable Communities (2003) cites the experiences Lodi, California; West Palm Beach, Florida; and Mountain View, California to demonstrate the benefits of walking infrastructure on economic development. In each case, city investment in walkable centers in the 1990s, including traffic calming measures and streetscape enhancements, are credited with attracting new business investment, dramatically increasing building occupancy, and increasing tax revenues. In West Palm Beach, a city transportation planner avowed that

the city's $10 million investment "paid for itself, easily" within four years. (Local Government Commission for Livable Communities, 2003)

When economic development is foreseeable, transportation agencies may have more opportunity to attract supplementary funding to support their initiatives. For example the city of Lodi, California partnered with the private sector to raise the necessary $4.5 million for their downtown walkability project (Local Government Commission for Livable Communities, 2003). In another, more recent example, the city of Durango, Colorado completed a community-oriented multimodal transportation plan in 2012, which attracted both federal and private funding support. The Durango multimodal administrator, Amber Blake, described in a 2013 interview how "affordability is kind of multipronged." In terms of the cost of the planning process itself, the agency was able to get an FTA grant to cover approximately $25,000 of the total $32,000. Blake acknowledged that this low cost, and the ability to attract federal funding, was due to an innovative approach:

> *We took a little different approach to a long-range transportation plan. Instead of doing the plan first and then trying to implement it, we actually started having our public meetings… cherry-picking the easy projects, and getting those done as we were in the planning process. The Multimodal Transportation Master Plan looked at bicycles, pedestrians, transit… the overall vehicular network… carpooling and parking and rides. We found there were few key areas that were missing connectivity.*

Because of the innovative approach, with early community involvement, the city experienced "an enormous amount of buy-in" from the public and the business community. Several businesses, including pizzerias, local breweries, and a trade museum, donated space and refreshments to host public meetings. This helped to lower the public involvement cost. Community perspectives, including some from people with mobility

impairments, supplemented the staff's data collection and analysis to identify those "key areas" with "easy projects." As Blake described, "staff went out on a bike and with tennis shoes… and audited the network." Objective connectivity and condition information was mapped with the city's GIS system, and then supplemented with perspectives from "some of our disabled community members" regarding their subjective experiences of lacking accessibility. Having identified key deficiencies in the network, Durango hired a consultant team to complete schematic designs and cost estimates that would fill the gaps. Blake (2013) explained:

> *The other piece of [affordability] was using consultant-driven hours for those schematic designs. Designs that we can pull off the shelf and throw into a NOFA (notice of funding availability) that comes out and you have 2 weeks to get your funding application in. Boom, you're ready to go. That makes it affordable for us to apply for as many grants as possible, when there are not very many extra staff hours.*

Examples such as these indicate that transportation agencies can promote affordability of their initiatives through innovative organizational processes that gain support from the public and other stakeholders, and promote livability and QOL outcomes.

4.5.2 User Investment and Affordability

The Texas Transportation Institute estimates "congestion cost per auto commuter" as a combined monetization of excess fuel purchased and excess time spent on the roadways due to congestion. For 2011, this value was estimated at $818 for the average urban area commuter, and $1,128 per commuter in areas with more than 3 million population (Schrank et al. 2012). The case is similar for any mode: all transportation users invest time and money in order to travel from their origins to their destinations. From the user's perspective, driving alone is often the most expensive mode of

transportation in terms of financial investment. Litman (2011) cites a study done in 2000, which "found that households in automobile-dependent communities devote 50% more [money] to transportation … than households in communities with more accessible land use and more multi-modal transportation systems." However, if the multimodal network is incomplete, and/or if origins and destinations tend to be far from each other, then other slower modes can become equally expensive if the value of time is considered. According to Bullard (2004), "the average American household spends one fifth of its income… for each car that it owns and operates, [but] it is not uncommon for many low-income… households to spend up to one-third." For those so-called "transit captive" travelers who are priced out of private automobile use altogether, additional time costs also diminish their opportunity for QOL; Bullard et al. (2000) cite that "generally, people who commute using public transit spend twice as much time traveling as those who use their cars."

In a study of the 2009 National Household Travel Survey, Mattson (2012) found "price of travel", in other words *affordability*, was rated "the most important issue" to survey respondents, "regardless of geography, medical condition, age, or even income." Citing the Center for Transit Oriented Development and the Center for Neighborhood Technology's "Affordability Index" (CTOD and CNET 2006), Litman (2014) summarizes affordability from a transportation system user's perspective:

> *Many experts define affordability as lower-income household's ability to spend less than 20% of their budgets on transportation expenses, and less than 45% on transport and housing expenditures combined (CTOD and CNET 2006). Exceeding these levels is not necessarily a problem: Some households may choose high transport expenditures, for example, because they enjoy recreational travel or vehicle collecting, or because the expenditures provide offsetting savings, such as reduced housing costs. Unaffordability exists if households want to*

> *spend less but cannot because affordable transportation options are inadequate. For example, a transport system is unaffordable if lower-income households are forced to own more vehicles, drive fore, and rely less on alternative modes than they want. Affordability can therefore be evaluated based on consumers' ability to save money, even if they do not always use affordable options, which is sometimes called option value.*

Litman (2014) further points out that several factors will influence the affordability of transportation for different groups, including income and wealth, daily household responsibilities (commuting, caregiving, or medical treatment) that affect transportation needs, physical and mental abilities, language fluency, and the ability to drive. Since travel cost may affect different groups differently, affordability becomes an equity concern. It is therefore important, from a social sustainability perspective, that affordability is factored into transportation decision making, and that cost burdens are evaluated for different groups of the population.

4.5.3 Affordability-focused Metrics

As can be seen from the discussion in this section, transportation agencies prioritizing affordability may wish to focus on providing a robust multimodal system with increased non-automobile options. Performance metrics related to infrastructure provision, introduced in section 4.3.3, can therefore be used to track agency efforts in this area. However, many additional operational metrics and broader QOL and livability outcomes are specifically relevant to cost and affordability. Table 10 lists affordability metrics relevant to both perspectives discussed in this section.

Table 10: Affordability Metrics

Metrics	Notes
Agency/Network Perspective Affordability	
Congestion cost per capita	Lower values are more desirable. This metric can help evaluate the cumulative effectiveness of congestion-mitigation efforts in the short term. However, unless a region undergoes drastic structural change in its transport-land use system, long term savings may be unlikely due to the effects of population growth, economic growth, and triple convergence on congestion.
Cost of travel time delay, per capita	
Public expenditure per transit boarding	Lower values are desirable. This is different from measuring "public expenditure on transit service per capita," for which higher values may be desirable. The per-transit-user metric will have lower values as transit ridership increases.
Cost recovery ratio by mode	Farebox recovery is a common cost efficiency metric for transit agencies. Cost recovery can also be calculated for other modes; for example, using tax and toll revenue as inputs.
Energy consumption per passenger mile	Lower values are desirable. These metrics can be tracked in aggregate, and by mode.
Energy consumption per freight ton-mile	
Ratio of GDP growth rate to VMT growth rate	Higher values are desirable. If this ratio declines over time, it may indicate a need to change development policies to slow congestion growth.
Percent of GDP spent on transportation fuel.	Lower values are desirable. This metric may improve as mode shifts to more energy-efficient (and thus cost-efficient) modes.
Projected and actual economic impact per million dollars invested in transportation initiatives (jobs created, GDP growth, tax revenue, monetized crash costs)	Higher values are desirable. This metric expresses return on investment. Projected values are important for designing and prioritizing initiatives. Actual values, evaluated after implementation, are important to track success.
User Perspective Affordability	
Portion of household expenditures devoted to transport, including vehicle expenses, fares, parking, and relevant taxes.	Lower values are more desirable. This metric can be segmented by population group to evaluate the relative equity of affordable transportation.
Percentage of low-income households that spend more than 20% of their budget on transportation.	Lower values are more desirable. Low-income households are especially vulnerable to hardship due to high costs of living. These metrics can be used in equity evaluations for proposed pricing changes on the transportation system, and for proposed infrastructure improvements meant at increasing the availability of low-cost modes, which may also increase property values and rents.
Percentage of low-income households that spend more than 45% of their budgets on transportation and housing combined	
Out-of-pocket user cost per trip, by mode, trip type, and population group	Lower values are more desirable. Monetary and time costs are both important affordability considerations for all travelers and all modes. Although typical travel demand modeling methods assume a lower value of time for low-income travelers – who are more likely transit-dependent, this assumption can undervalue transit service investments. If modes (especially automobile and transit) remain competitive in terms of these metrics, the wider system may benefit by attracting higher income travelers out of their cars, and by increasing the economic capacity of lower-income travelers.
Travel time cost per trip, by mode, trip type, and population group	

4.6 Physical Safety

Safety is a high priority for transportation agencies. Pei et al. (2010) found that it is the #1 goal area for state DOTs, considered by 67% of their survey respondents. As reported in the GDOT OPM study (Kennedy et al. In Press), DOTs typically measure safety by tracking the number of annual incidents and/or incident rates per 100 Million VMT or 100,000 people. To improve QOL, transportation agencies should strive to minimize both incident numbers and rates, but fatality rates are more comparable across populations of different sizes, as in neighboring areas or within the same area as it changes over time. Also, rates per VMT and rates per population are useful for different purposes. Specifically, while VMT can represent exposure to the highway network, this is only true for people who ride in cars; incident rates per population are more appropriate if incident rates are going to be compared across modes or aggregated for all modes.

Among DOTs tracking safety, most track fatalities on their roadway systems, while fewer track crashes, injuries, and serious or immobilizing injuries. Several state DOTs also separate incidents by mode, cause and/or circumstance; for example, separate performance measures may track incidents associated with pedestrians, bicycles, motorcycles, transit riders, transportation workers, alcohol use, seatbelt use or nonuse, and construction zones. More specialized, detailed performance information such as this can help agencies to take more targeted actions to equitably improve QOL. Some examples are as follows.

- South Carolina DOT tracks multiple “types” of crash events for motor vehicles and also takes note of high-crash locations within their network. Based on this

performance data, the agency made investments to enforce traffic laws within and around construction zones, cutting decreasing fatality rates in those zones by more than half over a period of four years (SCDOT 2011).

- Louisiana DOTD identifies high-crash locations for investments in safety improvements each year. The agency measures localized crash rates before and after each individual safety improvement and reports the average percent reduction in crash rates at all safety improvement project locations (Division of Administration 2012). LADOTD also contracts researchers at Louisiana State University to separately track traffic fatality and injuries within the state by mode of travel, and as of 2010, the agency has committed to implementing a complete streets policy that will "annually identify corridors and intersections with disproportionate number of pedestrian and bicycle crashes and injuries," and "incorporate bicycle and pedestrian safety considerations into other safety projects and ensure that safety projects improve safety for all modes." (Complete Streets Work Group 2010)
- Maryland DOT tracks customer perceptions of safety on the MTA transit system while Oregon DOT tracks the percent of the public that feels safe on the transportation system as a whole. (MTKN 2011)

Crash quantities, and injury counts (i.e. crash severity) are the simplest and most direct route for observing safety outcomes for all modes, and they have each been acknowledged as a "core safety performance measure" (Oh et al. 2013). However, these can be difficult to track for non-motorized modes since they may not be reported unless the non-motorized traveler is involved in a crash with a motorized vehicle. When these

are reported, conventional crash rates are either population-based (i.e. total crashes divided by an area's population), exposure-based (i.e. total crashes divided by traffic volumes or miles traveled), or frequency-based (i.e. total crashes divided by a specific time period). These rates may not be calculable for non-motorized modes with limited volume data available.

Instead of observed safety outcomes, such as crash and injury rates, *perceived safety* has been an important factor for bicycle and pedestrian networks. The two most common measures for perceived safety for a bicycle network, or more specifically the individual links in the network, are bicycle level of service (BLOS) and bicycle compatibility index (BCI). Both measures represent the perceived hazard of the shared-roadway environment, and are based on subjective ratings by bicyclists. BLOS uses the perceptions of bicyclists who have ridden the route being evaluated, and rated its safety at checkpoints along the way. BCI uses the perceptions of bicyclists who have observed conditions on the roadway being evaluated by viewing videotapes of midblock segments. Both measures are based on linear regression models developed to predict the perceptions based on facility characteristics. Each evaluation tool includes variables indicating adjacent traffic volume and speed, width of curb lane, a heavy vehicle factor, uncontrolled access factors, and the effects of adjacent land use. Because bicycle volumes and crash data are often incomplete or unavailable, neither measure requires them. (Klobucar and Fricker 2007)

BLOS and BCI require a large amount of information, and the cooperation of cyclists to rate the system. Historically, this data has made such metrics cumbersome for evaluating large networks (Klobucar and Fricker 2007). However, recent technological

innovations are making data collection more feasible. The Cycle Atlanta and CycleTracks (San Francisco) smart phone applications allow cyclists to send GPS data to city planners, identifying preferred bicycling routes and reporting problems. As transportation organizations improve their infrastructure inventories, and supplement them with user-reported data, more comprehensive safety evaluation for non-motorized travel could become more attainable. Using many of the infrastructure and operational characteristics included in BLOS and BCI, Allen-Munley et al. (2006) developed a multivariate logistic model to predict the severity of an injury sustained by a bicyclist involved in a crash with a motor vehicle at a specific location in an urban bicycle network. The indicator for the model was injury severity, not crash rate. The underlying rationale for using this indicator is that relative bicycle safety of a route can be inferred from trends in the severity of bicyclist injuries.

In a report for the Michigan Department of Transportation, Oh et el. (2013) categorizes performance measures used for bicycle and pedestrian safety around the United States. Many of these metrics are analogous to metrics used for motorized modes as well. The FHWA Community Vision Metrics database lists safety metrics that can be used for each mode, including transit safety which has more of a focus on security from crime. Table 11 lists safety-oriented performance measures, informed by these sources and the GDOT OPM study.

Table 11: Safety Metrics (Informed by Oh et al. 2013, FHWA 2012, Kennedy et al. In Press)

Type	Measure
Quantity	Number of fatalities
	Number injuries by severity (serious, moderate, minor), possibly segmented by context (involving alcohol, occurring in crosswalks etc.)
	Number of crashes, possibly segmented by context
Rates	Percent of traffic fatalities that are pedestrians, bicyclists, motorists, transit riders
	Injuries and fatalities normalized by 100,000 population or travel volumes (miles, trips): may be segmented by age, urban/rural context, facility type, etc.
	Crash rates per 100,000 population or travel volumes (miles, trips)
	Frequency of traffic crashes between modes
Facilities	High-volume locations (corridors, intersections) for non-motorized travel
	Number of locations with crash rates higher than the national average
Investment	Annual funding for safe routes to schools
	Percent of total funding spent on safety
Enforcement/ Government Services	Number of pedestrian arrests
	Number of warnings or citations targeting road user behaviors that compromise non-motorized safety
	Average response time for emergency vehicles
	Average incident clearance time (highway, transit system, separated path)
Cultural	Incidents of crime on transport facilities, by mode or system
	Percent of people feeling a lack of security from crime
	Percent of bicyclists who wear a helmet
	Percent of motorists wearing seatbelts
	Percent of schools participating in safe routes to schools programs
Cost	Aggregated cost of safety incidents
Perception	Percent of survey respondents who feel safe when they travel, segmented by travel mode, user characteristics, or facility

4.7 Public Health

As introduced in section 3.6 of this dissertation, Health Impact Assessment (HIA) has been gaining traction as an important process in transportation decision making. In the context of HIA, health is defined as "a state of complete physical, mental, and social

well-being and not merely the absence of disease or infirmity" (WHO 1948). A broad range of health outcomes related to transportation have been enumerated in the literature, including physical injuries and fatalities due to transportation crashes (addressed in the discussion of safety in 4.6), respiratory and cardiac health related to air quality, physical activity and obesity, access to healthcare and healthy food (addressed in section 4.3), disease due to water pollution, security from crime (addressed in 4.6), and the mental health effects of transportation noise. (Ingles 2013)

Recent public health literature has focused on promoting non-motorized travel (walking and biking) in order to encourage physical activity, or "active living" *(*Sallis et al. 2006; Maddison et al. 2009; McGinn et al. 2007; Spittaels et al. 2010). This is because "Physical activity is widely recognized for its ability to prevent and treat a wide range of physical and psychological disorders" (Sallis et al. 2006), so much so that the U.S. Department of Health and Human Services has been recommending minimum physical activity levels since the 1960s. In the 1990s, due to new findings of dose-response research, the emphasis of these recommendations shifted from "vigorous exercise… three or more times per week" to "at least 30 minutes of moderate intensity physical activity… each day" (Sallis et al. 2006). "Active living" integrates physical activity into daily routines related to recreation, transport, occupation, and household activities, and it is in stark contrast to "the epidemic of sedentary lifestyles" associated with "extensive use of cars and electronic entertainment, …computer-centric work environments, [and a] proliferation of labor-saving devices" (Sallis et al. 2006).

A criticism of the "active living" model, which promotes walking as a mode of transportation, is that walking can actually put travelers' health and safety at risk despite

the gains of increased physical activity. If walking conditions are insufficient to protect walkers from collisions with cars, they may be at risk of injury or death. Also, increased time outdoors, especially during peak commuting hours, can increase a person's exposure to harmful air pollution (Schweitzer and Zhou 2010). Air pollution emitted from motor vehicles includes several components that are harmful to human health (Table 12) and, despite regulation by the Clean Air Act, are still present in urban air, especially during peak traffic hours (Nebel and Wright 1998).

Table 12: Harmful air pollutants in automobile emissions (Nebel and Wright 1998)

Pollutant	Health Effects
Particulate Matter (PM_{10} and $PM_{2.5}$)	Impairs many respiratory functions, especially in individuals with chronic respiratory problems.
Volatile organic compounds (VOCs)	Contribute to the formation of ground-level ozone (O_3), which can inflame the lungs and increase the risk of fibrosis.
Carbon monoxide (CO)	Can block the delivery of oxygen to organs and tissues and has been associated with heart disease due to low oxygen levels in the blood.
Nitrogen oxides (NO_x)	A major source of acid deposition; NO_2 is a lung irritant that can lead to acute respiratory disease in children and has been associated with impaired immune systems.
Sulfur oxides (especially SO_2)	A major source of acid deposition and has been associated with an increased risk of bronchitis, especially in children and the elderly.

The perception that these risks (and others) exist can be significant deterrents to active travel, as long as travelers have a choice of mode. However, some people must travel by non-motorized modes due to personal characteristics that obstruct them from choosing other modes, such as low income and certain disabilities. When these people are subjected to unhealthy or unpleasant travel conditions, this an issue of the equitable distribution of resources, or environmental justice.

Another pathway through which transportation affects health is noise pollution. Regular noise exposure higher than 55 dB, for example from road traffic, aircraft, and

rail, has been associated with undesirable health outcomes. As Sygna et al. (2014) summarize, “Annoyance and sleep disturbances are the most widespread and well-documented subjectively reported effects of environmental noise… but morning tiredness, headaches, and milder psychological conditions [such as anxiety] have also been reported to be associated with noise in adult populations.” Health effects have also been observed in child populations; as described by Haines and Stansfeld (2003), evidence suggests “that noise exposure adversely affects child cognitive performance… annoyance and impaired well-being… motivation, blood pressure, and catecholamine hormone secretion.”

Most of the health outcomes discussed in this section are influenced by transportation systems via indirect impact pathways. The outcomes can be, and often are tracked by departments of public health and other health-related organizations; however, attribution of health outcomes to transportation agency actions may be limited as these outcomes occur in the context of complex sociotechnical and environmental interactions. Therefore, Ingles (2013) suggests a number of performance measures – related to infrastructure provision and operational service quality - that are linked to health outcomes, but are much more within the control of transportation agencies. For example:

- VMT can be input into air quality models to estimate emissions of harmful pollutants. These can become inputs to geospatial analyses to help identify locations of high exposure to air quality.
- Bicycle and pedestrian PMT can be used to estimate physical activity. In advanced analysis, this can be correlated with obesity outcomes.

  Additional health-related measures are listed in Table 13.

Table 13: Health related metrics (Informed by FHWA 2012, Ingles 2013)

Metrics	Notes
Environmental Quality	
Population in in nonattainment areas	These metrics represent mediating factors in the indirect pathways between transportation and health. Transportation agencies may wish to partner with environmental protection and public health agencies to monitor and manage these metrics.
Number of days with poor air quality, ozone action days, etc.	
Expected concentrations of criteria pollutants, and other mobile source air toxics as a result of capacity investments – construction and operations	
Per capita emissions of local air pollutants from transportation (PM, VOCs, NOx, CO, etc.)	
Amount of wastewater produced by transport-related facilities and industries	
Watershed improvement due to transportation projects	
Noise and vibration levels affecting schools, churches, public gathering spaces, residences, and disadvantaged population groups	
Percent of population exposed to high noise levels (e.g. 60 Db)	
Resource Access	
Residential displacement due to transportation projects	These metrics are directly impacted by design choices for the transport-land use system. They also have important equity implications, when analyzed by segmented population groups.
Land consumption by new transportation projects – amount and percent change in greenery and open space	
Percent of population living within target travel time of schools, full-service supermarkets, health services, social services, by mode	
Number of recreational opportunities within target travel time of residential areas, by mode	
Broader Human and Social Outcomes	
Percent of people who perceive their community as a good place to live	These metrics are influenced in part by transportation system, but also by many other factors. They are worth monitoring, in partnership with public health agencies, and analyses may be performed to assess potential associations with transportation outputs such as air quality emissions and the opportunity for active living.
Percent of persons with asthma, cancer, diabetes, heart disease, obesity	

4.8 Customer Experience and Satisfaction

People may perceive the physical factors of the environment differently, depending on a number of person-level attributes such as age, gender, education level, the presence and number of children in the household, income and marital status (McGinn et al. 2007; Christian et al.2011). These characteristics not only affect people's decisions but can also influence their transportation needs and limitations more broadly. Truly *inclusive* transportation systems will be sensitive to the needs and constraints of all population groups. For example, they will consider the trip-chaining needs of mothers in comparison to traditional home-work commutes (Rosenbloom 1989), as well as the importance of transit access for people who cannot afford automobiles.

When people's needs and limitations are accommodated by the transportation system, it is also more likely for them to be satisfied with transportation services. Customer satisfaction (CS), discussed in the economic and marketing literature as the state in which a customer's expectations are met or exceeded by what he or she actually receives or experiences (Oliver 1993), is important to the social sustainability of transportation systems, and more directly the social sustainability of transportation agencies. In this vein, CS has been termed "perhaps the most important outcome for DOTs," and "vitally important to every aspect of strategic performance measurement" (TransTech 2003). Gathering CS-related information, through a variety of public outreach processes, can enable an agency to make more informed decisions, address customer expectations, values and priorities, and in turn gain the trust and cooperation of the public in its future endeavors (Fischer et al. 2014).

Customer evaluations are especially important in the context of a service such as transportation provision because it is one of "many services" for which "production and consumption… are inseparable; quality occurs during service delivery, usually in an interaction [involving] the client" (Parasuraman et al. 1985). In such a situation, "If service quality is evaluated only from the point of view of a service provider... this may lead to very poor estimates of quality as experienced by the customer"; therefore, customer opinions are necessary to "provide a lens" through which transportation decision makers can view and understand user experience (Fischer et al. 2014). Fischer et al. (2014) identify six categories of customer-opinion data that can be input into powerful performance measures for transportation decision making. These six types of opinion data are listed in Table 14.

Customer opinion based measures are used extensively by DOTs and public transit agencies. For example:

- South Carolina DOT couples land owner satisfaction with condemnation rate to improve public relations, save time, and save money. (Limehouse and Swails 2010)
- Louisiana DOTD asks customers to rank eight categories of investment, in order of personal priority, and then segments the answers into categories such as residential region and commuter/non-commuter (McKensie 2011).
- Illinois DOT asks customers, "How often can you trust IDOT to do what is right regarding transportation issues?" (IDOT 2009)

Table 14: Customer Opinion Data and Metrics (Abbreviated from Fischer et al. 2014)

Data Types	Notes
Satisfaction Ratings	Typically collected through an ordinal-scale survey tool, with questions in the following form: 'How satisfied are you with…' (rate from 1 to 5 or 'not satisfied to very satisfied'), these data can be aggregated to determine an average level of CS with the question object, or to determine a percentage of customers who are satisfied at a certain level or better. Consistently high or improving satisfaction ratings can indicate that the transportation agency has earned or is earning the trust and respect of its customers.
Service Grading and Rating	Also based on an ordinal scale, with questions such as: 'What grade would you give to…? (A–F)', or 'In your opinion, what is the condition of…? (poor–good–excellent, 1–7)', these can be aggregated similarly to data from satisfaction questions. Unlike questions that explicitly deal with satisfaction, however, grading and rating questions do not as effectively reveal the sense of trust between the agency and the public. They are more effective for tracking the benefits of service changes over time, as perceived by the system users or customers.
Ranking or Importance Rating	Collected through ordinal-scale survey tools, ranking questions come in such forms as 'Which of these is most important to you personally…' where the respondents are asked to indicate their first, second, and third priorities. Ranking or importance rating survey results can be aggregated according to an average importance level that is given to the question object, or the percent of respondents that ranked a particular option as highest/most preferred or lowest/least preferred. These results can suggest which investments would be perceived as having the highest positive effect on service quality and QOL, in essence capturing the underlying values or preferences of customers.
Level of Agreement	Collected using either an ordinal scale (for example, not at all to very much) or a binary scale (agree or disagree) survey tools, these data are most often aggregated in terms of percentage of respondents who agree, with performance measures such as 'percent of customers who believe that…'. More complex analyses have aggregated responses to multiple level-of-agreement questions to derive a multidimensional indicator of satisfaction. Level of agreement is a highly versatile tool that can be used to reveal customer behavior, expectations, underlying values, and political will.
Open-Ended Questions	Open-ended questions invite respondents to 'fill in the blank' with any responses that they choose. They come in forms such as 'Please describe…' or 'What do you think about…'. Answers to open-ended questions can be used to identify areas of concern or pleasure from the customer perspective, to clarify inconsistent or surprising data that is collected through other survey forms, and to provide anecdotal evidence of customer attitudes and perspectives. Also, the use of open-ended questions allows customers to feel heard and appreciated, which can build trust.
Stated Preference	In stated preference questions, respondents are asked to choose between multiple options, often with the opportunity to mark their most preferred/most likely and least preferred/ least likely choices. The objects of stated preference questions typically include multiple multi-attribute scenarios, one that represents existing conditions, and others with some changed attributes. Similar to ranking and importance rating-type questions, stated preference results can be aggregated according to the percent of respondents that ranked particular scenarios as their highest/most preferred or lowest/least preferred. However, this survey tool is more often used as an input to more complex analyses, which use discrete choice modeling techniques. Stated preference tools may be used by decision-makers who are attempting to predict customer reactions to a proposed change in transportation service, and they can help to inform the design of more demand-oriented service changes as needed.

Many agencies also use customer service and public outreach measures that can be tracked through observation and do not require surveys. These include average wait times for customer service response, for instance by email or in lines at the department of motor vehicles; number of complaints per 100,000 users or customers of a particular transportation service; number of participants at public meetings; or hits on a website (MTKN 2011). The most important aspect of measuring customer experience is to use "demand-oriented," rather than "supply-oriented" measures; Rietveld (2005) illustrates this point with multiple examples, including train car occupancy:

> *When a train has an average occupancy rate of 100%, this may look just acceptable because in principle there is a place for everybody. However, suppose that when entering 55% of the passengers enter at the front and 45% at the back. Then the experienced occupancy rate is higher than 100%: ([0.55 × 1.1] + [0.45 × 0.9]). Finally, 5% of the travellers [sic] do not get a seat. The problem of the front versus the back of a train appears to depend on the type of railway station and the location of entrances with respect to the platforms. In particular, terminal stations appear to be vulnerable. Experienced users of the specific rail services will know the best place to enter the trains, which improves the position for travellers with less experience, but not always sufficiently.*

Rietveld's (2005) example for on-time arrival is also particularly instructive:

> *The probability of delays is higher during peak hours. Buses and trains are fuller during these times. In addition, there is a tendency that during peak hours, travellers put a heavier weight on arriving in time at work or an appointment compared with outside the peak. Thus, the average probability of a delay of a bus or train indicates little of the number of passengers who are affected and the size of the effect. Suppose, for example, that 80% of the trains arrive in time and 20% are late. Suppose too that the number of users of the late trains is twice as large as in the trains that are on time. The reason is that during the peak, occupancy rates are higher, and besides trains are often longer during peak hours. Thus, from the perspective of the traveller, the share of the late arrivals is not 20%, but {(2 × 20)/ (80 + [2 × 20])} = 33%.*

Finally, Rietveld's (2005) discussion of propagation of delays in multimodal chains sheds important light on the user's experience in an interjurisdictional context:

> *Public transport passengers usually make trips where various modes are employed. For the passenger it is the quality of the entire chain that matters, not that of the individual elements of the chain. Supply-oriented indicators of service quality focus on the performance of one operator, whereas travellers usually face more than one operator… [P]roblems of delays in a certain mode may lead to aggravation of the delay when another mode has to be used to bring the traveller to his/her final destination. The aggravation is substantial when one of the two following conditions apply: the final mode has a low frequency, and timetables of the two modes have been coordinated.*

In general, it is important for transportation agencies to consider user perspectives when designing performance metrics. Public opinion surveys and other outreach methods such as public meetings and focus groups can assist with this effort. Table 15 summarizes Rietveld's (2005) comparison of supply- and demand-oriented measures as a demonstration. While Rietveld focuses on transit operations, a similar exercise could be done for other modes.

Table 15: Comparison of supply- and demand-oriented quality measures in public transportation (Adapted from Rietveld 2005)

Supply-oriented Metric	Demand-oriented Metric
Mean inter-arrival time of buses, frequency	Mean waiting time of traveler
Mean occupancy rate of seats	Percentage of travelers that could not find a seat
Share of trains/seats that arrives on time	Share of travelers who arrive on time
Probability that a bus/train misses a connection	Probability that travelers miss a connection
Late arrival of trains in stations	Late arrival of traveler to the final destination
Distance between stops	Average walking distance of travelers from their origin to the stop

4.9 Conclusions and Next Steps

Many of metrics identified in this chapter are quite focused and action oriented; what Little (2008) would call "clinical" measures. One clear example, for highway reliability, relates to incident clearance time: transportation agencies have direct control of the speed with which highway assistance vehicles arrive at and clear the scene of an incident, and this action has an immediate impact on traffic flow, improving the travel time, travel cost, and user experience of drivers and passengers. Some other metrics reported here, which are often tracked by transportation agencies, deal with outcomes that are less attributable to agency actions. For example, VMT is often linked with mobility goals in DOT performance documents, but it does not actually give any indication of the mobility experience of system users. However, if changes in VMT from one month or year to the next can be associated with specific agency actions, and perhaps associated with changes in other metrics, then these values could be used as inputs for accessibility, affordability, and even health-related measures at the systems level. Several opportunities for these innovative uses of traditionally reported but less useful metrics are also presented in this chapter.

More research is necessary to identify low-cost data sources that can be used for agencies like DOTs, MPOs, and transit agencies to develop QOL-oriented performance measures and performance management processes. One important opportunity to be explored is collaboration among agencies in a multijurisdictional region. For such efforts to be effective, individual agencies will also need effective internal structures and performance management processes and effective public outreach methods for gathering

customer-opinion related information. These processes have been introduced in earlier chapters of this dissertation.

Moving forward, Chapter 5 applies the perspective of the stacked systems framework (SSF) to a case study of transportation planning and program delivery in the Metropolitan Atlanta region. The case study includes an organizational influence profile, a profile and gap analysis of the activated feedback space, and a demonstration of how enhancing the feedback space with performance measures that more appropriately reflect the user experience of service quality, as linked with broader livability and QOL outcomes, can enhance performance management and organizational influence. Chapter 5 uses Metro Atlanta as a limited-scope test case for a broader methodology that can be reproduced for other regions and other geographic scales.

CHAPTER 5: METRO ATLANTA CASE STUDY

5.1 Methodology for Applying the Stacked Systems Framework

The purpose of this case study is to apply the collective learning from Chapters 1-4, which crystallizes in the Stacked Systems Framework (SSF) for sustainable development, to recommend enhancements for transportation performance management in a real world inter-organizational context. Metropolitan Atlanta was a logical case study region due to the author's proximity and access to the transportation-related performance measurement and decision making processes in the region. This section formulates a methodology which translates the components of the SSF into four phases of analysis. The four phases are (I) Organizational Influence Profile, (II) Feedback Space Profile, (III) Performance Measurement Gap Analysis, and (IV) Metrics Testing. The case study proceeds to illustrate an application of each of the methodology's four phases to the Metro Atlanta context. This case study is meant to provide a proof of concept, which can be expanded upon in the Metro Atlanta Region, and which can provide a model for similar processes in other regions.

5.1.1 Organizational Influence Profile Methodology

The methodology for Phase I, the Organizational Influence Profile, is derived directly from the stacked systems framework introduced in Chapter 4. A complete profile includes characterizations of the inter-organizational system, and the scope of direct and indirect influence that organizational actions have on the sociotechnical transportation system and broader livability and QOL outcomes. Several key questions are important for

guiding the organizational influence profile. These questions are similar (but not identical) to those developed for individual agencies in the *Organizational Performance Management Self-Assessment Tool* (OPM tool), an interactive, spreadsheet-based survey instrument developed by this author as part of the GDOT OPM study (Kennedy et al. In Press). A summary of the OPM tool is provided in Appendix A. The guiding questions for the Organizational Influence Profile are informed by Input A – Agency Context, and Input C - Organizational Processes, as shown in Appendix A.

Guiding Questions

- Who are the public agencies responsible for managing the sociotechnical transportation system in the region (transportation executors)?
- How does each transportation executor operate internally (individual organizational structures and processes)?
    - What are the internal functional units of each transportation executor?
    - How do these functional units interact with each other; are there elements of horizontal and vertical integration?
    - How does each functional unit individually affect or otherwise interact with the sociotechnical transportation system, transportation service quality, and/or broader QOL outcomes?
- Who are the major stakeholders of each transportation executor, within the inter-organizational system of transportation executors, and within the broader socioeconomic situations sub-stack?
- How do transportation executors interact with each other, and with other stakeholders (inter-organizational structures and processes)?

- Do some entities have full or partial authority over others? What is the nature of this influence?
- Do entities share information or other social resources? If so, how?
- Do entities collaborate to set a joint strategic direction for the region?

- How do inter-organizational actions influence change within the sociotechnical transportation system, transportation service quality, and/or among broader QOL outcomes?

An illustrative Organizational Influence Profile for Metro Atlanta is provided in section 5.2.

5.1.2 Feedback Space Profile Methodology

The methodology for Phase II – Feedback Space Profile is informed by the discussion of performance management in Chapter 5 of this dissertation, and also by the *Organizational Performance Management Self-Diagnostic Tool* (OPM tool). Guiding questions to formulate this profile relate to strategic-level management, performance measurement, reporting, and feedback (similar to questions in Input A, Input B and Input D, as shown in Appendix A). Similar to the Organizational Influence Profile, these characterizing questions were answered in this study through a web scan, document review, and informational interviews. Unlike the Organizational Influence Profile, the Feedback Space Profile provides a current snapshot with very little historical background.

Guiding Questions

- What are the shared regional strategic goals and objectives of the inter-organizational system of transportation executors, with respect to transportation service quality and broader livability and QOL outcomes?

- For each regional strategic goal and related objective…
    - Have performance measures been defined?
    - Which transportation executors are responsible for tracking each performance measure?
    - Are defined performance measures defined quantifiably?
    - Are defined performance measures regularly tracked with existing data? If so, what are the data sources in use, and how frequently are the performance metrics refreshed/recalculated?
    - Have the measures been linked with desired trend directions or targets?
    - To what extent do identified performance measures add decision making value by informing organizational actions?
- What additional feedback mechanisms do the transportation executors have in place to learn about system performance or broader outcomes?

To illustrate an application of the Feedback Space Profile, section 5.3 focuses on the feedback space activated by the Atlanta Regional Commission to support regional planning, programming, and program-delivery functions in Atlanta.

5.1.3 Performance Measurement Gap Analysis Methodology

The purpose of Phase III – Performance Measurement Gap Analysis is to identify performance gaps related to regional strategic goals and objectives, and to identify measurement gaps associated with performance gaps. This phase is motivated by the concept that "what gets measured gets managed." Guiding questions for this analysis are informed by the discussion in Chapter 4 of this dissertation and also by the OPM tool (specifically Inputs B, C, and D, as shown in Appendix A).

Guiding Questions

- Since the last plan or program update, for each regional strategic goal and objective with defined performance measures, as identified in the Feedback Space Profile, has the region achieved desirable performance?
- For any performance gaps (goals or objectives where the region has not been achieving its desirable performance outcomes, as defined)…
    - Are the defined performance measures clearly relevant to the organizational actions and influence pathways available to the individual organization(s) who track them?
    - What organizational actions have been taken based on the available performance information?
    - Is there any indication from the existing feedback space about why organizational actions have not been leading to desirable performance outcomes?

A gap analysis of Metro Atlanta's regional planning metrics is provided in section 5.4, in parallel with the Feedback Space Profile.

5.1.4 Metric Testing Methodology

The purpose of Phase IV – Metric Testing is to identify new performance measures that can fill performance measurement gaps and help increase the choice intelligence of transportation executors. Guiding questions for this phase include:

Guiding questions:

- For measurement gaps identified in Phase III, what new performance measures could better link organizational actions with changes in transportation service quality that leads to broader livability and QOL outcomes?
- Do data and modeling capacity already exist, which can be used to calculate these newly proposed performance measures?
- Can new data and/or modeling capacity be generated with available financial and human resources, in order to calculate these performance measures?
- For each calculable measure, what is the current, and recent, performance status, at an appropriate scale of analysis (e.g. regional/system wide scale for plan evaluation)?
- Are the current performance status and recent performance trends satisfactory?
    - If so, what organizational actions may have contributed to performance outcomes?
    - If not, what organizational actions might help change performance outcome?
- What additional analysis could clarify the linkage between organizational actions and performance outcomes?
- Given analysis results for each tested measure, are relevant transportation executors comfortable with tracking and reporting it on a regular basis, thereby claiming accountability for the performance outcomes?

The guiding questions for this phase reflect the analytical nature of performance measurement. Metrics testing is an important part of the performance management cycle,

and it should ideally be conducted at least once per cycle of decision making. The regular tracking, questioning, and refining of performance measures aims to increase choice intelligence to inform organizational actions. To illustrate an application of the Metrics Testing phase, section 5.4 focuses on recommending new performance measures to fill the performance measurement gaps for regional transportation planning and programming in metro Atlanta, with limited discussion of quantitative values, where data was readily available. The results of this application can be expanded by Metro Atlanta's transportation executors as they move forward to advance their performance-based decision making processes.

5.2 Organizational Influence Profile

The transportation system in metropolitan Atlanta is managed by a complex inter-organizational system of public and semi-public agencies (transportation executors), each of which also relates to multiple other stakeholders in the public, private and non-profit sectors. Considering these organizations exist within the socioeconomic systems sub-stack in the SFF, it is important to acknowledge that although the interactions of transportation executors are systemic (i.e. they do have patterns), they may not always be systematic (intentionally organized to promote consistency and efficiency) in the real world (see Checkland 1999 for a more extensive differentiation of terms between systemic and systematic). Characterizing these interactions as social resource flows among components of a system enables researchers to identify existing patterns and make recommendations for increased systematization.

The governmental and semi-public transportation executors with direct responsibility for managing Metro Atlanta's transportation system include the Georgia

Department of Transportation (GDOT), Atlanta Regional Commission (ARC), Georgia Regional Transportation Authority (GRTA), State Road and Tollway Authority (SRTA), Metro Atlanta Rapid Transit Authority (MARTA), and local governments (counties and cities). Figure 12 illustrates several types of interactions among these transportation executors. These interactions include regulation, funding disbursement, and representation on each other's boards of directors. The three smaller blue ovals represent the transportation-related committees of the ARC: the Transportation and Air Quality Committee (TAQC), Transportation Coordinating Committee (TCC), and the Regional Transit Committee (RTC).

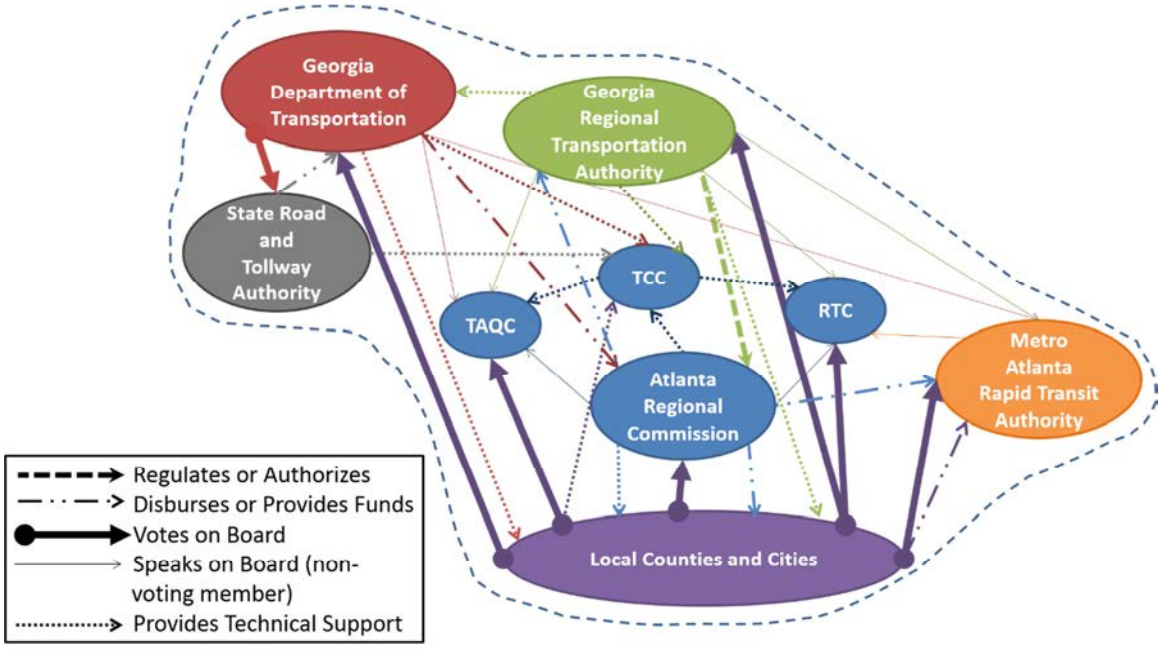


Figure 12: Inter-organizational system of public-agency transportation executors with direct responsibility in the Metropolitan Atlanta region

The influence of an inter-organizational system as a whole depends upon the relationships among its individual component organizations as well as the effectiveness of each individual organization in implementing its particular functions. The effectiveness of each individual organization, in turn, depends upon the relationships of its own functional units. Appendix B shows organizational charts for GDOT, GRTA, SRTA, ARC, and MARTA.

Outside of the system boundary drawn in Figure 12, several key external stakeholders operate at national, state, regional, and local levels. These external stakeholders each contribute socioeconomic resource inputs to Metro Atlanta's inter-organizational system of transportation executors (Figure 13):

- From the state-level, the Governor of Georgia appoints board members for SRTA and GRTA, directs the level of authority that can be taken by GRTA within the bounds of its enabling legislation, and appoints the Director of Planning for GDOT.
- The Speaker of the Georgia House of Representatives appoints a board member for SRTA; the state legislature provides funding for GDOT and GRTA to build and operate transportation projects through budget appropriations; and the state legislature defines (or has previously defined) the scope of authority and many operational elements that may be taken by GRTA, MARTA, and local governments, especially regarding the use of funds. (ARC 2013)
- Other state agencies such as the Department of Natural Resources (Environmental Protection Division) and the Department of Community Affairs contribute to some regional transportation planning discussions in Metro Atlanta (ARC 2014).

- From the Federal level the USDOT and its modal administrations regulate the use of federal funds for transportation projects; a significant influence since federal money accounts for $22.29 Billion of the forecasted $53.98 Billion (2014 constant value dollars) to be spent on Metro Atlanta's transportation system during the period of the current regional transportation plan (RTP), 2014-2040. Atlanta regional transportation planning is also governed, in part by the EPA. Representatives from FTA and FHWA participate in many of the discussions at ARC committees. (ARC 2014)
- From the local level, Community Improvement Districts (CIDs) recommend projects for inclusion in Metro Atlanta's transportation plans, and partner with GDOT and local governments to fund projects in their districts. (Fischer and Long, 2014)
- At the regional level, modal advocacy groups and other non-profit organizations such as the Atlanta Bicycle Coalition (ABC), Citizens for Progressive Transit (CfPT), Pedestrians Educating Drivers about Safety (PEDS), and the Atlanta BeltLine Partnership (ABLP) participate in planning conversations in ARC's committees.
- Often representing national or statewide interests, industry groups such as the trucking industry and freight railroads, participate in planning conversations in ARC's committees. (ARC 2013)

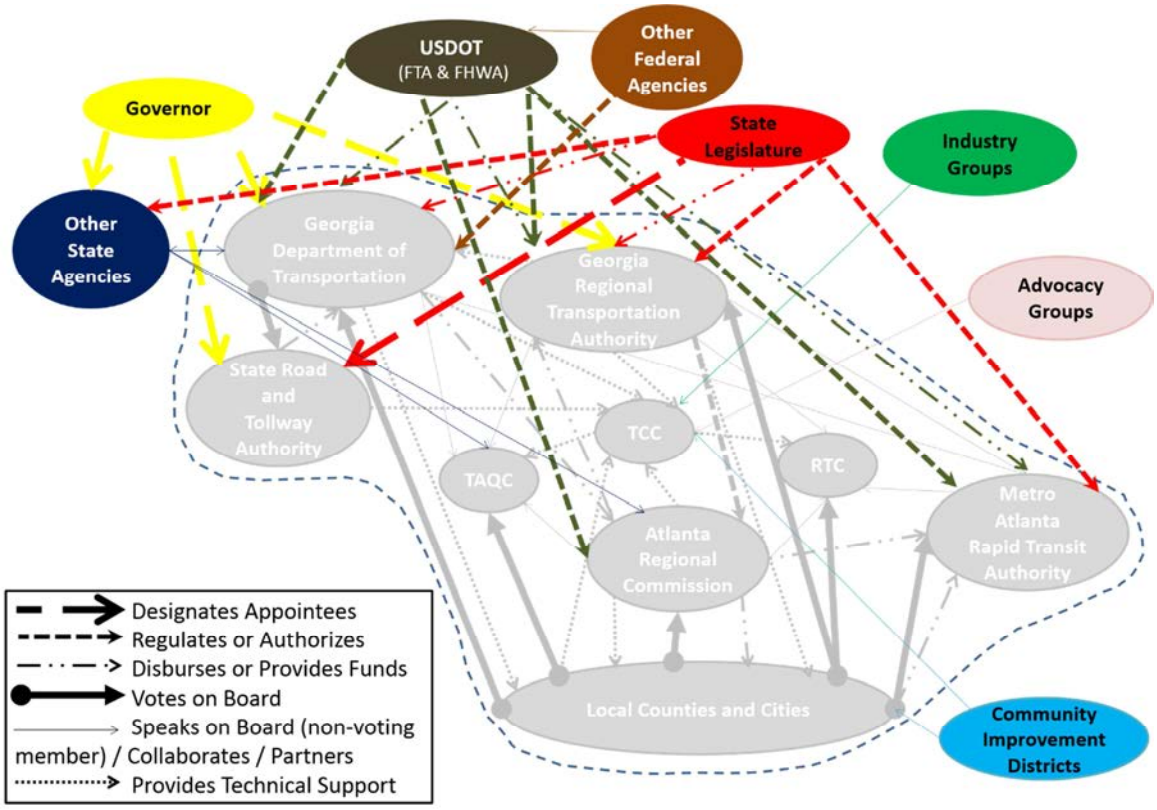


Figure 13: Influence of external stakeholders on Metro Atlanta's transportation executors

Each of the internal and external stakeholders of Metro Atlanta's inter-jurisdictional organizational system of transportation executors has its own priorities, relative to its own mandates, vision, mission, goals, and scope of influence. Table 16 lists Metro Atlanta's transportation executors (considered "internal stakeholders" of the inter-organizational system under consideration) with their primary influence pathways on the sociotechnical transportation organized by mode.

Table 16: Metro Atlanta's Transportation Executors' Priorities and Influence on the Sociotechnical Transportation System, by Mode

	Types of System Influence	Roadway / Personal Auto	Public Transit	Bicycle	Pedestrian
GDOT	**Strategic Oversight:** State Priorities **Program Delivery & System Management:** State-owned Roadways	Plans, constructs and maintains state and federal highways; helps local gov'ts maintain their roads	Collaborates with transit providers on roadway alignment and access from federal and state roads	Implements and manages bike lanes and bicycle facilities on federal and state roadways, according to 2012 Complete Streets Policy	
GRTA	**Strategic Oversight:** State Priorities **Program Delivery & System Management:** Xpress Buses	• Approves TIP on behalf of the Georgia Governor • Reviews DRIs • Provides Park & Ride Lots	Operates *Xpress* & Vanpool services	Approves TIP on behalf of Governor	
SRTA	**Strategic Oversight:** State Priorities **Program Delivery & System Management:** Priced Lanes	Controls pricing on managed lanes; collects tolls	Provides bus access to managed lanes		
ARC	**Regional Planning**	Coordinates the regional transportation planning process through Board committees; develops the RTP and TIP; tracks and facilitates plan implementation; provides information on commute options			
MARTA	**Program Delivery & System Management:** MARTA rail and bus	Provides parking at rail locations	Provides and manages rail, local bus, and demand response transit service	Provides bike access to rail and bus	Provides pedestrian access at rail stations
Local Gov.	**Program Delivery & System Management:** Locally owned facilities	Constructs & Manages Local Roads	Operates Local & Express Bus, Demand Response	Constructs & Manages Local Bike Lanes and Paths	Constructs & Manages Local Sidewalks and Paths

Both Figure 12 and Table 16 order transportation executors, top to bottom, along a geographically-defined jurisdictional hierarchy from state-level to local-level. However, the relationships among these transportation executors actually include a mix of hierarchical and consultative interactions. As the region's MPO, ARC is responsible for coordinating these relationships through its committees in order to develop regional plans; therefore, it may be considered the central regional agency. The following subsections begin with a detailed profile of the inter-organizational system's planning influence, as facilitated by the Atlanta Regional Commission, and then proceed with further discussion of other transportation executors according to three additional categories of influence: planning/funding oversight and system implementation.

5.2.1 Regional Planning Influence – Atlanta Regional Commission

The Atlanta Regional Commission (ARC) is the designated Metropolitan Planning Organization (MPO) for the Metro Atlanta Area. As such, ARC is responsible for ensuring "a continuing, cooperative, and comprehensive" approach to transportation planning, producing and regularly updating the region's Long Range/Regional Transportation Plan (LRTP/RTP) and short term Transportation Improvement Program (TIP). The current RTP is included in PLAN 2040 (which also includes a complementary land-use plan), and was most recently updated in spring of 2014. As of the date of this dissertation, the current TIP is for the period of 2014-2019. Both the RTP and TIP are living documents; they are developed based on projections of future funding availability and regional needs, and they must be updated periodically to reflect the most current modeling and expectations.

As described in Table 16, ARC's primary influence pathway is through facilitating the regional transportation planning process, and then supporting implementation of the regional plans and programs. The regional transportation planning process is facilitated through three transportation-focused committees of the ARC Board of Directors. ARC's 39-member Board of Directors includes representatives from city and county governments as voting members, and representatives of other transportation executors as nonvoting members. The ARC Board governs eleven committees, three of which are specific to transportation (ARC 2013); the three transportation-related committees are also shown on Figure 12 (smaller blue ovals). These committees are facilitated and supported by ARC professional staff.

The Transportation Coordinating Committee (TCC), which provides technical support to the Regional Transit Committee (RTC) and the Transportation & Air Quality Committee (TAQC), is actually comprised of several subcommittees, as shown in Figure 14. Aside from those noted in Figure 14, informal TCC subcommittees may be formed temporarily based on the needs of RTC and TAQC. Other transportation executors in the region participate actively in the TCC subcommittees on an as-needed basis, when their particular perspective or expertise is relevant. For example, transit providers typically participate in the four subcommittees that serve the RTC; SRTA participates in the Financial Planning Team; and GRTA participates in the TIP/RTP Blueprint Working Group. Also, many subcommittees include representatives of federal oversight agencies (especially FHWA, FTA, and EPA), citizen advocacy groups, and private entities. For example the Atlanta Bicycle Coalition and Pedestrians Educating Drivers on Safety (PEDS) actively participate in the Bike/Ped Advisory Group, whereas trucking companies and railroads participate in the Freight Advisory Group. (ARC 2013; R. Hammond, unpublished informational interview, December 17, 2013)

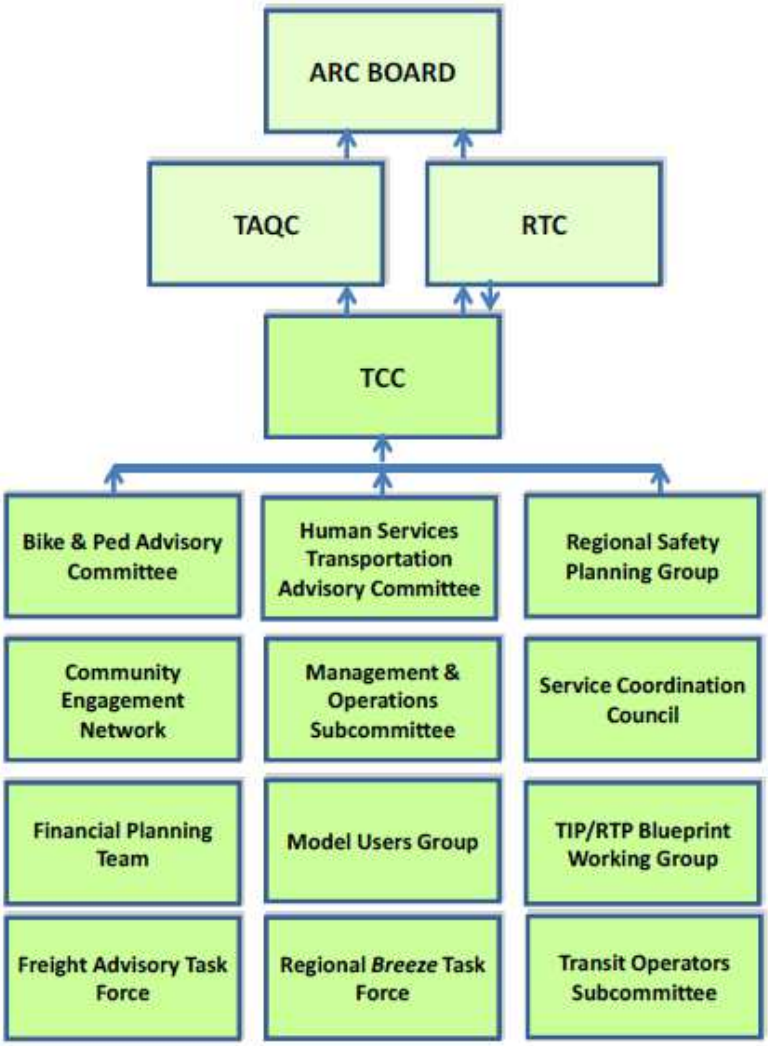


Figure 14: ARC Transportation Committees, showing TCC Subcommittees (ARC 2013)

Outside of committees, ARC employs staff in an organizational structure comprising of three overlapping "centers": the Center for Community Services, Center for Livable Communities, and Center for Strategic Relations [Appendix B, page B-1]. This organizational structure is new as of 2013, following a re-organization led by ARC's executive director. The new structure was the agency's "first reorganization in a generation," replacing a traditional, more siloed, division structure (Pendered 2013). The ARC executive director, Doug Hooker, described the motivation behind this change:

> *Because we are changing in so many ways as a region, ARC realizes we have to be more adaptable to help local governments solve more problems. (Pendered 2013)*

Part of becoming "more adaptable" for ARC was to re-imagine the relationships among staff functions to allow for more internal collaboration. For example, the Center for Livable Communities includes working groups for Community Development as well as Transportation Access & Mobility. In a more traditional and siloed organizational structure, staff in these different groups would work separately. However, through the lens of the SSF, it is clear that transportation planning decisions will influence broader community development outcomes. Also, community development needs can inform transportation needs. Therefore, it is logical for planning activities related to community development and transportation systems to be carried out in a highly collaborative manner. Furthermore, it is important that the Center for Livable Communities conceptually and functionally overlaps with the Center for Community Services, which includes working groups related for Aging and Health Resources, and Workforce Solutions. This overlap is important because the transportation system will mediate access to many community services. Finally, staff in the Center for Strategic Relations, with its working group for Community Engagement, can facilitate the flow of information from planners in the other two centers to the wider community and vice versa.

ARC's internal reorganization has paralleled a change in the way that the MPO facilitates the planning process among the region's transportation executors. This inter-organizational change was motivated by an identified problem with program delivery. Specifically, during the period of approximately 2006-2011, Metro Atlanta's TIP was significantly backlogged, with many projects that had failed to move forward according

to their programmed timeframes. During this time, ARC suspended project solicitations, in order to re-evaluate the TIP development and implementation process (Haynes, D., unpublished informational interview, May 1, 2014). Reacting to this crisis, ARC published an "RTP/TIP Blueprint" in 2010 that established five "Guiding Principles" for TIP development:

> 1. *Project information will be presented in a user-friendly, concise and informative manner.*
>
> 2. *Projects will be programmed based on realistic costs and feasible implementation schedules.*
>
> 3. *Projects will be programmed consistent with the policies, goals and priorities established through the regular MPO planning process and will adhere to all applicable federal and state legal requirements*
>
> 4. *Updates, amendments and administrative modifications will be conducted on a regular and predictable basis and in an efficient manner to facilitate project implementation goals.*
>
> 5. *The decision making process for updating project information will be well documented and conducted in a consistent manner. (ARC 2010)*

In order to make these guiding principles actionable, ARC also defined "core functions" and "business rules" related to each principle. For example, Core Function 1.4 "Monitor TIP project implementation" included three business rules, the first of which states that "ARC will publish an annual report… detailing the status of projects and phases scheduled for advancement in the previous fiscal year." As another example, Business Rule 2.1.1 outlines the project phases that may be defined for a particular project; the first one being a "scoping" phase dedicated to clarifying the project scope and developing the feasible project budget and schedule, as required by Guiding Principle 2.

Each of these example business rules address the challenge of program delivery that ARC had observed in the immediately preceding years.

What ARC recognized in the latter years of the 2000's decade is one of the key concepts of performance management: as described in section 3.2, "the allocation of resources and implementation of decisions" is "why it all matters." Unimplemented planning decisions do not effect change in the sociotechnical transportation system. If plans are made and published without being implemented, this failure to implement can lead to customer dissatisfaction, and mistrust in the organizational system, thereby diminishing the social capital available for future use. Therefore, it is paramount for planning decisions to be developed with realistic expectations of the opportunities and constraints for implementation.

5.2.2 Oversight Influence – State-level Agencies

There are four ways shown in Figure 12 for state-level transportation agencies (GDOT, GRTA, and SRTA) to influence the transportation planning process facilitated by ARC: regulation/authorization, dispersal of funds, speaking at ARC Board meetings, and providing staff technical support through collaborating on ARC's committees. The first two of these four types of influence may be considered forms of oversight. Although these oversight roles imply a hierarchical relationship between the state and the region, as described in section 3.5, "hierarchical and consultative models of inter-organizational performance management are not mutually exclusive," and the latter two types of influence shown in Figure 12 are more consultative.

In their oversight-oriented roles, state-level agencies are responsible for representing state-level priorities. As expressed in Georgia's Strategic Statewide

Transportation Plan (SSTP) approved by GDOT the Governor in 2010 and updated in 2013, the top statewide priority for transportation agencies is "supporting Georgia's economic growth and competitiveness" (GDOT 2013). With the Atlanta region supporting "more than 60 percent of the state's economic activity" (ARC 2013d), a major part of supporting economic growth and competitiveness in the State overall is supporting the same in Atlanta. The sociotechnical transportation system plays an important role in promoting economic growth by providing accessibility to employment centers and by facilitating the movement of freight. This role of the transportation system is acknowledged by the State's investment strategies, of which the SSTP identifies three categories: statewide freight and logistics, people mobility outside of Metro Atlanta, and people mobility within Metro Atlanta. SSTP investment strategies relevant to Metro Atlanta are summarized in Table 17.

Table 17: SSTP Investment Categories Relevant to Metro Atlanta (GDOT 2013)

Investment Category	Strategies with Existing Funds	Strategies with Additional Funds
Freight and Logistics	• Interstate interchange improvements • Improved last-mile connectivity	• New bypass facilities • New intermodal facilities
People Mobility	• Enhancing existing employment centers that have mixed-use zoning, transit, and plans to attract residential development • Operate express buses in HOT lanes • Improve mobility and connectivity on arterials hat connect to employment centers • Expand Interstate HOT lanes.	• Expand commuter transit (BRT and long-haul rail) network, focusing on access to employment centers • Augment commuter transit with short-haul circulators • Enhance existing core transit systems operations to be competitive with peer cities

GDOT and SRTA are the designated stewards of State and most Federal transportation dollars, responsible for disbursing these funds to regional and local entities around the state. In this oversight role, these state-level agencies are responsible for ensuring that state dollars, in particular, are spent in a manner that is compatible with statewide goals and objectives. GRTA, which also works "on behalf of the Governor," has a similar responsibility in the Metro Atlanta region in particular, expressed through the agency's oversight role in approving the Metro Atlanta TIP. Due to their defined oversight responsibilities, all of these state-level agencies must ensure that when state-level dollars are spent in Metro Atlanta, these expenditures reflect state-level investment priorities, such as those summarized in Table 17.

The combination of oversight responsibilities with collaboration on ARC's committees can enable state-level agencies to engage in more effective performance management within the inter-organizational system. This sort of inter-agency interaction, which combines hierarchical and consultative relationships, supports vertical integration (Pei et al. 2010) between the state and region's investment strategies. Through the frequent communication involved in their inter-organizational structure, the state-level agencies have agreed with ARC on a decision-making framework for updating the RTP and TIP. This framework was approved in 2013 and used to "guide the update of the PLAN 2040 RTP/TIP," (GRTA 2013) which was approved at a GRTA Board meeting in spring, 2014. As described in a GRTA (2013) document, the framework "builds on earlier endeavors" related to previous RTPs, and "is intended as a tool for directing limited resources for both this and the next RTP and TIP updates." Aligning with the principles of performance management, the framework uses performance measures to

help align statewide and regional investment strategies. The “framework goal” is to “Prioritize existing revenue streams toward the investments that drive the betterment of the systemwide performance measures, [which] support the goals of the Statewide Strategic Plan, the Governor’s Strategic Goals and PLAN 2040 goals, with an emphasis on enhancing the economic growth of the region” (GRTA 2013).

5.2.3 Program Delivery Influence

Any project that receives Federal funding in the region must be identified in the TIP developed by the ARC, which is then adopted into GDOT’s STIP. During TIP development, each funded project must be “sponsored” by one of the region’s transportation executors, which will be responsible for ensuring implementation. Typically, but not always, project sponsors are also facility owners who will be responsible for managing and operating projects after completion. Projects in the TIP are typically delivered with a combination of Federal funds plus state or local (public and/or private) funds, depending on whether the state or a local jurisdiction owns the facility. Projects in the TIP include capacity expansion, operational improvements, safety improvements, bicycle lanes, sidewalks, and regional programs such as the Livable Centers Initiative. The full implementation of a project in the TIP will often include several phases, from among those defined in ARC’s TIP Blueprint (2010):

- Scoping (SCP)
- Preliminary Engineering/ engineering/design/planning (PE)
- GDOT oversight services for engineering (PE-OV)
- Right-of-way acquisition (ROW)
- Utility relocation (UTL)

- Construction/implementation (CST)
- Total estimated cost, inclusive of all phases (ALL)

Since developing the TIP Blueprint in calendar year (CY) 2010, ARC has seen substantial improvement in project phase advancement rates, as shown in Figure 15.

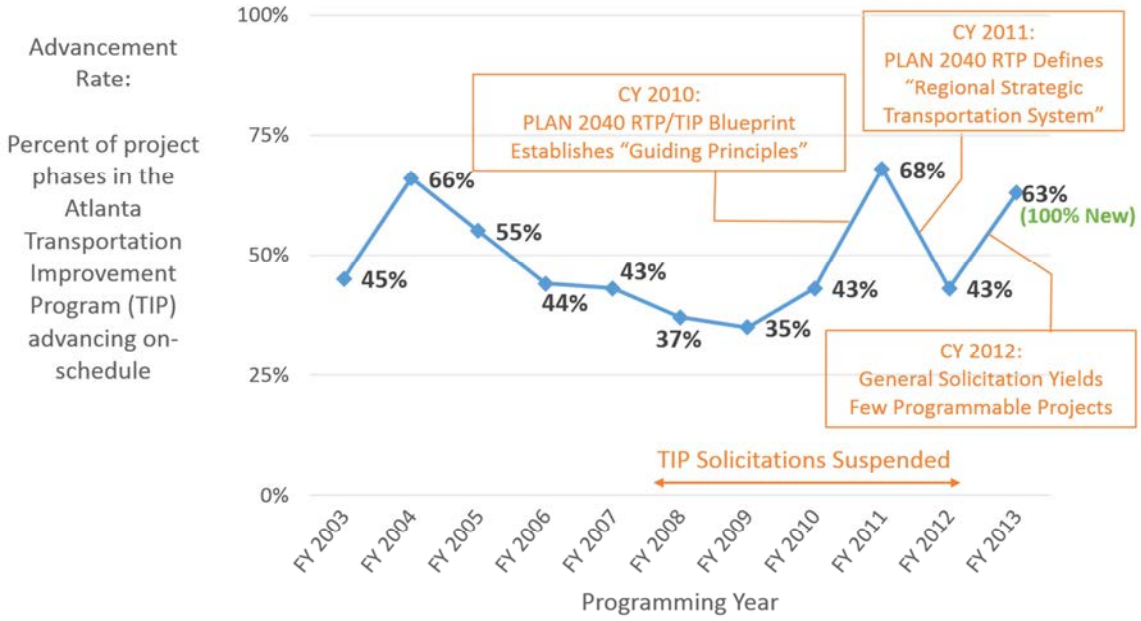


Figure 15: Metro Atlanta TIP Project Phase Advancement Rates for FY 2003- FY 2013, with important milestones in inter-organizational performance management (ARC 2013b)

When beginning to tackle its challenge with project implementation in the latter half of the 2000s decade, ARC defined a Regional Strategic Transportation System (RSTS) to guide the focus of new investment. As described in the 2014 Update of PLAN 2040:

> *The RSTS furthers the development of an integrated multimodal transportation system to facilitate the safe and efficient movement of people and goods, including addressing current and future transportation demand… The RSTS accommodates the region's most critical trip movements and is comprised of:*

- *Interstate highways and freeways;*
- *National Highway System (NHS) classified facilities and State highways, including intermodal connectors for freight facilities;*
- *Existing and future regional transit service; and*
- *Principal arterials, critical minor arterials and other facilities that provide continuous cross-regional mobility by ensuring adequate spacing of major roadways that connect regional activity centers, town centers and freight corridors.*

According to the 2014 Update of PLAN 2040, "It is ARC policy to only fund roadway and transit capacity expansions on RSTS facilities." Figure 16 shows the RSTS network of roadways, and Figure 17 shows the adopted regional vision for transit expansion, Concept 3, which is also incorporated into the RSTS.

As shown in Figure 16 and Figure 17, the adopted RSTS includes existing and operational facilities and services, as well as many components that have not yet been constructed, procured, or even designed through preliminary engineering (listed as "future" or "proposed" in these two figures). In order to realize the vision portrayed by the RSTS within the 25-year time frame of PLAN2040, effective plan implementation- through programming and facilitating program delivery- is paramount.

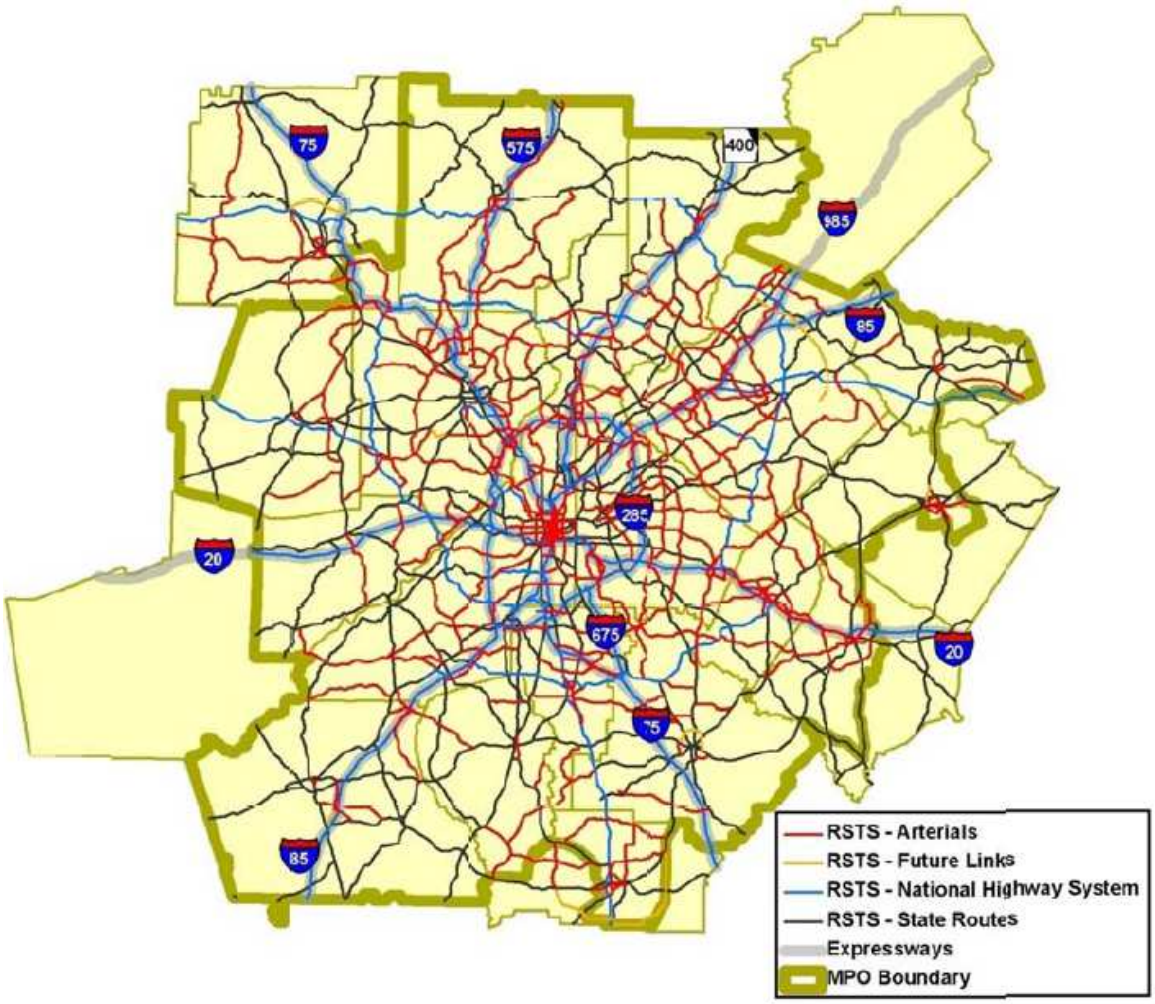


Figure 16: RSTS Roadway Network (ARC 2014)

Figure 17: Concept 3 Regional Transit Vision, Adopted 2008 (ARC 2014)

Having suspended calls for projects for several years during the latter half of the 2000s decade, ARC chose to issue its first call for projects in 2012, once there was space and uncommitted funding available for a new TIP. By this point, ARC had defined the RSTS, including Concept 3, and had gone through one cycle of updating the defined network in order to include it in the original PLAN2040 (adopted in 2011). This first call for projects was meant to be "quick" with a "scaled-down" application process that allowed local governments to work together to identify priority projects located on three ARC-identified networks, which were subsets of the RSTS (Haynes, D., unpublished informational interview, May 1, 2014). These three networks include:

- A Regional Thoroughfares Network (RTN) consisting of "corridors with the highest level of long-distance travel and corridors that connect activity centers" (Willis, M. personal email communication, June 26, 2014);
- A Freight Network subset of the RTN, consisting of "corridors that have a relatively high number of trucks plus the corridor linkages between activity centers" (Willis, M. personal email communication, June 26, 2014); and
- The Concept 3 network, which overlaps with the RTN in some corridors along proposed light rail and bus rapid transit lines (Haynes, D., unpublished informational interview, May 1, 2014).

By the time ARC issued its 2012 call for projects, agency staff had done a lot of work defining these networks and the strategic direction for PLAN2040; however, local project sponsors were much less familiar with the regional direction. As a result of this uneven understanding, a majority of responses to the call did not meet ARC's defined criteria; most proposed projects did not align with the strategic networks or represent

cross-jurisdictional interaction. Learning from this experience, ARC decided to produce additional guidance and design a more collaborative process for subsequent project calls to begin in 2013.

ARC issued two calls for projects in 2013, each focused on one of USDOT's federal funding programs: the Transportation Alternatives Program (TAP), and the Congestion Mitigation and Air Quality (CMAQ) program. As of the date of this dissertation, a third call was planned for 2014, in order to allocate federal Surface Transportation Program (STP) Urban funds (Haynes, D., unpublished informational interview, May 1, 2014). Prior to the 2013 calls, ARC staff prepared a document entitled "Which Program is the Best Fit for my Project" (Figure 18) in order to guide local project sponsors in submitting proposed projects. This guidance document identifies strategic "goals and principles" associated with each of the three funding programs, along with "emphasis areas" that reference the priority networks and related strategies developed for PLAN2040. Along with this guidance, ARC defined a two-stage process for project proposals. In the first stage, project sponsors submit letters of interest that each describe a proposed project, providing details about its expected scope, funding need, multi-jurisdictional support, phasing, and how it addresses relevant emphasis areas. Upon receiving these letters of interest, ARC staff creates a shortlist based on projects' "ability to demonstrate regional significance and their ability to utilize federal funds" (ARC TAP Program Overview, May 2013). In the second stage, ARC staff talks with project sponsors on the shortlist, working together to better define the project budget, schedule, and so forth. This process was officially described by ARC as follows (ARC TAP Program Overview, May 2013):

> *"Shortlisted submissions will then be invited to submit a more thorough proposal to receive Federal funds, including detailed information on the need, scope, and implementability of proposed projects… It is anticipated that ARC staff will take an active role in working with applicants during proposal development to ensure projects meet all goals and criteria."*

During this collaborative second stage, some projects are diminished in scope, others transform into something slightly different from the original descriptions submitted in letters of interests, and some drop off of the priority list due to limited capacity for implementation. Implementing this new two-stage process for the first 2013 project calls, which solicited projects for the federal Transportation Alternatives Program (TAP), ARC staff was able to move 17 projects into the TIP, feeling confident in project sponsors' ability to implement these projects. According to ARC's senior principal planner, project sponsors also had an increased level of confidence in the programming process, in comparison to previous calls, due to the increased level of collaboration (Haynes, D., unpublished informational interview, May 1, 2014). However, when ARC published the list of awarded projects, project sponsors noted a need for making the reasons for programming choices more explicit, so that these could be referenced later. Therefore, following the CMAQ call later in the year, ARC published a 16-page project funding report that documented the entire solicitation process, including details of all shortlisted projects with explanations of why each project did or did not receive a final award.

ARC's new project solicitation process was notably different from previous interactions that seemed much more hierarchical. In an informational interview, ARC's senior principal transportation planner, made two important observations based on the agency's experience with the 2013 project calls. Firstly, a competitive process does not

have to be passive. When project sponsors are involved in the deliberative process of programming, and they have the opportunity to consult with the planning agency to refine project scopes, they are more likely to understand final programming decisions. This increased transparency gives project sponsors the feeling of fair competition, in comparison to more typical methods of programming. This increased feeling of fairness, in turn, tends to increase satisfaction among project sponsors whose projects are ultimately selected as well as those whose projects do not make it into the current TIP. Secondly, although the increased communication between the MPO and local governments extends the solicitation process, the improved results are worth the additional time. Based on ARC's 2013 experience, the deliberative process takes about 3-4 months to "iron out" project details. This as an "entrepreneurial, proactive approach" to programming because it leads to more implementable projects than other, less communicative, approaches. The longer consultative process allows more stakeholders among MPO staff, project sponsors, and partnering entities to express and address their concerns and gain a more complete understanding of project scopes, schedules, and needs for successful implementation (Haynes, D. unpublished informational interview, May 1, 2014).

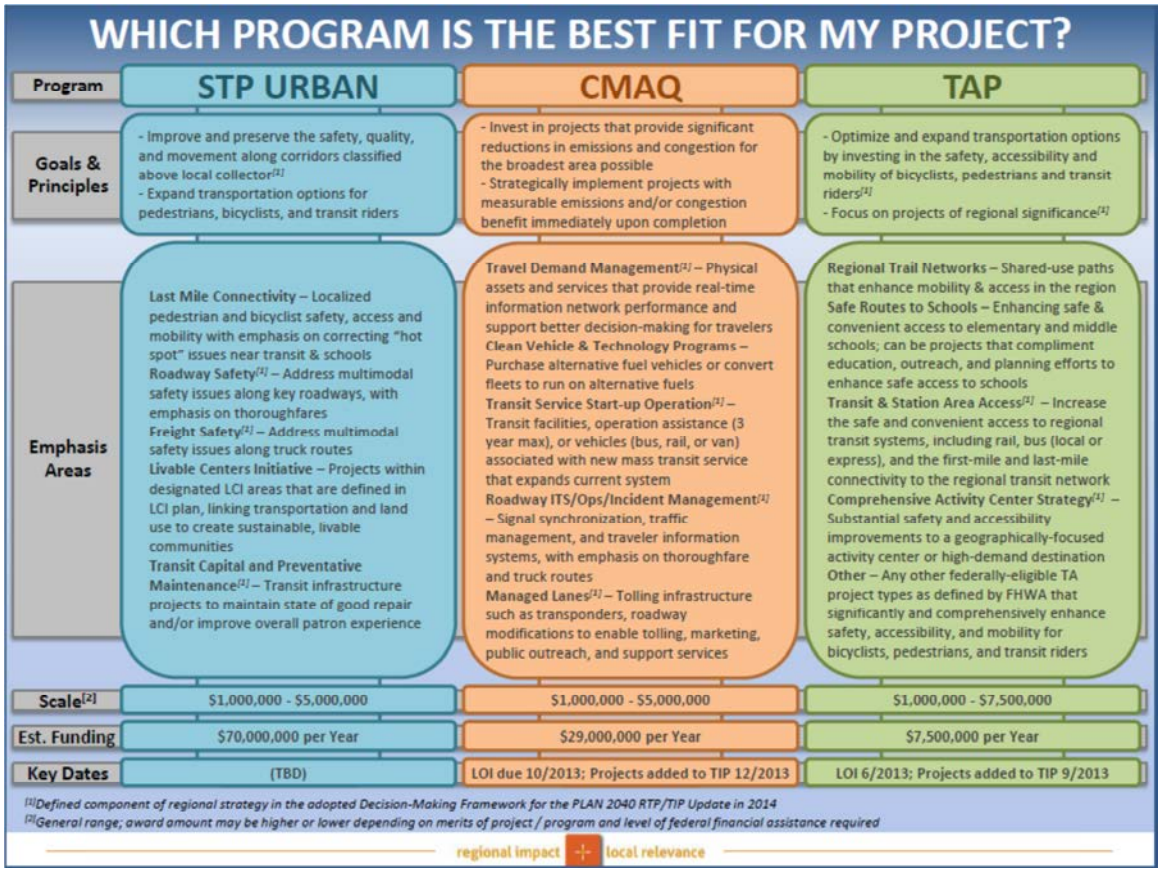


Figure 18: ARC guidance document issued to local project sponsors prior to 2013 calls for projects

Learning from its increased collaboration with project sponsors in the 2013 TAP solicitation, ARC extended the practice of vertical integration for the 2013 CMAQ call to include an "extremely high level of cooperation" with the state DOT (Willis, M. personal email communication, June 26, 2014). Specific elements of this cooperation included (ARC and GDOT 2013):

- Prior to issuing the solicitation, ARC collaborated with GDOT (and members of the TAQC) to develop CMAQ program goals and principles and emphasis areas, as listed in Figure 18.

- The CMAQ project selection committee, which reviewed letters of interest from project sponsors, included staff from both ARC and GDOT. This committee worked together to shortlist projects based on "a cost/benefit analysis" of several non-monetary performance measures related to emissions reduction, population affected, reduced delay, and deliverability.
- ARC worked with the GDOT Office of Program Delivery to develop a set of deliverability questions, and a detailed project schedule, for all applicants to address.
- All applicants were required to participate in a "delivery summit" hosted by the GDOT Program Delivery office.
- ARC and GDOT decision makers developed and approved the final list of funding recommendations prior to being reviewed and approved by the Georgia Environmental Protection Division and the Georgia branch of FHWA, and then being released for public comment.

Finally, after the TIP was approved with the newly added CMAQ projects, allowing these projects to move forward, the first programmed phase of each project was commenced with a "kick-off meeting" including local project sponsors, ARC, and GDOT. As a culminating communicative step in a highly communicative process, kick-off meetings propel projects from pure planning (programming) into implementation (program delivery).

The communication-intensive process described in this subsection may be understood as an example of building inter-organizational social capital. It is through building trust, understanding, and systematic working relationships among the various

transportation executors in the inter-organizational system that ARC has been able to make progress on its goal (implied by the first and second Guiding Principle defined in the TIP Blueprint (ARC 2010)) of enhancing TIP implementation. It is worth noting that the increase in social capital such as trust and understanding is inherently linked with the exchange of social resources across organizational boundaries; for example ARC, GDOT, and sometimes federal entities all provide technical assistance to local project sponsors in order to support project implementability. In another example, transportation executors share data and internal knowledge from each of their individual organizations to support inter-organizational decision making. Inter-organizational social capital can strengthen and inform the individual agencies as they deliver their respective TIP projects, and also as they carry ongoing management of the sociotechnical transportation system.

5.2.4 System Management Influence – Project Sponsors and Owners

As listed in Table 16, multiple entities at the state, semi-regional, and local-levels are responsible for building, maintaining, and operating transportation facilities and services in the region. These entities include GDOT, SRTA, GRTA, MARTA, local governments, and a few others such as universities and community improvement groups. In terms of infrastructure provision for roadways, GDOT is directly responsible for managing about 33% of centerline miles in the 18-county Atlanta MPO area, whereas the remaining majority is managed by local governments (ARC 2014). SRTA is responsible for managing the pricing on high occupancy/toll (HOT) lanes in the region. GRTA operates regional commuter bus service (*Xpress*). MARTA provides fixed rail transit and local bus service; several local governments provide local transit, including Cobb County, Cherokee County, Gwinnett County, Douglas County, and the City of Atlanta;

and several other entities provide local circulator shuttles, including the Atlanta University Center, Emory University, Georgia State University, Georgia Tech, Atlantic Station, and the Buckhead Community Improvement District (ARC 2012).

Most of the day-to-day work of system management is done without federal dollars, and it therefore is not listed in the TIP. As such, day-to-day system management depends upon the individual practices and organizational structure of each transportation executor. Appendix B provides organizational charts for Atlanta's state and regional-level public agency transportation (current as of the date of this dissertation).

Compared to ARC's overlapping centers structure, the other state and regional-level agencies map their organizational structures more traditionally, with hierarchical divisions and no overlap between functional groups. GDOT and MARTA, in particular are very large agencies, each with more than 4000 employees. In organizations of this size, a divisional structure can be helpful to focus staff efforts on specific products of the agency; however, several layers of hierarchy and lacking communication across divisions (i.e. siloes) can hinder efficiency and make any efforts at organizational change to be very cumbersome and slow. SRTA and GRTA, on the other hand, each have approximately 50 employees, and while they are also organized in discrete functional units, their organizational structures are much flatter, and thereby more adaptable.

Table 18 expresses the day-to-day system management influence of specific functional units within the organizational structures of GDOT, GRTA, SRTA, and MARTA. The functional units shown in Table 18 interact directly with the sociotechnical transportation system. Their functions are supported by other functional units in their respective agencies. The effectiveness of day-to-day management is largely dependent

upon the information and other support available to each of these functional units, and the extent to which divisions with overlapping or interdependent areas of influence can agree upon performance-based decisions.

Table 18: Day-to-day System Management Influence of Functional Units within Atlanta's State- and Regional-levelPublic Agency Transportation Executors, Tabulated by Mode and Service Quality Outcomes

	Connectivity	Mobility	Reliability	Safety	Affordability
Automobile	[1], [2], [3], [4], [6]	[5], [12]	[5] , [12]	[5]	[1], [6], [17]
Transit	[2], [7], [14], [13], [16]*	[7], [9], [10], [11], [13]	[7], [8], [9] , [12] , [13]	[7], [9], [14], [15]	[7], [9], [13]
Bicycle	[3], [5], [6]			[5]	
Pedestrian	[3], [5], [6]			[5], [14], [15]	

GDOT Functional Units: [1] Local Grants & Field Services (Districts 1,2,3,6, and 7), [2] Engineering, [3] Construction, [4] Program Delivery, [5] Office of Traffic Operations, [6] Office of Maintenance

GRTA Functional Units: [7] Transportation Performance, [8] Procurement Team, [9] Xpress Transit Operations, [10] Customer Service

SRTA Functional Units: [11] Marketing and Communications, [12] Operations

MARTA Functional Units: [13] Operations, [14] Safety & Quality Assurance, [15] Police & Emergency Management, [16] Transit Oriented Development (TOD) * Connection to Land Use System

5.3 Feedback Space Profile and Performance Measurement Gap Analysis

Part of the communication involved in improving program delivery in the Atlanta region has included transportation executors agreeing upon shared performance metrics for evaluating the merits of proposed projects for the RTP and the TIP. As discussed in Chapters 3 and 4 of this dissertation, performance metrics are crucial components of effective performance management. They are also part of the broader *feedback space* of an inter-organizational system, which facilitates performance management. This section

characterizes the feedback space currently activated by the ARC and other transportation executors, to support regional transportation planning, programming, and program-delivery in support of broader livability and QOL outcomes.

As described in section 3.2, the definition of performance measures should follow directly from the definition of strategic goals and objectives. As discussed in Chapter 4, the effectiveness of performance-based decision making depends upon performance measures being directly relevant to the organizational actions and influence pathways relevant to measurement champions. These two types of relevance - relevance to strategic goals and relevance to influence pathways – allow an agency or inter-organizational system to *activate* its feedback space by using performance information in decision making. The need for activated feedback, in terms of both sorts of relevance, is why the Feedback Space Profile must begin with identifying strategic priorities (goals and objectives) for the region.

5.3.1 Strategic Regional Priorities in PLAN 2040

Considering the high level of collaboration emerging in Metro Atlanta's regional planning process – which has begun to manifest through in the RTP/TIP development framework agreed upon by ARC and GRTA, and the close working relationship among ARC, GDOT, and local project sponsors in the 2013 call for CMAQ projects – it is reasonable to view the goals and objectives stated in ARC's 2014 RTP update to be broadly representative of the inter-organizational system's regional priorities. The PLAN 2040 Update was approved by the ARC and GRTA Boards of Directors in March and April, 2014, respectively. As described in the PLAN 2040 Update – Volume I (ARC 2014), the plan's strategic direction is set by a vision statement, three goals, five

objectives, and multiple guiding principles associated with each objective. The vision statement is “Visionary leadership for sustainable growth by balancing environmental responsibility, economic growth and social needs while maximizing benefits to all.” The goals refer to broader QOL and livability outcomes and broader social capital: “lead as the global gateway to the South,” “encourage healthy communities,” and “expand access to community resources.” The objectives and principles are listed in Table 19. (ARC 2014)

The PLAN 2040 objectives and principles in Table 19 have many linkages to the influence pathways of transportation executors. The principles associated with the first “mobility options” objective all relate directly to the physical infrastructure or operational characteristics of the sociotechnical transportation system. One of these principles also alludes to the interaction of the transportation and land use systems within the built environment. Although the other objectives focus on broader outcomes, several of their related principles indicate potential influence by transportation executors. Specifically, access to education, employment, and other important opportunities; public safety and security; active living opportunities; the minimization of travel distances and promotion of walking, bicycling, and transit use; promoting and preserving the connectivity of greenspace; protecting neighborhood integrity; and preserving air and water quality can all be addressed, in part, through transportation decision making.

Table 19: PLAN 2040 Objectives and Guiding Principles (ARC 2014)

Objectives	Guiding Principles
Increase mobility options for people and goods	• Preserve, maintain and operate the existing multimodal transportation system. • Implement cost-effective improvements such as sidewalks, multi-use trails, bicycle lanes and roadway operational upgrades to expand transportation alternatives, improve safety and maximize existing assets. • Maintain industrial and freight land uses at strategic locations with efficient access and mobility. • Maintain and expand infrastructure to support air and rail travel and transport. • Target strategic roadway capacity improvements to serve regionally significant corridors and centers.
Foster a healthy, educated, well trained, safe and secure population	• Build communities that encourage healthy lifestyles and active living for all ages, with provisions for healthcare, education, recreation, cultural arts and entertainment opportunities. • Promote a regional community that embraces diversity – age, ethnicity and lifestyle – as its strength. • Promote access to quality schools, career training and technology literacy to provide a workforce that can support economic opportunity. • Promote public safety efforts to create vibrant and safe 24-hour communities.
Promote places to live with easy access to jobs and services	• Build compact development in existing communities with integrated land uses that will minimize travel distances and support walking, cycling and transit. • Increase housing, services, and employment opportunities around transit stations. • Provide a range of housing choices to accommodate households of all income levels, sizes and needs and to ensure that workers in the community have the option to live there. • Protect the character and integrity of existing neighborhoods, while also meeting the needs of the community.
Improve energy efficiency while preserving the region's environment	• Conserve and protect environmentally-sensitive areas and increasing the amount and connectivity of greenspace. • Continue to enhance stewardship of water resources throughout the region. • Promote energy-efficient land development and infrastructure investments that foster the sustainable use of resources and minimize impacts to air quality. • Encourage appropriate infill, redevelopment and adaptive reuse of the built environment to maintain the regional footprint and optimize the use of existing investments.
Identify innovative approaches to economic recovery and long-term prosperity	• Focus financial resources and public investments in existing communities. • Establish a region-wide economic and growth management strategy that includes federal, state, regional and local agencies, as well as non-governmental partners. • Enhance and diversify economic development activities to include sectors like life sciences, logistics and transportation, agribusiness, energy and environmental technology, healthcare and eldercare, aerospace technology and entertainment and media production. • Leverage the diversity of the region – people, places, and opportunities – to continue to attract business and residents.

Considering the inter-organizational context in which ARC operates, it is worthwhile to note that the PLAN 2040 objectives and principles shown in Table 19 relate to statewide priorities identified in GDOT's SSTP goals and objectives (GDOT 2013):

- *Supporting Georgia's economic growth and competitiveness*
    - *Improved access to jobs, encouraging growth in private-sector employment, workforce*
    - *Reduction in traffic congestion reliability of commutes in major metropolitan areas*
    - *Efficiency and reliability of freight, cargo, and goods movement*
    - *Border to border and interregional connectivity*
    - *Support for local connectivity to statewide transportation network*
- *Ensuring safety and security*
    - *Reduction in crashes resulting in injury and loss of life*
- *Maximizing the value of Georgia's assets, getting the most out of the existing network*
    - *Optimized capital asset management*
    - *Optimized throughput of people and goods through network assets throughout the day*
- *Minimize impact on the environment*
    - *Reduce emissions, improve air quality statewide, limit footprint*

…and federal priorities identified in the MAP-21 planning factors, as quoted in the PLAN 2040 Update RTP Narrative (ARC 2014):

- *Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency.*

- *Increase the safety of the transportation system for motorized and non-motorized users.*
- *Increase the security of the transportation system for motorized and non-motorized users.*
- *Increase accessibility and mobility of people and freight.*
- *Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns.*
- *Enhance the integration and connectivity of the transportation system across and between modes, people and freight.*
- *Promote efficient system management and operation.*
- *Emphasize the preservation of the existing transportation system.*

Although it is only briefly mentioned in PLAN 2040's Guiding Principles, the concept of "regionally significant corridors and centers" is very important to developing a regional strategy. The concept is addressed more comprehensively in the adopted PLAN 2040 Regional Development Guide (RDG), which complements the RTP as the region's land-use plan (ARC 2011). As described in the RDG (ARC 2011):

> *Regional Centers… have 10,000 jobs or more in approximately four square miles. People travel from around the region to these centers for employment, shopping and entertainment. These centers should be connected to the regional transportation network with existing or planned high capacity transit service. In most cases, these centers have a jobs-housing imbalance, so housing options should be expanded within their boundaries, especially around existing or planned transit. Some Regional Centers could also be considered "Edge Cities," developed in a suburban, auto-oriented way. They have limited multi modal transportation options and are challenged by increasing congestion. Local plans and policies should support efforts to transform these areas into highly accessible mixed-use urban hubs.*

The RDG identifies 21 Regional Centers: six in the region's urban core, ten along defined employment corridors, one in the airport investment area around Hartsfield Jackson International Airport, three maturing neighborhoods, and one developing suburb.

5.3.2 Regional Transportation Planning Performance Measures and Gaps

As expressed by the SSF, performance measurement is the activation of feedback space in order to help organizations to translate their strategic goals into organizational actions and, ultimately, desirable outcomes. Metro Atlanta's transportation executors each use performance measures associated with some of their influence pathways, but there are some important elements of the strategic priorities listed in Table 19 that are not yet translated into actionable performance measures. Table 20 lists performance measures used for long-range regional transportation planning, prescribed by the ARC and its planning partners through the Decision-Making Framework for PLAN 2040. The leftmost columns categorize performance measures according to their relevance to the stacked systems framework, and the rightmost columns list identified targets and current system performance information, where published.

All of the performance metrics listed in Table 20 were used to either evaluate projects for inclusion in the PLAN 2040 RTP, or to evaluate the RTP's overall projected peformance. It is important to note that some of these metrics, while appropriate for one or the other application, may not be appropriate for both. For example, average weekday traffic volume is not appropriate as a systemwide metric although it can be a valuable impact measure for project evaluation purposes;operational improvements on heavily trafficed roadways will improve the experience of more people in the short term than operational improvements low volume roadways.

Table 20: Performance measures used to develop and evaluate the updated PLAN 2040 RTP, tabulated by relevance to the stacked systems framework, showing targets and current status where published.

Sub-stack or Resource Category	Performance Category	Defined Performance Measure	System-wide Target or Desired Trend	Performance Status (Most recent, 2011-2014)
Sociotechnical Transportation System	Physical Infrastructure → Connectivity	Percent of RSTS pavements, bridges, bus, and rail adequately maintained [1b]	70% roads and bridges in fair or better condition [1c] Not defined for transit	Approximately 95% RSTS pavement and 95% bridge in "good condition" [1] Not published for transit
	Sociotechnical Operations → Economic Outcomes	Peak-hour highway speeds on Metro Atlanta general purpose (GP) and managed (Mng) freeway lanes [1b]	At least 40 miles per hour or higher on general purpose lanes; at least 45 mph on managed lanes [2a]	Morning: 42mph GP, 47Mng *Evening:* 38mph GP, 37 Mng (calculated for a subset of most congested links) [2b]
		Peak-hour VMT [1b]	RTP decreases projected growth from no-build scenario [1]	Not published; however, Average Daily VMT 144,584,000 system-wide, 28.9 per capita [4]
		Average Weekday Traffic Volume [1a]	No target defined	Not published. However, AADT is published for individual links [5]
		Peak truck delay [1b]	No target defined	Not published
		Annual congestion cost per person	Reduce by 10% per year [3a]	$1,120 [3c]
Transportation Service Quality	Connectivity → Employment Access	Worker access to employment centers within 45 minutes by car and by transit [1b], [2]	RTP designed to increase access from no-build scenario. [1]	Not published.
		Average number of jobs within 45 minutes of home for typical person [1b]	RTP designed to increase access from no-build scenario. [1]	Not published.
		Accessibility Ratio [1a] (percent of vehicle trips with origin or destination in major activity centers)	No targets defined.	Not published.
	Safety	Injury and Fatality Crash Rates (per 100 million VMT) [1a]	No target defined	Not published.
		Annual Fatalities [1b]	Decrease by 41 each year, statewide [3a]	Approximately 500, region wide (approximately 1/3 of state traffic deaths) [4]
		Incident Response Rate and Clearance Time [1a]	HERO response time - 10 minutes or less [3a]	HERO response time – 13 minutes [3b] ; TRIP clearance time –30 minutes [6]
REFERENCES		[1] ARC 2014 PLAN 2040 Update Volume I - RTP Narrative: (a) project evaluation measure, (b) plan evaluation measure, (c) long-range target, (d) 2014 status | [2] GDOT SSTP Update 2013 | [3] GDOT Dashboard July 2014: (a) annual target, (b) 2013 status, (c) 2011 status | [4] ARC Factbook 2012: 2011 status | [5] GDOT Traffic Counts in Georgia website [6] Georgia TIME Task Force website: 2013 status		

Another important observation is that the same data types can be used for multiple performance measurement applications. In another example, number of fatalities and fatality rates per 100,000 VMT may both be useful as systemwide metrics, but only the fatality rate is appropriate for project-level evaluation, and especially prioritization among multiple projects, when considering social equity. That is because high-crash, high-fatality locations are likely to be on heavily used roads; however, some roads may have relatively low VMT, but high fatality rates; indicating that the people who use this roadway, although few in comparison, may be exposed to inordinate risk. Nonetheless, no single metric will tell the whole story, and a robust understanding of broader QOL outcomes is only revealed through a multicriteria decision making approach. In a multi-criteria approach to project evaluation, a proposed safety improvement designed to signifcantly improve crash rates on a roadway segment that shows both high average traffic volumes (likely AADT instead of AAWT) and high fatality (or severe injury) rates would gain priority over a similar project on a roadway with lower AADT or lower safety risk.

Data for developing and evaluating the PLAN 2040 RTP came from a combination of ARC's Regional Travel Demand Model outputs, and data provided by GDOT and FHWA: the Georgia Electronic Accident Reporting System (GEARS), and the HERE Geographical and Traffic Data sets (ARC 2014). Although current systemwide status is not published for several of the performance measures listed in Table 20, data is available among the region's transportation executors in order to calculate some of them on at least an annual basis. For example, injury rates, fatality rates, and crash rates can be calculated on an annual basis using data from GEARS and GDOT's traffic counts

database. The ARC 2012 Factbook does show a time series graph of the number of fatalities in the region, with most recent values for 2011 (approximately 500). Another chart suggests that the total number of crashes, fatalities, and injuries in the region declined from 2010 to 2011 as VMT increased, but time series values are not provided for any of these rates. 2011 crash rates for the state, the region, and each of the region's counties are compared in a bar chart, but the units for this chart are not the same as the crash rate metric described in the PLAN 2040 RTP narrative.

The absence of annual tracking for injury rates, fatality rates, and crash rates - identified metrics for project evaluation to develop PLAN 2040 - represents a measurement gap for metro Atlanta's transportation executors. Without tracking these outcomes regularly, ARC and other partners have less information with which to evaluate the overall influence of safety improvements, as the plan is implemented. These metrics proved valuable for project evaluation at the long-range planning stage, and they can be similarly valuable for project evaluation in the onlgoing process of programming for the TIP. An application of these safety metrics to programming may become relevant to ARC as early as 2014, during the planned call for STP Urban projects, since the STP Urban program includes roadway safety as one of its emphasis areas.

Although 2011-2014 status is not published for any of the identified metrics related to employment accessibility, GDOT's February 2012 SSTP Progress Report published that, on average, each of 13 major employment centers in Metro Atlanta could be reached by a "worker shed" of 800,000 workers by car or 120,000 workers by transit within 45 minute during the morning peak commuting period (GDOT 2012). This metric was excluded from GDOT's December 2013 SSTP Progress Report due to data and

attribution challenges. Modelers at GRTA, who support GDOT on SSTP-related reporting according to an inter-agency memorandum of understanding (Goodwin 2012), identified that 2010 data were still the most recently available for calculating these metrics. Even if more recent data were available, however, decision makers were not comfortable with the extent to which annual changes in these metrics could be attributed to GDOT's organizational actions (Goodwin, R. Unpublished informational interview with Rob Goodwin, July 25, 2014).

As described in GDOT's 2012 SSTP Progress report, "Without significant investment in new transportation infrastructure and/or marked shifts in development patterns, travel demand forecasts predict that future employment-sheds in Atlanta will shrink compared to current levels." This is a major reason why employment access is a critically important planning priority for the region, and why plan implementation – through effective programming and program delivery – is necessary. The "worker shed" metrics for employment accessibility were used to evaluate PLAN 2040 by projecting access in year 2040, indexing this to a projected 2015 base year, and comparing PLAN 2040's build-out results to a no-build scenario. ARC modelers estimated a 10% increase in worker access by transit for PLAN 2040 build-out, compared with a 13% decrease for the no-build scenario. For access by car, PLAN 2040 shows a 23% decrease, compared with a 43% decrease for the no-build scenario. The related metric of "average number of jobs within 45 minutes of home for typical person" was projected to decrease 15% in the PLAN 2040 scenario, but this is preferable to a nearly 35% decrease for the no-build scenario.

The “employment shed” metrics are meaningful because they link travel time, which is a mobility-oriented characteristic of transportation service quality, to the broader QOL outcome of employment access. However, GDOT is validly concerned about attributing annual changes in the system-wide aggregate metric reported in 2012. Nonetheless, considering that long-range models always contain much uncertainty, Atlanta’s transportation executors will need to regularly monitor changes in employment access in order to know if the strategies identified in PLAN 2040 effectively “move the needle.” Measures of employment accessibility should be calculated, and re-projected at least once per programming cycle to inform project selection in subsequent updates to PLAN 2040 and the TIP. Employment accessibility metrics align well with the emphasis areas that ARC identified for TAP projects, and could therefore help evaluate projects during regular call for TAP projects; however the data challenge still must be solved.

For the most part, the metrics listed in Table 20 are defined for the highway modes, specifically single-occupancy vehicle (SOV) travel. The three exceptions refer to transit state of good repair, access to employment centers via transit, and managed lane speeds (which are relevant to HOV travel and commuter buses). Of these, current status is not published for the two transit-specific measures. Although not explicitly identified as performance measures for RTP development, the RTP Narrative does mention “ridership, financial viability , and overall readiness” as additional criteria used for evaluating transit projects. These areas of emphasis, and the transit potion of the RTP, “resulted from extensive consensus-building ith transit project sponsors” (ARC 2014). Of these criteria, only ridership is reported on a regular basis; MARTA provides a time-series graph of annual ridership in its Annual Report (2013), and GRTA provides a time-

series bar chart of quarterly boardings at its Board meetings, once per quarter (GRTA 2013b). Ridership is a common metric related to transit operations, however it is much more agency-oriented than customer-oriented. Transit access to employment centers within 45 minutes is more relevant to user experience, but that is not tracked on a regular basis.

Considering the PLAN 2040 objective of increasing mobility options, and the associated guiding principles listed in Table 19, there is a notable lack of performance measures relating to transit, bicycle, and pedestrian travel modes in the RTP Narrative (ARC 2014). Likewise, measurement gaps for plan development and evaluation exist related to the guiding principles referencing broader outcomes such as access to education and other important opportunities aside from employment; active living opportunities; promoting and preserving the connectivity of greenspace; protecting neighborhood integrity; and preserving air and water quality.

5.3.3 Programming and Program Delivery Performance Measures and Gaps

Experience has shown that, without using performance measures to support programming, with a subsequent focus on program delivery, long-range planning goals are at risk of delay. Considering at minimum the decrease in employment accessibility, and increase in per capita congestion costs that Atlanta is projected to face by 2040 if PLAN 2040 is not successfully implemented, it becomes clear that programming and program delivery metrics are critical to the region.

For the first time in 2013, ARC and GDOT worked together to define performance measures to support the project prioritization and programming of CMAQ

projects. These performance measures were linked to the CMAQ goals and principles identified in Figure 18. CMAQ performance measures are listed in Table 21.

Table 21: Performance measures used for CMAQ programming (ARC 2013)

Goal Category	Performance Measure
Congestion	(Reduced) Hours of Delay
Air Quality	(Reduced) GHG Emissions, NOx Emissions (Reduced) VOC Emissions, $PM_{2.5}$ Emissions
Impact	Population and Employment within a ¼ mile radius

The CMAQ program evaluation measures shown in Table 21 address the issue of air quality outcomes, which is absent among the PLAN 2040 evaluation measures shown in Table 20. Regional air quality is also tracked and reported quarterly at GRTA Board meetings in terms of the EPA's Air Quality Index (AQI), which is defined on a scale from good to hazardous with respect to public health risk (GRTA 2013c). Air quality targets are defined by the EPA standards.

Coming out of its challenge with program delivery in the latter half of the 2000s decade, ARC instituted an annual Breaking Ground Report, which reports several project delivery metrics. The 2013 Breaking Ground Report includes several performance measures in its executive summary, as listed in Table 22. These metrics track the organizational actions of the inter-organizational system, identifying separate actions related to "three modal programs" addressed by the 2012 solicitation for TIP projects, which "balance the emphasis on system preservation [with] projects that improve the efficiency, safety, and effectiveness of the Atlanta region's transportation network for

motorists, pedestrians, cyclists and ground freight operators" (ARC 2013b). As further described by ARC (2013b):

> ***General Roadway Operations and Safety Program*** *– The goal of this program is to improve the safety and performance of the region's existing roadway network through targeted improvements on the region's arterial streets. Common projects eligible for funding from this program include railroad crossing upgrades, intersection improvements, and intelligent transportation system installations. A minimum of $50 million was set aside for this program within the 2012-2017 TIP at the [2011] adoption of PLAN 2040.*
>
> ***Last Mile Connectivity Program*** *– The Last Mile Connectivity program encourages and supports active transportation through improvements to local cycling and pedestrian infrastructure. Improvements funded by this program include sidewalks, crosswalks, pedestrian refuge islands and provisions for safer routes to schools and transit facilities. A minimum of $50 million was set aside for this program within the 2012-2017 TIP at the adoption of PLAN 2040.*
>
> ***Freight Operations and Safety Program*** *– This program is focused on improving freight mobility within and across the Atlanta region by funding cost effective and easily delivered projects within established freight corridors. In addition to access management treatments and truck passing lanes, many of the project categories eligible for funding under the General Roadway Operations and Safety Program are also suitable for the Freight Operations and Safety Program, giving ARC staff a degree of flexibility in awarding funds to potential sponsors. A minimum of $75 million in total funding was set aside for this program within the 2012-2017 TIP at the adoption of PLAN 2040.*

Of these three programs, the Last Mile Connectivity Program addresses the issue of multimodal mobility options, which is absent from the PLAN 2040 evaluation measures. However, performance measures were not defined for use with these programs, and they have since been superseded in the TIP development process by alignment with the Federal STP Urban, CMAQ, and TAP programs, as defined in Figure 18. Performance measures are still needed to prioritize new transit, bicycle, and pedestrian-oriented projects through future solicitations.

Table 22: Performance measures used to track TIP implementation (ARC 2013b)

Metric	FY 2013 Status
Total funds committed to advancing project phases	$283
Number and percent of project phases, scheduled for FY 2013, that advanced on schedule, were delayed, and were dropped	
• Overall	168 (63%) advanced 36% delayed, 1% dropped
• Bicycle and Pedestrian	45 (65%) advanced 35% delayed, 0% dropped
• Roadway	116 (63%) advanced 36% delayed, 1% dropped
• Transit	1 (13%) advanced, 87% delayed, 0% dropped
• Other	6 (75%) advanced, 25% delayed, 0% dropped
• New (2012) TIP solicitation project phases	25 (100%) advanced
Funding sources for new (2012) TIP solicitation project phases advanced in FY 2013, by "project service group"	
• Freight Operations and Safety (2 phases)	$260k Federal, $65k Local
• Last Mile Connectivity (7 phases)	$528k Federal, $408k Local
• Roadway Operations and Safety (16 phases)	$1.87M Federal, $17k State, $450k Local

5.3.4 Broader Outcome Metrics

ARC has one additional layer to performance reporting, the *Regional Scorecard*, to track regional outcomes related to the PLAN 2040 objectives. Scorecard metrics are listed shown in Table 23. ARC's Regional Scorecard reports annual performance status for each metric, drawing from external data sources including the American Community Survey, the TTI Urban Mobility Report, the Georgia Environmental Protection Division, and the Bureau of Labor Statistics. Depending on the data source, the 2014 scorecard shows most recent performance status for 2011, 2012, or 2013. Scorecard measures expand ARC's activated feedback space to include many broader livability and QOL outcomes, but it does little to connect these outcomes directly to organizational actions.

Table 23: Regional Scorecard Measures (Summarized from ARC 2014b)

Objective & Status	Performance Category	Performance Measure
Community: Promote places to live with easy access to jobs and services 	Proximity to Jobs	Percent of workers who live in the "Region Core" or along "Regional Employment Corridors" (as defined by Unified Growth Policy map)
		Number of workers who both live and work in same employment corridors
	Income spent on housing	Percent of individuals spending more than 30% of income on housing cost
		Average percent of income spent by moderate-income households on housing and transportation
	Commute Length	Percent of workers with one-way commute of less than 45 minutes (rank, largest 100 metros)
	Access to Arts	Number of "creative establishments" per 1000 population
Growing a Vibrant Economy: Identify innovative approaches to economic recovery and long term prosperity 	Exports	Total exports value in dollars (rank, largest 100 metros)
		Exports share of Metro GDP (rank, largest 100 metros)
		Direct Export-production jobs, in thousands (rank, largest 100 metros)
		Total export-supported jobs, thousands (rank, largest 100 metros)
		Annualized export growth rate, by value (rank, largest 100 metros)
		Exports composition by goods and services
	Patents	Percent (share) of all patents in 99 large Metro Areas
		Patents per 10,000 population
	Concentration of "Knowledge Jobs"	Location quotients in four strategic hubs: Logistics, Knowledge, Production, and Entertainment
	Unemployment	Unemployment rate (tracked quarterly, compared to national rate)
	Gross Metropolitan Product (GMP) in millions (compared to other large metros)	
	Home Price Index (Percent of January 2000)	
Sustainable Environment: Improve energy efficiency while preserving the region's environment 	Percentage of Commuters with "Green Commutes" – transit, walking, bicycling, teleworking	
	Air Quality	Annual number of exceedances of the Federal ozone standard
		Annual mean concentration of $PM_{2.5}$
	Water Resources	Per capita water use, 15-county planning district
Mobility: Increase mobility options for people and goods 	Project Advancement	Percent transportation projects advancing on TIP schedule
	Cost of Congestion	Congestion cost per urbanized area auto commuter
		Congestion Index
		Average annual hours of delay per auto commuter
People 	Education	Percentage of adult (25+) population with at least a bachelor's degree
		Percentage that education required for the average job opening (demand) exceeds the education attained by the average worker (supply)
		High school graduation rates
		Percent of children of low income families enrolled in Georgia Pre-K
	Obesity	Percent of the population Obese
	Poverty	Percent older Adults in Poverty
Accomplished  **Getting Started**		

Three scorecard metrics, however, do link broader outcomes to transportation service quality:

- "Percent of workers who live in the 'Region Core' or along 'Regional Employment Corridors'" acknowledges the interaction between the transportation infrastructure and land use systems in the built environment, which allows connectivity to lead to opportunity access.
- "Average percent of income spent by moderate-income households on housing and transportation" considers transportation affordability as a function of the transportation-land use interaction in the broader built environment.
- "Percentage of Commuters with 'Green Commutes'" explicitly connects transportation mode choice, which may be conceptualized as a function of both multimodal connectivity and user preference, to environmental stewardship.

Other broader outcome-oriented metrics in the Scorecard can also be linked to transportation service quality, based on the discussion in Chapter 4. For example, some transportation planning and public health research has linked obesity outcomes to the availability of opportunities for active transportation; in other words the connectivity infrastructure for non-motorized travel. To acknowledge this linkage, "Percentage of Commuters with 'Green Commutes'" could be recast as "Percentage of Commuters with 'Active Commutes'" – focusing on trips that incorporate bicycling and walking. However, a gap would still exist in measuring physical infrastructure connectivity for these modes, which is called for by ARC's 2012-defined Last Mile Connectivity Program, which has been subsumed into the 2013-defined STP Urban emphasis areas (Figure 18).

5.3.3 Broader Feedback Space

Aside from the performance measures that it has used for long-range planning, programming, and tracking performance, ARC also has collected additional feedback through multiple studies. Other transportation executors in the metro Atlanta region have also collected feedback, particularly opinion data from metro Atlanta's traveling public and business community, beyond what is published in their performance reports. These additional feedback sources include ARC's Metro Atlanta Speaks and subsequent MetroQuest Surveys, GDOT's Public Opinion Poll, and the Governor's Development Council's Transportation Competitiveness Initiative.

Hearing from the Public

The Metro Atlanta Speaks study was unveiled at the ARC's State-of-the-Region breakfast in 2013 (ARC 2013c). This study surveyed a statistically significant sample of voting-age residents of the 10-county Atlanta region regarding QOL issues. The highest proportion of respondents (nearly 25%) identified "economy" as the "biggest problem facing the Atlanta region." This was followed by more than 20% identifying "traffic" as the biggest problem." These two performance areas mirror the major objectives of PLAN 2040, indicating that the plan's strategic focus is sensitive to the public experience in the region. Related to the PLAN 2040 RTP's primary economic indicator, access to jobs, significantly more respondents rated "availability of job opportunities" in the region as poor (20.3%) or fair (36.3%), rather than good (29.%) or excellent (6.7%). In order to solve this problem, planners need to analyze factors that may either boost or inhibit job availability, including access via the transportation network, and the interactions of transportation and land use in the built environment.

Traffic, which 56.8% of Metro Atlanta Speaks respondents said has "gotten worse" in the region in recent years, is associated with economic activity. The Texas Transportation Institute's Urban Mobility Report, cited on GDOT's performance dashboard, does in fact show increasing annual congestion costs per auto commuter in metro Atlanta from 2009-2011; however, this is after a sharp decline 2006-2008, which corresponded with an economic downturn, significant job losses in the region, and reduced VMT (GDOT 2014, ARC 2012). Ironically, increased VMT on a constrained transportation network both indicates and inhibits economic growth. It is because of the barrier-effect of traffic, which diminishes QOL for transportation system users, that PLAN 2040's RTP is designed to decrease VMT compared to the no-build scenario, while increasing access to jobs. Unfortunately, however, projections associated with the RTP anticipate an approximately 15% decrease in the average number of jobs within a 45 minute commute of the typical person's home in metro Atlanta between 2015 and 2040.

In another recent study of public opinion, conducted by GDOT in 2011, 26.3% of respondents residing in the 13-county Metro Atlanta region graded state highways poorly ("D" or "F"), and an additional 38.2% gave them a "C" grade, in terms of "smooth traffic flow or the absence of excessive congestion." Although traffic flow was not prioritized quite as highly as traffic safety (receiving a mean rating of 9.1 on an importance scale of 1 to 10, lower than safety's mean rating of 9.6), highway safety was graded highly ("A" or "B") by 71.6% of Metro Atlanta respondents. The relative dissatisfaction with traffic issues by GDOT's respondents, combined with the still high priority rating for this performance category, corroborates the findings of the Metro Atlanta Speaks study that organizational actions aimed to improve traffic flow (and reduce congestion) are aligned

with the priorities of the traveling public. With the majority of Metro Atlanta Speaks respondents believing that "traffic has gotten worse" in recent years (ARC 2013c), it is understandable that GDOT's metro-region respondents to the 2011 public opinion survey also show relative dissatisfaction with transportation executors' "planning effectively for long term transportation improvements"; more Metro Atlanta respondents gave GDOT a poor grade than a good grade in this performance category of effective planning (31% A/B, 32.7% D/F), with a slight plurality rating the agency's planning effectiveness as passable (36.3% C) (Poister et al. 2012).

As described in 5.2, Metro Atlanta's transportation executors must work together to create effective plans, and then translate those plans into changed performance outcomes through program delivery. Among Metro Atlanta Speaks respondents, 40.9% think that the "best long-term solution to traffic problems" in the region is "improvements to public transportation"; 30% recommend "better roads and highways," and 21.9% recommend that the region encourage development of communities "in which people live close to where they work." As one contribution to regional QOL, 71.3% of respondents agree that public transportation is "very important" for Metro Atlanta's future. Considering the wide public agreement about the need to implement public transportation in Metro Atlanta, the region's transportation executors are clearly in need of performance measures that can help guide and track the enhancement of regional transit. Furthermore, the promotion of transit complements ARC's "Regional Centers" and "Livable Centers" approaches to development. Therefore, performance measures aimed at enhancing the quality of infrastructure in livable centers and employment

centers, and the multimodal connectivity between these places, can help transportation executors to select and prioritize projects moving forward.

As of the date of this dissertation, ARC's Community Engagement staff recently opened another public survey effort, seeking "input to help us create a vision for our future," allowing the region to "sustain the things we love about our communities," "be more economically competitive", "improve our health and protect the environment", "and enhance our housing and transportation choices." The survey asks respondents to rank their priorities among six goal areas, and identify strategies to help meet each goal. (PLAN 2040 MetroQuest web survey 2014) Survey results will be considered in the next PLAN 2040 update, in 2016. Within less than one month after its launch, this survey had collected more than 1800 responses from residents throughout the Metro Atlanta region, with the highest density of respondents seen within the I-285 border (Roberts, M., unpublished report, July 18th, 2014). This represents rapid progress, having already achieved approximately 85% of the number of responses to the 2013 Metro Atlanta Speaks. According to the ARC's Community Engagement Coordinator, the survey's rapid progress can be attributed to its simultaneous simplicity and comprehensive coverage (Roberts, M., personal email, July 18, 2014):

> *[I]nternally this has been a very collaborative opportunity for ARC to create a survey that fully represents the breadth of the work that we do. … The topics and language used in the survey were inspired by our ARC Board retreat, but directly created by a small working team of inter-disciplinary staff. Every member of this team actively participated in the development of the specific survey content, no matter their individual area of expertise. In that way, we found much more accessible language and great internal dialogue about our work and the meaning of the strategies that we suggested for the public responses. As there is a strong, and equal, representation of all of ARC's planning efforts contained within this comprehensive strategy,*

> *many of the staff seem to feel ownership over the survey content and anticipation for the results. …*
>
> *Externally, many of our community partners are often helpful in promoting ARC events and input opportunities. This particular survey … allows for numerous opportunities to type in specific comments and suggestions [in addition to an already 'wide range' of identified strategies]. For this reason, many people and organizations are finding value in promoting the survey to through their networks. … [O]ur external partners feel that the survey is an important tool for their constituents to voice … support of particular policy directions.*

Other recent survey efforts by ARC have included a 2010 Regional On-Board Transit Survey and 2011 Regional Household Travel Survey, which focused on collecting objective characteristics relevant to travel behavior, and a 2013 survey of Atlanta's bicycling population, which collected both objective characteristics and a wide range of subjective opinion data.

Learning about Economic Development

Considering that economic development is the primary objective of both the SSTP and PLAN 2040 RTP, feedback from stakeholders among the economic development and business communities can be helpful to identify transportation needs, strengths, and weaknesses. As of the date of this dissertation, the Governor's Development Council (GDC, housed at GRTA), was conducting the "Transportation Competitiveness Initiative" (TCI), the purpose of which was "to research the ways that Georgia's strategic industries depend upon and benefit from our state's transportation network" (Fischer, J., personal communications on behalf of GDC, March-May 2014)[6]. TCI research included interviews with members of Georgia's

6 This author served as project manager for the GDC's TCI while working as a part-time contractor with GRTA, August 2013-August 2014. TCI-related materials are cited in this dissertation with permission from GRTA's Director of Transportation Performance, Rob Goodwin.

economic development community, and a survey of Georgia businesses. Both the interviews and survey targeted industry groups which are considered strategic by the Georgia Department of Economic Development, some of which also overlap with industry sectors identified in Metro Atlanta's own Regional Economic Competitiveness Strategy (ARC 2013d), shown in Figure 19. TCI interviewees discussed several established and emerging strengths of Metro Atlanta's transportation system, in terms of how they support businesses of different types. In Metro Atlanta, "Knowledge Hub" businesses especially care about (Fischer and Zegers 2014; Fischer and Henderson 2014):

- Attracting highly skilled employees who, more and more, prefer to live and work in walkable, bikeable, and transit-accessible places with access to diverse land uses that support QOL;
- Public transit access to Atlanta's Hartsfield-Jackson airport, which provides frequent-flying employees direct flights to domestic and international locations;
- Proximity and quick transportation access to business partners, including other firms and universities, to support collaboration.

"Production Hub" and "Logistics Hub" businesses also seek access to a highly-skilled workforce, but their business success also depends heavily on freight movement. For example, depending on the type of product being manufactured, "Production Hub" businesses may want to locate within close proximity to Hartsfield-Jackson airport, or within a particular travel time, by truck, of their in-state suppliers. If they are going to create jobs, and create wealth, is important for business to be able to balance transportation needs for attracting employees, and

other needs for accessing a supply chain. (Fischer and Zegers 2014; Fischer and Simoglou 2014)

Organizational systems create their own feedback space by collecting data, and they systematize this feedback into performance management processes. As of the date of this dissertation, GDOT's Office of Planning was working with a consultant team to develop an internal process and tool for evaluating the economic benefits of roadway and bridge projects. This initiative has begun with a series of case studies that assess traditionally considered transportation outcomes such as travel time savings, vehicle operating costs, safety changes, and emissions savings; as well as broader economic indicators such as employment, GDP, and personal disposable income (Fischer, Van Dyke, et al. 2014). If the final tool can successfully associate changes in infrastructure connectivity and condition with changes in transportation service quality, and then with broader economic outcomes, it could significantly enhance GDOT's decision making power and influence over broader QOL and livability outcomes. This sort of study, which GDOT will be able to leverage in its future collaborations with ARC on regional transportation planning and programming, demonstrates the kind of effort needed to leverage an organization's feedback space to build choice intelligence. Demonstrating the iterative nature of developing choice intelligence, the current initiative builds upon GDOT's previous experience with developing a project prioritization tool that was not ultimately used by the agency. The previously built project prioritization tool (developed 2007-2009) was ultimately deemed limited because it calculated project benefits in terms of travel time savings alone (Fischer, Van Dyke, et al. 2014) The new process, on the other hand, can support a more mature, performance-based approach to planning, which

considers broader QOL and livability outcomes associated with socioeconomic situations that are influenced by the sociotechnical transportation system.

Figure 19: Targeted business sectors in Metro Atlanta's regional Economic Competitiveness Strategy (ARC 2013d)

5.4 Recommended Supplemental Performance Measures

Having identified major performance measurement gaps with respect to their regional transportation-related QOL priorities, transportation executors must expand their activated feedback space to fill these gaps. Based on the findings of the Feedback Space Profile and Gap Analysis presented in 5.3, a more robust set of performance measures is needed to help ARC and the region's other transportation executors deliver a system of multimodal access to important QOL-supporting opportunities including jobs, education, and active living. By focusing on multimodal accessibility, valuable new measures will

expand upon the (largely roadway-focused) connectivity and safety metrics already calculated for RTP development, in a way that associates these transportation service quality elements with broader priorities expressed by ARC's regional scorecard, and leverages opportunities associated with existing land use and transportation patterns in the region.

In 2012, Georgia Tech's Center for Quality Growth and Regional Development (CQGRD) conducted a Health Impact Assessment of the original PLAN 2040. This analysis went well beyond the metrics used by ARC, and it suggested several performance measures to be used augment future planning endeavors, and to monitor system performance. The CQGRD (2012) researchers based recommended measures on several observations from the research literature:

- "Travel options affect access" to many important opportunities, such as "nutritious food, medicine, and healthcare," employment, and education; indicating that multimodal connectivity metrics should be linked to opportunity access;
- The lack of travel options is especially problematic for vulnerable populations like "the elderly, children, persons with disability, and households with limited time or mobility" or economic means; indicating that metrics should be useful for evaluating equity; and
- "Research links walkable mixed-use neighborhoods, access to stores and services, multimodal transportation options, and short commutes to better physical, mental, and social health"; indicating that the ARC's "regional centers" and "livable

centers"-oriented approach for linking transportation and land use planning can be an effective strategy for advancing several QOL-oriented goals.

These observations reinforce that valuable new metrics will ultimately support regional transportation planning and programming, program delivery, and system management in Metro Atlanta in a way that advances the ARC's strategy around leveraging Regional Centers to promote economic development. Table 24 identifies new recommended measures that can fill the gaps identified in 5.3. Each measure is listed in parallel with "results drivers" - organizational actions and the transportation executors within Atlanta's inter-organizational system that will have to implement these actions. As discussed in Chapter 3, effective performance management often includes the assignment of champions – those responsible for measuring and impacting performance. While ARC would monitor performance associated with each recommended measure, and use these outcomes to inform periodic planning and programming efforts, other transportation executors will be responsible for project delivery and day-to-day system management. This division of labor within the inter-organizational system puts ARC in more of an oversight role, with other transportation executors at the "front-lines" of performance measurement.

Table 24: Recommended performance measures to fill measurement gaps in Atlanta's regional performance-based planning and programming for livability and QOL outcomes

Performance Category	Recommended Measure	Uses*	Results Drivers†
Transit Connectivity	Number of regional centers that are served by high capacity transit (heavy rail or express bus)	A, B, C, D	Construction and operation of high-capacity transit, public engagement [2, 3, 4, 5, 6]
	Unused capacity of transit service serving each center	C, D, E	
	Percent of households within a 45 minute walk + transit commute of one (or multiple) regional activity centers, possibly segmented by population group	B, D, E	
Non-Motorized Connectivity	Percent of RSTS roadway miles with bicycle facilities meeting LOS and condition standards	C, D, E	Construction and maintenance of bicycle and pedestrian facilities [2, 6] Land use management [1, 3]
	Percentage of RSTS roadway miles with pedestrian facilities meeting LOS and condition standards	C, D, E	
	Walk Score® rating of identified regional centers and LCIs (average rating, change in rating, number of centers with Walk Score® rating >70)	C, D	
Inter-Modal Connectivity	Percent bus stops meeting the minimum safe pedestrian access standards (crossing treatments, ADA-compliance)	C, D, E	Placement of bus stops, maintenance of pedestrian facilities, [1, 2, 4, 6]
Safety	Number of injuries and fatalities per 100,000 residents, segmented by travel mode of victim	B	Infrastructure connectivity; Safety treatments [2, 6]
	Percent of survey respondents who would feel safe travelling by each mode for each trip type	D	Infrastructure connectivity; public engagement; safety treatments [1, 2, 6]
Mobility	Percent of survey respondents who rate their most-often used travel mode as good or excellent, possibly according to multiple modal attributes (comfort, speed, etc.)	D	Multimodal connectivity and reliability [2, 3, 4, 5, 6]
	Percent of trips taken by mode (SOV, HOV, transit, bike, walk) for each trip type (HBW, HBS, HBO, NHB)	A, B, C, D	Multimodal connectivity, public engagement [1, 2, 3, 4, 5, 6]
	Average travel time from homes to closest regional centers, compared by mode	A, C, D	Roadway and transit operations [2, 3, 4, 5, 6]
Roadway Reliability	Buffer time index on regional thoroughfares network	C, D, E	Roadway operations [2, 6]
Transit Reliability	On-time performance rate of transit vehicles at stops, weighted by time-of-day ridership	C, D, E	Transit operations [3, 4, 5, 6]
Affordability	Median percent of household income spent on transportation, by population group	B	Road, transit, and non-motorized infrastructure operations and maintenance [2, 3, 4, 5, 6]
	Out of pocket user cost per trip, by mode, trip type, and population group	C, D	
Notes	* Recommended uses for new metrics: [A] project evaluation for the RTP, [B] overall RTP evaluation, [C] project evaluation for the TIP, [D] tracking progress, [E] system management † Organizational actions and the transportation executors that will have to implement them: [1] ARC, [2] GDOT, [3] GRTA, [4] MARTA, [5] SRTA, [6] Local governments and community groups		

The measures listed in Table 24 are proposed to supplement those already identified in 5.3, which have been used by ARC for RTP development (A) and evaluation(B), and TIP development (C) in the 2013 CMAQ solicitation. As noted in the "uses" column, some metrics are also relevant to tracking progress in the Regional Scorecard (D), and others can be used by other transportation executors in their day-to-day management (maintenance and operations) of the system (E). Categorized in Table 24 by their relevance to transportation service quality, all of the proposed metrics are meant to more concretely link agency actions, subsequent changes in transportation service quality, and broader livability and QOL outcomes, as illustrated by the SSF. As noted in the "results drivers" column, several transportation executors may influence these metrics, although "moving the needle" will undoubtedly take time and a strengthening of inter-organizational structures and processes that promote coordinated program delivery.

5.4.1 Transit Connectivity

Recommended transit connectivity measures will supplement "worker access to employment centers within 45 minutes by transit," which was used by ARC to evaluate the overall PLAN 2040 RTP. As described in 5.3.3, GDOT's 2012 SSTP Progress Report reported an average of the number of workers who could access each of 13 regional employment centers in 45 minutes by transit, but this metric was omitted from the 2013 Progress Report due to concerns about data and attribution. The attribution concern is valid for GDOT because the agency does not provide or manage transit in Metro Atlanta.; this metric would be more appropriately tracked by GRTA, MARTA, and ARC, the first of which provide express commuter bus and rail transit access respectively, and the three

of which collaboratively provide the ATLTransit trip planning website (www.atltransit.org) that integrates scheduling and fare information for regional transit services. To address the data challenge for this metric, modelers could use a methodology developed by researchers at the University of Minnesota's Accessibility Observatory, which calculates "cumulative opportunities accessibility" due to transit connectivity by using published transit schedules (Owen and McLafferty 2014). Although population estimates may not be updated regularly, and annual changes are unlikely when transit schedules remain unchanged, this metric will be meaningful as transit capacity is increased. For example, ARC's 2014-2017 TIP includes a project to increase the frequency of MARTA rail service (ARC 2014c). This is likely to increase the worker shed available to several regional employment centers, which are adjacent to MARTA rail stations. A before-and-after study of worker sheds using the updated rail schedule information could be a valuable inclusion for the Regional Scorecard. This project is already programmed with STP Urban funds; future TIP solicitations for STP Urban projects may consider this metric in project evaluation if any project sponsors propose new transit routes, or increased frequency. For project evaluation purposes, it will be useful to consider regional employment centers separately, as well as in aggregate, because newly proposed routes or schedules may only connect with one or few centers.

The newly proposed metric "number of regional centers that are served by high capacity transit" is simple to compute using regional transit maps of MARTA and GRTA service. This metric is relevant to a scenario analysis that ARC intends to use in its 2016 update to PLAN 2040 (ARC 2014d). Currently, fewer than half of the 21 regional centers identified in ARC's Regional Development Guide are accessible by

MARTA rail or GRTA Xpress bus service. Although others are accessible by local bus, the travel time involved to reach them is unattractive to people who have other travel mode options. This metric, while simple to compute, can powerfully assist ARC to track and report the implementation of PLAN 2040 goals (via the Regional Scorecard). It may also be used for project evaluation for the RTP update and TIP updates; routes opening new employment centers to direct access via high capacity transit will have the greatest opportunity to attract travelers who otherwise feel their only commute option is to drive, and these would receive high planning and programming priority. This metric could be relevant to STP Urban, CMAQ, and TAP project solicitations; however it would need to be accompanied by a more detailed metric related to actual transit capacity in order to compare competing projects. The newly proposed metric of "unused capacity of transit service serving each center" could meet this need. For the purpose of TIP development, "unused capacity" may be interpreted as "new capacity of proposed projects," measured, for example, in daily trips. This metric may also be used for system management by transit providers when "unused capacity" exists in the current transit system. For example, a GRTA *Xpress* route that regularly has many empty seats has excess capacity that could potentially be filled through marketing and public engagement. In both programming and system management, this metric would trigger additional analysis. That is, proposed TIP projects with high capacity should also be analyzed in terms of expected ridership; however, taking a lesson from the management application, ridership may be expected to increase given effective marketing and other strategies.

The final recommended metric for transit connectivity, which is to be calculated at the system-wide level, captures user experience and personal accessibility more than

the others. This is important for reporting (i.e. through the Regional Scorecard) to be effective in engaging its audience (i.e. the traveling public, the customers of regional transportation executors). Also, like other more user-focused metrics that are seen in subsequent categories, this "percent of households" metric can be segmented by population group and used to evaluate equity outcomes.

5.4.2 Non-Motorized and Inter-Modal Connectivity

Recommended measures for non-motorized connectivity and safety address the measurement related to bicycle and pedestrian infrastructure, which are not addressed at all in ARC's current performance measures for regional planning and programming. These new measures are necessary to address the PLAN 2040 guiding principle to "Implement cost-effective improvements such as sidewalks, multi-use trails, bicycle lanes and roadway operational upgrades to expand transportation alternatives, improve safety and maximize existing assets."

A 2014 survey of bicyclists in Atlanta revealed that more than 80% of survey respondents, across all levels of comfort with cycling (spanning from "strong and fearless" to "no way, no how") are or would be more likely to cycle to work on routes with bicycle lanes, separated bike paths, and an increased feeling of safety in traffic conditions (Rushing, B., unpublished report, December 10, 2013). Similarly, a 2013 study by graduate students at Georgia Tech found that both walking trips and bus ridership are significantly increased in areas with greater sidewalk coverage; however "there is a critical mismatch between walking demand and walkability" in the city of Atlanta (DiGioia et al. 2013). Therefore infrastructure connectivity for non-motorized

transportation, including condition elements that promote a feeling of safety, are important outcomes that should be addressed through organizational actions.

ARC commissioned an update to its *Atlanta Region Bicycle Transportation and Pedestrian Walkways Plan* (Bike/Ped Plan) in 2007. The strategies outlined in this Bike/Ped Plan update, if implemented, will support PLAN 2040 goals by "creating both a regional scale bicycle network… and a pedestrian network focused around major activity centers" (Sprinkle Consulting 2007). The Bike/Ped Plan analyzed the level of bicycle accommodation across the 18-county ARC planning area, and the level of pedestrian accommodation through a sampling of high-demand areas. (Sprinkle Consulting 2007)

Bicycling analysis in ARC's Bike/Ped Plan identified a "study network of regionally strategic bicycle corridors which serve as links between regionally significant nodes," and evaluated bicycling conditions on this network according to the Bicycle Level of Service Model, Version 2.0 (BLOS). In 2007, existing conditions on the study network included more than 85% of network miles with a BLOS of D, E, or F (Figure 20). Atlanta's distance-weighted BLOS score, according to this analysis, was equivalent to a system-wide grade of E. Furthermore, "the average level of bicycle accommodation of the Atlanta Region's study network is relatively poor" both "[i]n comparison with other major metropolitan areas" and "when gauged against the expectations of local residents." The Bike/Ped Plan research team conducted Community Open House Workshops in October 2006, in which participants were "shown the preliminary results of the Bicycle LOS assessment…, introduced to the factors that contribute to Bicycle LOS… [and] asked what level of bicycle accommodation they felt should be the standard [for] the Region's roadways." The majority of workshop participants identified BLOS of

C as desirable (Figure 21). Final recommendations by the Bike/Ped Plan identify segments of the strategic bicycling network for investment to achieve LOS C, and D, depending on proximity to regional centers.

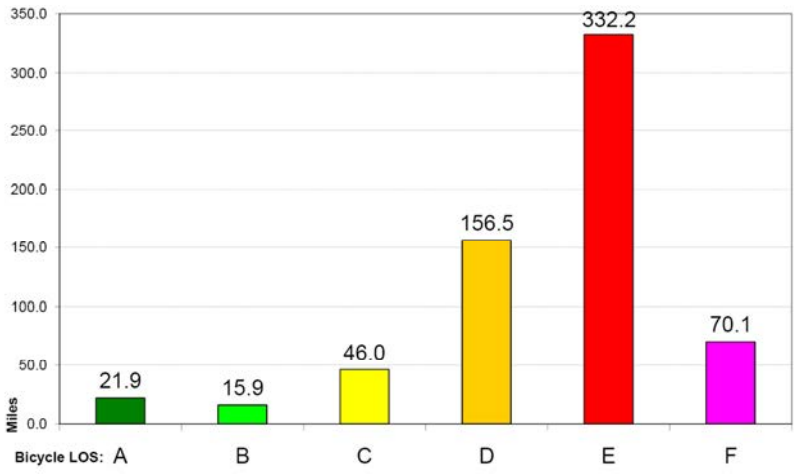


Figure 20: Bicycle LOS results of 2007 Condition Assessment along the Regional Bicycle Study Network from ARC's Atlanta Region Bicycle Transportation and Pedestrian Walkways Plan (Sprinkle Consulting 2007)

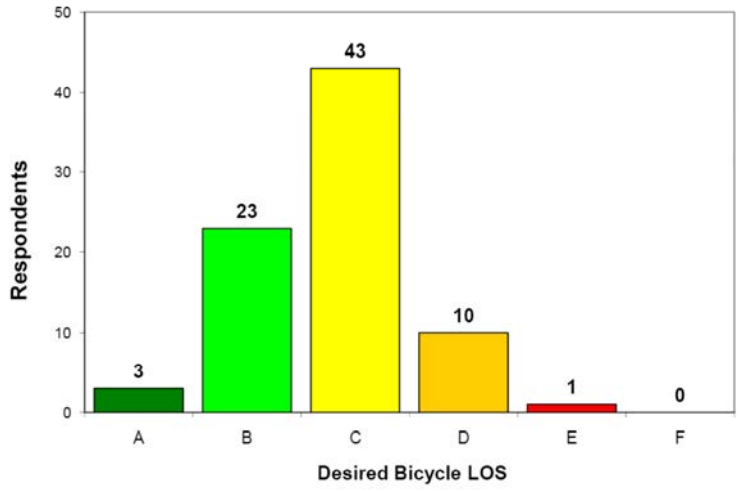


Figure 21: Desired General Bicycle LOS among Atlanta Region Workshop Participants, October 2006 (Sprinkle Consulting 2007)

ARC's updated Bike/Ped Plan studied a subset of roadway segments along the regionally-significant roadways, "selected due to their high potential for pedestrian activity, as indicated by the results of… latent demand analysis." Walking experience on the selected roadway segments was analyzed using the Pedestrian LOS (PLOS) method, which considers "the condition for walking along the roadside, the condition for crossing the roadside at intersections, and the condition for crossing the roadside in areas between intersections." The Bike/Ped Plan report does not summarize PLOS results by distance as it does for BLOS. However, a majority of the segments (approximately 58%) were calculated as having PLOS of D, E, or F; and the analysis qualitatively "confirmed what many residents of the Atlanta Region know intuitively that walking along the Region's roadways, especially the regionally significant roadways… is seldom comfortable and is quite option very challenging." Final recommendations from the Bike/Ped Plan identify the objective of achieving "Pedestrian LOS 'B' within the boundaries of LCI study cites and 'Regional Places' and Pedestrian LOS C along roadways outside these areas."

The recommended performance measures for "percent of RSTS roadway miles" with bicycle and pedestrian facilities meeting their respective LOS standards will allow ARC track the implementation of its Bike/Ped Plan, which supports PLAN 2040 goals. These metrics can be calculated system wide to monitor plan progress in the Regional Scorecard, or they can be calculated along particular corridors or within particular regional centers to help with project evaluation and programming, especially during STP Urban and TAP solicitations. The "bus stops meeting minimum safe pedestrian access standards" similarly supports tracking of the Bike/Ped Plan implementation, which

identifies mid-block crossing condition as a significant safety issue in Atlanta. This metric was recommended by PEDS Atlanta, in its 2014 Report *Safe Routes to Transit: Toolkits for Safe Crossings in Metro Atlanta.* The same report also recommends metrics similar to the two "percent of RSTS" metrics described above (PEDS 2014).

Starting from the current status of asset management practices in Metro Atlanta, it is likely that a significant investment will be needed to collect and maintain the necessary data for calculating the recommended "percent of system" –type connectivity measures. Data inputs for these metrics include infrastructure characteristics, which would be included in a complete asset management inventory, and some operational characteristics for automobile traffic that are already collected on most RSTS roadways. For example PLOS is calculated as a function of the number and width of lanes, shoulder widths, the presence of on-street parking, the presence and width of sidewalks, average traffic volumes, and average speeds. Some of these metrics are included in well-maintained street maps throughout the region. However, although effective asset management has become acknowledged as a core engineering function, and "local agencies… may be legally responsible for inadequate infrastructure maintenance," pedestrian infrastructure is not regularly inventoried in Metro Atlanta (Frackleton et al. 2013). Researchers at Georgia Tech, however, have developed an automated assessment tool "to support the cost-effective collection of data that can be used to assess sidewalk quality" using "an Android-based system that operates in a tablet to automatically generate spatial sidewalk inventories, evaluate sidewalk quality, and prioritize sidewalk repairs" (Frackleton et al. 2013). The cost to conduct regular inventories of pedestrian infrastructure, using this technology, could logically be shared among multiple transportation executors in Metro

Atlanta, depending on facility ownership. Bicycle network data are inventoried more extensively, as indicated by its accessibility at the RidetheCity.com/Atlanta (linked from Atlanta Bicycle Coalition 2014). Bus stop location data is already inventoried by transit providers in the region. Other data needed, such as the location of mid-block crossings, may take additional investments.

The recommendation of a Walk Score® rating metric for identified regional centers and LCIs acknowledges the impact of land use mix and density on walkability. The Walk Score® rating system, accessible at www.walkscore.com, "measures walkability on a scale from 0-100 based on walking routes to destinations such as grocery stores, schools, parks, restaurants, and retail" (Walk Score 2014). A Walk Score® rating of 70 or higher indicates that a particular location is "very walkable" (Walk Score 2014b). Walk Score® rating data was used in a recent study of Walkable Urban Places (WalkUPs) in the Metro Atlanta region by researchers from the George Washington University School of Business (Leinberger 2013). As described by Leinberger (2013):

> *Walk Score measures walkability from the perspective of lifestyle and the concept of "complete communities." It assesses whether the daily needs of residents and workers can be met within a reasonable walking distance or, alternatively, if land uses are spatially segregated, necessitating a car to get around. Notably, Walk Score does not measure the quality of the pedestrian environment. Factors such as pedestrian infrastructure, community design, safety, topography, weather—each of these has a significant influence on the experience of pedestrians and on whether workers and residents will choose to walk, rather than drive. A high quality, successful WalkUP requires both high levels of pedestrian accessibility (what Walk Score measures) and a high quality pedestrian environment (what it does not measure). However, they play different roles in that success. A positive pedestrian experience may encourage those who might other-wise choose not to walk to instead walk. Furthermore, those who prefer the option of walking are likely to be drawn to places where it is more pleasant to travel on foot. However, a place that lacks pedestrian-accessible services and amenities can never be walkable, no matter how much is*

> *invested in pedestrian infrastructure; there is no number of street trees that will encourage residents to walk if they have nowhere to go. It is for this reason that we have chosen to focus on accessibility as a "first principle" of walkability, and the metric used to designate walkable urban places.*

A review of Leinberger's (2013) study, which was unveiled at ARC's State of the Region Breakfast in 2013, reveals that:

- Metro Atlanta has 27 "Established WalkUPs", which have an overall Walk Score rating above 70.5, and account for 19% of the region's jobs; 9 "Emerging WalkUPs" with Walk Scores from 57.0 to 70.5; and 10 "Potential WalkUPs" identified "based on factors… including MARTA rail accessibility, major redeveloping opportunities, the presence of walkability-supportive place management entities, and/or on-going investments in pedestrian infrastructure."
- 20 of the Established WalkUPs are in the City of Atlanta, with 7 Established WalkUPs and 9 Emerging WalkUPs in the suburbs.
- 10 of the 21 Regional Centers identified in ARC's Regional Development Guide correspond with Established WalkUPs; two others correspond with Emerging WalkUPs.

By incorporating the Walk Score® metric into its performance measurement processes, complementing the "percent of network"- type connectivity measures, ARC can capture an important linkage between sociotechnical transportation operations and the wider land use system, an interaction that can generate both social and economic resources. Leinberger (2013) ranks Established WalkUPs according to "two independent performance metrics": economic performance and social equity. The economic performance metric is based on effective rents for office, retail, rental, and for-sale

residential. The social equity metric is a composite index based on: household combined housing and transportation costs, a racial diversity index and income diversity index, share of the population that can access the WalkUP by transit within 45 minutes, and share of the population that can access the WalkUP by car within 20 minutes. Both metrics are ranked in four categories: copper, silver, gold, and platinum. These metrics both address broader QOL and livability outcomes in the socioeconomic situations layer of the SSF, and they are not directly related to the sociotechnical system. While they are therefore inappropriate for transportation project evaluation and day-to-day system management (and therefore are not included in Table 24), these broader metrics could be re-calculated periodically (at an interval longer than a year) for each Regional Center and LCI, included in the Regional Scorecard, and analyzed to show associations with the transportation service quality-oriented metrics recommended in Table 24. This practice could add to the body of evidence that links transportation service quality with broader outcomes, help ARC to track the effectiveness of PLAN 2040, and increase choice intelligence for future planning and programming decisions.

5.4.3 Safety, Mobility, Reliability, and Affordability

The remaining recommended performance measures in Table 24 address service quality elements related to safety, mobility, reliability, and affordability. Most of these recommended measures can be assessed at the system wide level for plan evaluation and monitoring, or on the scale of a project or corridor. One exception is the “number of injuries and fatalities per 100,000 residents” metric. This metric was recommended by the CQGRD (2012) HIA of PLAN 2040, as a supplement to the injury and fatality rates that are normalized by VMT (and also should be segmented by mode). This supplemental

metric only works at the system-level, since traffic injuries and fatalities may appear far from the victims' residents. At the system wide level, "The supplemental metric gives a more accurate picture of the actual risk ratio faced by residents, and supports efforts to reduce injury rates regardless of future increases or decreases in VMT" (CQGRD 2012)." This recommended metric can be easily calculated based on available data.

The other safety metric and one of the mobility metrics require subjective, survey-based data to evaluate. The subjective safety metric would be aggregated from responses to a level-of-agreement question in the form of "I feel safe (or would feel safe) travelling to and from… [work, school, social outings] by… [car as the driver, carpool as a passenger, train, commuter bus, local bus, bicycle, walking]." The subjective mobility metric would be aggregated from responses to a grading or rating question. These metrics allow transportation executors to track customer opinions, inferring customer satisfaction as a measure of the success of implemented interventions, and potentially triggering more detailed analysis. The subjective mobility metric, in particular, can help indicate whether or not the regional transportation system is meeting customer preferences and expectations. Similar data to that needed for both of these metrics has been collected for state-owned roadways in GDOT's 2011 customer opinion survey (Poister et al. 2012), and for ARC's (2014) survey of bicyclists (Rushing, B., unpublished dataset, July 10, 2014) . However, to comprehensively address the goals of PLAN 2040, these metrics must be evaluable for every mode.

Additional analysis can be conducted by comparing the recommended subjective metrics with the other (objective) recommended mobility, reliability, and affordability metrics. For example, if the modal split metric (percent of trips taken by mode for each

trip type) shows heavy dominance in one mode – as it currently does for automobile travel -, that may indicate a deficiency in other modes. The modal split metric was also recommended by CQGRD's HIA (2012).

Recommended reliability metrics are designed to capture the user experience of traveling by roadway and by transit, drawing from the discussions in 4.4 and 4.9. Reliability metrics are currently absent from ARC's performance measurement practices. While reliability is not explicitly mentioned in the PLAN 2040 objectives and guiding principles, it is mentioned in GDOT's SSTP goals, and it is an important aspect of transportation service quality. Buffer time index on Metro Atlanta interstates has been calculated by GRTA modelers in the past, and published in the Metro Atlanta Performance (MAP) Report (Vulov 2010). The methodology used here could be expanded to any roadway for which travel time data is available. MARTA and GRTA each track and report on-time performance, but it is mostly tracked in terms of percent of vehicles (buses or rail cars) only, which is a more supply-oriented than demand-oriented metric. The exception is that MARTA tracks the "percentage of Mobility [paratransit] customer pickups within 30 minutes from scheduled pickup time" (MARTA 2014); however, there is no indication as to whether or not a 30-minute window is acceptable to Mobility customers. For both rail and bus on-time performance, "on time" is defined as 0-5 minutes after the scheduled arrival time (MARTA 2014; Nelson Nygaard, unpublished report, June 2014)[7]. MARTA has implemented automated vehicle location (AVL) and automatic passenger counter (APC) systems (Boyle, 2008; FTA nd), which would allow a recalculated metric to be accurately weighted by passenger trips rather

[7] *Direct Xpress: Georgia Regional Transportation Authority Service Measures and Design Guidelines*

than vehicle trips. GRTA, on the other hand, currently bases on-time performance on spot checking by road supervisors at the point of departure only (Nelson Nygaard, unpublished report, June 2014). With the current methodology, GRTA's on-time performance metric has limited value for both evaluating user experience, and evaluating system performance.

Like the reliability metrics, and the subjective safety and mobility metrics, the recommended affordability metrics in Table 24 are designed to directly address user experience. Furthermore, when segmented by population group, affordability metrics are inherently equity-oriented. As reported in CQGRD's (2012) HIA of PLAN 2040:

> *The time, cost, and feasibility of daily transportation can prevent lower-income households from getting to work or basic daily needs, and contribute to financial or emotional stress for lower income families. Median transportation costs can range from 5% of household income in regions where travel alternatives exist, up to 20% in a car-dependent community. Low income households may spend up to 40% for their transportation. According to Center for Neighborhood Technology's Housing +Transportation Index, transportation costs exceed 15% of household income for the vast majority of residents in the Atlanta region. In the City of Atlanta, transportation is generally 15-25% of household income; transportation costs are 30-35% outside of the City.*

Recommended affordability metrics can be assessed at the system-level, to supplement the already-reported "congestion cost per commuter." Also, they can be assessed at the project or corridor level to identify needs, and equity issues, to be addressed by new investment. Data exists to evaluate these metrics; ARC published average household transportation costs by TAZ in its 2010 Draft PLAN 2040 Regional Assessment (Figure 22), noting that "Households in the Atlanta region spend more on transportation each year than any other metropolitan area." By normalizing the costs by household incomes, decision makers can more effectively track the QOL impact on

different income groups. Normalizing by number of trips allows comparisons with other metrics – such as the costs that agencies spend on providing transportation services (also normalized by trips). This kind of comparison can be useful to indicate the efficiency of agency investments.

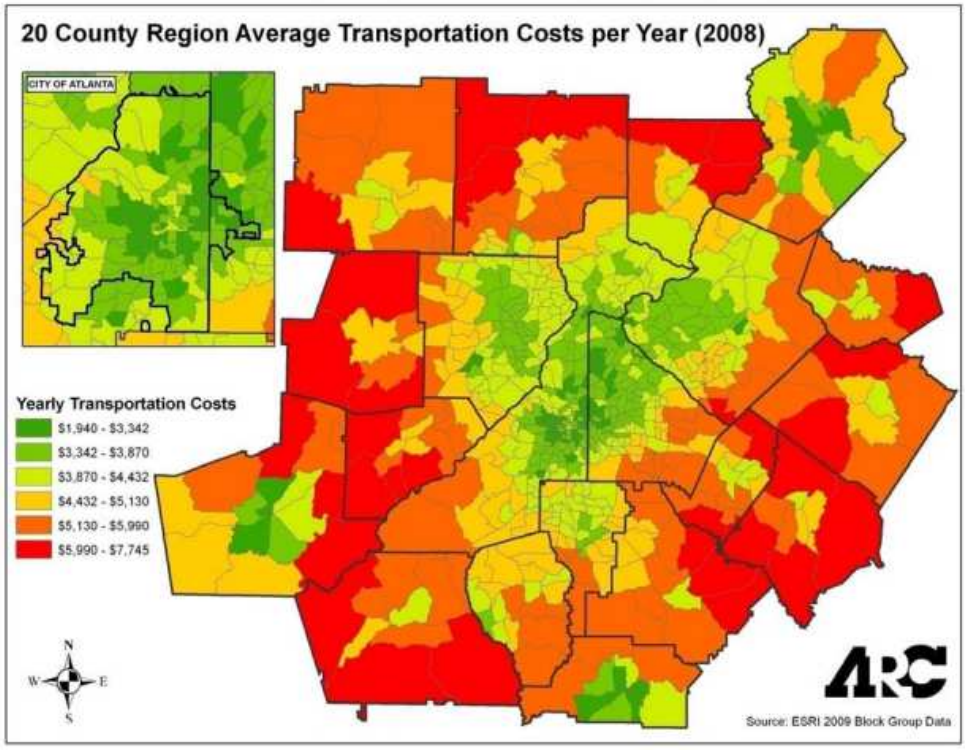


Figure 22: Average annual household transportation costs, 2008 (ARC 2010b)

CHAPTER 6: CLOSING DISCUSSION

6.1 Summary of Findings

This dissertation clarifies the concept of social sustainability, leveraging this clarification in Chapter 2 to define a new conceptual model – the bicycle model – of sustainable development, which draws upon and integrates concepts of resource stewardship, social, economic, and environmental processes, livability, quality of life (QOL), and social equity. Following this, Chapter 3 provides an extensive discussion of performance management as a process of building social sustainability within and among organizations. As described in section 3.5, the social sustainability that is built by implementing performance management principles can enable public agencies to more effectively carry out their charge to promote the well-being of the public, thus promoting social sustainability in a broader sense. This process of generating social resources through organizational influence is further illuminated in Chapter 4 by the introduction of a new conceptual framework for sustainable development – the Stacked Systems Framework (SSF); and by "unpacking" the SSF into multiple "sub-stacks" with social resources flowing between them. In the unpacked SSF illustrated in section 4.1.2, an (inter-)organizational system has the opportunity to use performance management principles to track and improve its social resource outputs and broader sustainability outcomes, which in turn can provide enhanced social capital inputs to the organizational system. This is illustrated in section 4.1.2 for public agency transportation executors, which directly manage the sociotechnical transportation system and indirectly influence broader livability and QOL outcomes; however, the SSF could be similarly unpacked into

sub-stacks related to many other contexts. The remainder of Chapter 4 illustrates the importance of a robust and activated feedback space for performance management; further discusses the effectiveness of organizational systems; tracks the influence of transportation executors through their social resource outputs and outcomes in the sociotechnical transportation system and broader context; and catalogs performance measures relevant to all of these elements of the unpacked SSF. Key findings from this discussion include:

- The concept of an *organizational influence pathway*, which decision makers must identify and use to clearly link agency actions to the desired outcomes that are addressed by strategic goals;
- The concept of *transportation service quality* as a social resource, which is produced by the sociotechnical transportation system and leveraged by broader systems to support livability and QOL;
- The importance of livability and QOL outcomes for generating social capital such as qualified human resources, stakeholder feedback, and political will;
- The necessity of strategic-level management, as well as careful stakeholder involvement and human resource management, to support effective organizational actions; and
- The seminal nature of a customer-orientation for public agencies to effectively promote livability, QOL, and broader social sustainability outcomes.

Chapter 5 introduces a four-phase methodology for applying the SSF to enhance performance management practices in a multi-organizational system, and applies this methodology to a case study of Metro Atlanta. Having identified emerging strengths in

the strategic-level management of Metro Atlanta's transportation executors, as well as gaps in the existing performance measures used for transportation planning and programming, the case study identifies recommended performance measures that can more appropriately link organizational actions to broader QOL and livability outcomes via changes in transportation service quality.

Atlanta's existing performance management strengths include, as of 2013, an increased level of collaboration (a) across working groups within ARC, the region's central planning agency, and (b) among transportation executors including ARC, GDOT, GRTA, and local project sponsors. Collaboration across working groups within ARC has enabled staff to develop a more accessible public engagement tool - the MetroQuest survey – aimed at collecting public feedback that can inform a performance-based, customer-oriented long range regional transportation plan (RTP). Collaboration among ARC, GDOT, and GRTA has clarified the shared motivations of these agencies, enabling a more performance-based approach to emerge for programing the region's short-range transportation improvement program (TIP). One major shared motivation identified among these regional and statewide stakeholders (which is also in line with the federal goals of MAP-21) is to increase project implementation rates, so that the RTP and TIP actually come to fruition in the sociotechnical transportation system. This increased collaboration and consensus (i.e. increased social capital) among regional and statewide transportation executors has enabled these agencies to develop a process of engaging more intensely with project sponsors during TIP development, which is leading to improved implementation rates. In other words, transportation-related social capital is expanding within the socioeconomic situations of metro Atlanta:

- ARC is gaining experience with building social capital internally.
- The wider inter-organizational system including ARC, GDOT, and GRTA has begun to build greater social capital in its structures, processes, and shared motivation.
- The even wider inter-organizational system of regional and state agencies, along with local project sponsors, is strengthening its choice intelligence through performance measurement around shared goals (i.e. plan implementation/project delivery), and gaining experience with successfully identifying and carrying out implementable inter-organizational actions.
- Activation of the broader feedback space, through public engagement, aims to infuse the next RTP update with a better representation of the region's shared priorities, which could lead to increased public support of the plan (i.e. improved political will to support plan implementation).

Considering the currently defined strategic goals and objectives of Atlanta's long range PLAN 2040 RTP, the feedback space currently activated by regional and statewide transportation executors includes several notable gaps. The recommended performance measures provided in 5.4 are externally-oriented, focused on the customer, and tailored toward filling measurement gaps related to non-automobile and multi-modal connectivity, safety, mobility, reliability, and affordability. Some of the recommended supplemental metrics have been previously suggested by external stakeholders such as PEDS and ABC, and university research groups. Some of these other entities, although they are outside the boundary of the inter-organizational system defined for this case study, could support transportation executors as performance measurement champions

through a more formalized inter-organizational structure. Considering the concept of inter-organizational social capital presented in this dissertation, it is likely that bringing external stakeholders into the formal performance management process will increase efficiency and effectiveness of inter-organizational actions over the long term. Likewise, by implementing more customer-oriented performance measures such as those recommended in 5.4, and iteratively improving their suite of performance measures with broader stakeholder feedback, Atlanta's transportation executors will better align their performance management processes with user experience, public needs, and the goals of socially sustainable development.

Beyond Metro Atlanta, the case study of Metro Atlanta crystallizes several observations, which can inform similar processes in other contexts:

- The SSF provides a useful conceptual framework through which to view sustainable development in terms of resource flows among interacting systems and subsystems.
- Applied here to inform transportation performance management by identifying three relevant "sub-stacks," the SSF could also be applied to inform performance management in other fields.
- Applied to transportation the SSF demonstrates that service quality, itself a multidimensional construct, is the mediating element between organizational actions and broader QOL and livability outcomes.
- In an inter-organizational system of transportation executors, it is likely that the various organizational actors have various influence pathways, affecting

various aspects of transportation service quality. Some of these influence pathways interact with each other, whereas some do not.

- An effective set of performance measures will include metrics that can be leveraged in multiple decision-making processes and that can address multiple influence pathways.
- In an organizational system, performance management first manifests in the collaboration (exchange of social resources) across organizational sub-units. This is the value of strategic-level management, which enables more effective organizational actions. The same is true in inter-organizational systems as in individual organizations.
- Internal reporting processes in an organizational system, especially through face-to-face conversations, can enhance both horizontal and vertical integration, thereby increasing understanding and shared vision, leading to more effective and implementable decisions, and increasing social capital.
- Although annual external reporting may be seen as a minimum for customer engagement (and a higher frequency may be needed for internal reporting), not every performance measure should necessarily be re-evaluated in every annual reporting cycle. Rather, enough time should be allowed to implement relevant organizational actions between subsequent evaluations. Metrics only truly address performance if "moving the needle" can be attributed, in part, to organizational actions. Time series can accumulate at 2 or 5 year intervals (for example), as appropriate. However, measurement champions in the organizational system should expect that performance measures will be

evaluated and used on a regular cycle, rather than only once or on occasion. Metrics should only be dropped if they prove to be un-attributable, and the context they provide cannot be used as a valuable input by other attributable metrics.

- By integrating performance measurement and management practices into transportation planning, this process that is already "continuous" can also become more systematic. In this setting, long-range plans and transportation improvement programs are living documents, regularly evolved through performance-based decision making. To effectively integrate transportation planning with performance management, and help ensure that fiscally constrained plans and programs reflect the highest QOL priorities of a region or other context, it is critical that performance information be integrated into every RTP and TIP update.
- Social capital can be increased in the interactions within an organizational system, and across its boundaries. By focusing on the development of social capital in both ways, an organization can become more sustainable over time, and more effectively contribute to broader sustainability.

6.2 Limitations

The cycle of social resource development described through the three transportation-related sub-stacks of the unpacked SSF is marked by:

- An iterative process involving the accumulation of evidence through the feedback space;

- The development of choice intelligence that leads to better, more effective organizational actions;
- A process that, over time, leads to enhanced livability and QOL outcomes for the public, who are the customers of public agencies; and therefore
- A cycle of sustainable development touching every layer of the SSF.

The scope of the case study presented in Chapter 5 includes an initial analysis that may spur and help build momentum for this cycle in the Metro Atlanta Region. In particular, the four-phase methodology defined in section 5.1 was only completed through Phase III, leaving off with recommended performance measures to be tested in Phase IV. There is no perfect performance measure, and this dissertation does not posit to have found the absolute "best" set of performance measures for transportation performance management in Metro Atlanta. Moreover, inter-organizational choice intelligence can only be developed through the participation of all relevant stakeholders in a structured process of consultation and collaboration that builds consensus over time. To see lasting results, the cyclical process defined in this dissertation will need to be continued by Metro Atlanta's transportation executors through in-depth metrics testing, periodic re-evaluations of inter-organizational influence, and gap analyses in order to better and better address the region's strategic livability and QOL priorities.

An existing limitation of the four-phase methodology for applying the SSF (defined in section 5.1) is its exploratory nature. The methodology's guiding questions are not prescriptive; they do not, for example, prescribe how to define the inter-organizational system for analysis. This is one reason that the four-phase methodology is

intended to be iterative; the value of each phase will be increased in each iteration, as decision makers build choice intelligence through reflection and adjustment.

Due to its limited scope, the case study presented in Chapter 5 defined the inter-organizational system for analysis as including only those public agencies that have direct ownership or responsibility for the Atlanta region's sociotechnical transportation system. However, as illustrated in section 5.2 (Figure 13), many other entities do have strong influence on these agencies' motivations, operations, and organizational influence. This is particularly true for the state Governor, USDOT's modal agencies, the federal EPA and Georgia DNR, in terms of oversight influence. It is also true for advocacy groups and industry groups (for example, the Atlanta Bicycle Coalition, Metro Atlanta Chamber of Commerce, and freight industry representatives), which partially mediate political will in the region, and which collect data that may be leveraged in a broader feedback space. Moreover, this case study conducted an in-depth examination of only the influence pathways related to regional transportation planning and programming, focusing on the role of ARC as the central planning agency. Considering the diverse influence pathways of Atlanta's transportation executors and their external stakeholders (introduced in section 5.2), which operate at multiple geographic scales, additional influence pathways may be better examined by defining the inter-organizational system for analysis in another configuration, with more or fewer organizations within the defined system boundary. The exploratory nature of this case study, as only the first iteration of the four-phase methodology, is limited in that it does not completely incorporate the constraints imposed by political influence and preferences across spatial scales.

6.3 Future Work

6.3.1 Metro Atlanta

Following the completion of this dissertation, the author is transitioning into a full-time role within metro Atlanta's inter-organizational system of transportation executors. This role, defined as the Senior Performance Analyst at GRTA, will entail, at minimum:

- Advancing the performance-orientation of GRTA and ARC's agreed-upon TIP development process;
- Supporting annual performance reporting by GDOT's Director of Planning, relevant to the SSTP; and
- Enhancing GRTA's internal performance management processes, in line with the agency's strategic plan.

The author has already begun contributing to some of these efforts while working on behalf of Georgia Tech. For example, supported by the STRIDE technology exchange project for FHWA's Community Vision Metrics tool, the author of this dissertation facilitated a workshop on livability-oriented performance management at ARC on July 29, 2014. This workshop also included participants from two neighboring MPOs, Gainesville-Hall County and Cartersville-Bartow County, which are each at earlier stages than ARC in the development of performance-based transportation plans (Lane et al., unpublished report), as well as ARC staff and GDOT staff. During this workshop, participants discussed the successes and challenges they have faced regarding performance measurement along their influence pathways, and they identified some performance metrics for additional testing. It is expected that the author's new full-time

role at GRTA will allow for continued, iterative application of the four-phase methodology defined in Chapter 5, in a context of increasing inter-organizational consultation and collaboration within Metro Atlanta, and potentially in partnership with other MPOs within Georgia.

To further support the evolution of transportation performance management in the Metro Atlanta region, additional research is needed. Most immediately, complete metric testing is necessary for the supplemental performance measures recommended in section 5.4. Complementary to the metric testing methodology defined in 5.1.4, which must be completed by Atlanta's transportation executors in order for them to adopt of any of the recommended performance measures, additional research is also needed through longitudinal studies to verify the extent to which adopted and other recommended performance metrics do in fact link organizational actions to desired livability and QOL outcomes. The results of these longitudinal studies will be valuable for future iterations of applying the four-phase SSF methodology.

In future iterations of the four-phase SSF methodology, organizational influence profiles should more explicitly consider the sustainability of larger organizational systems, defined in different ways at the regional scale, in terms of the constraints and opportunities imposed by smaller organizational systems, which operate primarily at the local scale. Such analysis may include the development of organizational influence profiles for local governments and other local-level entities; and it may include separate profiles focusing on different influence pathways, segmented for example by transportation mode, facility, corridor, or specific QOL outcome. In this way, the organizational influence profile may become a tool for identifying gaps, or missing links,

in the influence pathways needed to translate organizational actions into broader outcomes. Concurrent with finding new data with which to measure these influence pathways, transportation executors will may also need to find new partners, or otherwise adjust their own performance management process to identify new actions that fill the identified gaps in influence pathways.

6.3.2 Other Contexts and Regions

Beyond Metro Atlanta, there will be value in applying the four-phase SSF methodology to transportation performance management in other contexts and regions. Two documents were under development at the time of this dissertation, which begin to do exactly that: a paper comparing the strategic-level management of Atlanta's inter-organizational system with other regions within Georgia (Fischer, Smith-Colin and Kennedy, unpublished paper, submitted to Transportation Research Board), and a report to the STRIDE consortium sharing the results of five technology exchange workshops around the southeastern U.S., including those facilitated by the author of this dissertation in Atlanta and Fort Lauderdale, FL (Lane et al., unpublished report).

Future application of the four-phase SSF methodology to other regions would appropriately include workshops such as those sponsored by the STRIDE technology exchange project. These workshops provide a carefully prepared, structured context in which participants (within a single organization or representing multiple) can explicitly identify shared motivations and goals, interacting or overlapping influence pathways, and potential performance measures to help link organizational actions to desired outcomes along their influence pathways.

6.3.3 Cumulative Evidence

Performance management is an iterative process. The four-phase SSF methodology is likewise intended to be iterative for any given context. As this methodology is applied in multiple contexts, at multiple scales, and if these applications are well-documented, greater choice intelligence and a broad evidence base may be generated for a variety of effective interventions in transportation performance management. Therefore, there is a research need for collecting, tracking, and synthesizing the cumulative experience of applying this methodology through the collection and regular analysis of case studies. A similar need is identified by Smith-Colin et al. (In Press) for the related practice of transportation asset management (TAM), with the recommendation to construct an evidence-based database for collecting and evaluating case studies. A similar database might be constructed for SSF applications. Over time, this accumulated evidence base would at least provide transportation executors with ideas for effective strategic-level management, performance measurement, performance-based decision making, and performance reporting, spurring a more rapid evolution of performance management practices in transportation. Also, reviews of accumulated evidence may clarify some of the remaining ambiguities in the four-phase SSF methodology. In particular, the challenge with defining the right domain and boundary for an inter-organizational system, considering the constraints and opportunities imposed by stakeholders who operate at multiple scales, may be alleviated more quickly by the accumulation of experience in broad variety of contexts.

6.4 Broader Significance

The primary contribution of this dissertation is the development of a new conceptual framework - the stacked systems framework (SSF) - and a four-phase methodology for unpacking and applying it to enhance transportation performance management in an inter-jurisdictional context. The SSF represents a new conceptual link between two developing fields of research: socially sustainable transportation systems and transportation performance management. To fully develop the SSF, this research clarifies and characterizes relationships among the challenging concepts of social sustainability, livability, quality of life, performance management, and soft-systems analysis. To fully express the value of the SSF, this research also catalogs a wide range of performance measures and management strategies that can be used by public-sector transportation agencies to influence transportation-related QOL outcomes in their jurisdictions. Through the case study of the transportation performance management practices in Metro Atlanta, this dissertation demonstrates the value of the SSF in a real-world context, and the case study itself helps to clarify the broader significance of the framework.

As described in section 6.3, this dissertation research will lead to broader impacts as the unpacked SSF methodology is iteratively applied to transportation performance management in Metro Atlanta (a process that can be facilitated through the author's new professional role at GRTA), and in other regions and contexts (especially through facilitated workshops and with accumulated experience supported by an evidence-based database). Also, many of the conceptual clarifications offered by this dissertation research may be leveraged in educational settings related to transportation engineering,

urban planning, organizational management, and public policy. These conceptual contributions include:

- The bicycle model for sustainable development;
- The cycle of performance management for public agencies;
- The stacked-systems framework (SSF) in general, applicable to other fields beyond transportation;
- The concept of "service quality" as a social resource within a larger cycle of socially sustainable development in the unpacked SSF; and
- The review of performance metrics for socially sustainable transportation systems.

In summary, the results of this research can be immediately applied in public-sector transportation agencies to enhance their QOL-, livability-, and sustainability-oriented performance management practices; it may also be used to enhance concepts of performance management in other fields; and it may be leveraged in educational settings to better prepare professionals in a variety of fields to enhance the outcomes of their organizational actions. These substantial impacts can be enhanced by future research and publication, deepening understanding for a broadening audience.

APPENDIX A

Organizational Performance Management Interactive Self-Diagnostic Tool

Reproduced from the GDOT OPM Study (Kennedy et al. In Press)

The following sections provide a complete view of the Interactive Self-Diagnostic Tool developed for this study. The screenshots shown in Figures 24-35 include information about a fictional agency: Example Department of Transportation (EDOT).

Cover Page

Screenshots from the cover page of the Interactive Self-Diagnostic Tool are provided in Figures 23 and 24.

Best Practices in Organizational Performance for Transportation Applications:
Performance Management Diagnostic Tool*

Developed for: Georgia Department of Transportation
Developed by: Georgia Institute of Technology, Infrastructure Research Group

"Performance Management" is a business practice that allows an agency to track, maintain, and when necessary adjust progress towards achieving its important goals and objectives.
This in-depth diagnostic tool is designed to achieve two purposes:

1) Benchmark performance management practices in one agency against best practices in the field
2) Identify potential actions for enhancing the assessed agency's performance management program

This workbook contains 6 spreadsheet pages for the user, as follows:

Sheet	Function
1. Cover Page	Familiarizes users with the purpose of the tool and workbook organization
2. Input A: Agency Context	Accepts information about the agency's functional units, goals and objectives, and stakeholders
3. Input B: Performance Measurement	Accepts information about the agency's suite of performance measures and targets
4. Input C: Performance Review and Decision Making	Accepts information about how different parts of the agency use and interact with performancemeasurement information
5. Input D: Performance Reporting & Feedback	Accepts information about the agency's performance reporting tools and processes
6. Model Results	Characterizes the maturity of the agency's performance management program and identifies potential areas for enhancement

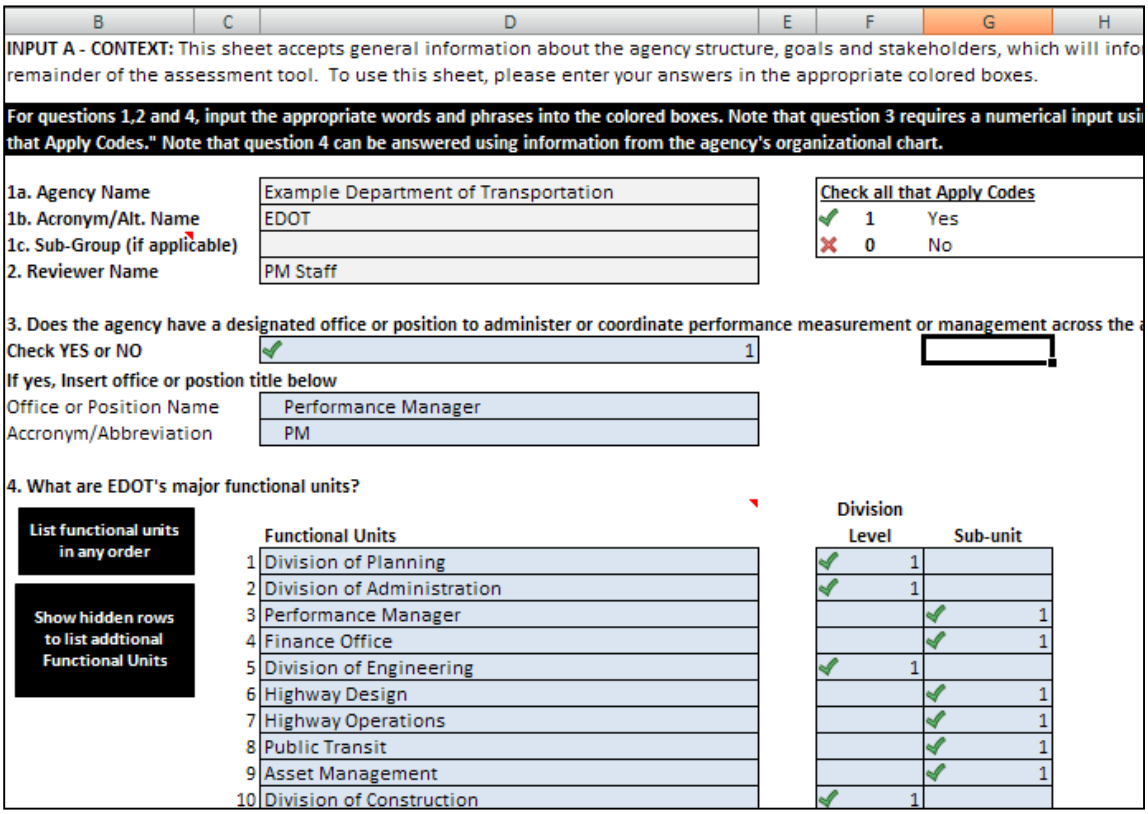
NOTE: Cells with a red flag in the corner such as this one can be scrolled over to reveal more information.

Figure 23: Screenshot of the Cover Page for the Interactive Self-Diagnostic Tool

The cover page familiarizes readers with the purpose of the interactive tool, its organization, and how it operates. Users do not interact with the cover page except to read it and to observe that a comment box appears when the mouse is used to scroll over red flags.

User Input A: Agency Context

The first input sheet accepts general information about the agency structure, goals and stakeholders, which informs the remainder of the diagnostic tool. Most information for this sheet may be gathered from the agency's organizational chart and published strategic planning documents. In this sheet, the user defines the level of depth and detail for the assessment. For example, organizational structure may be defined at the "division" or "bureau" level, or it may list sub-units at the "office" level. Alternatively, the assessment may be conducted for only one division of the agency, in which case it would necessarily include major "offices" or other sub-units of that division. Other contextual information gathered in this sheet includes strategic goals (and potentially objectives) of the agency, and the agency's key external stakeholders. Partial screenshots from Input A are provided in Figures 24, 25 and 26.



INPUT A - CONTEXT: This sheet accepts general information about the agency structure, goals and stakeholders, which will info
remainder of the assessment tool. To use this sheet, please enter your answers in the appropriate colored boxes.

**For questions 1,2 and 4, input the appropriate words and phrases into the colored boxes. Note that question 3 requires a numerical input usi
that Apply Codes." Note that question 4 can be answered using information from the agency's organizational chart.**

1a. Agency Name	Example Department of Transportation
1b. Acronym/Alt. Name	EDOT
1c. Sub-Group (if applicable)	
2. Reviewer Name	PM Staff

Check all that Apply Codes		
✓	1	Yes
✗	0	No

3. Does the agency have a designated office or position to administer or coordinate performance measurement or management across the a

Check YES or NO	✓ 1
If yes, Insert office or postion title below	
Office or Position Name	Performance Manager
Accronym/Abbreviation	PM

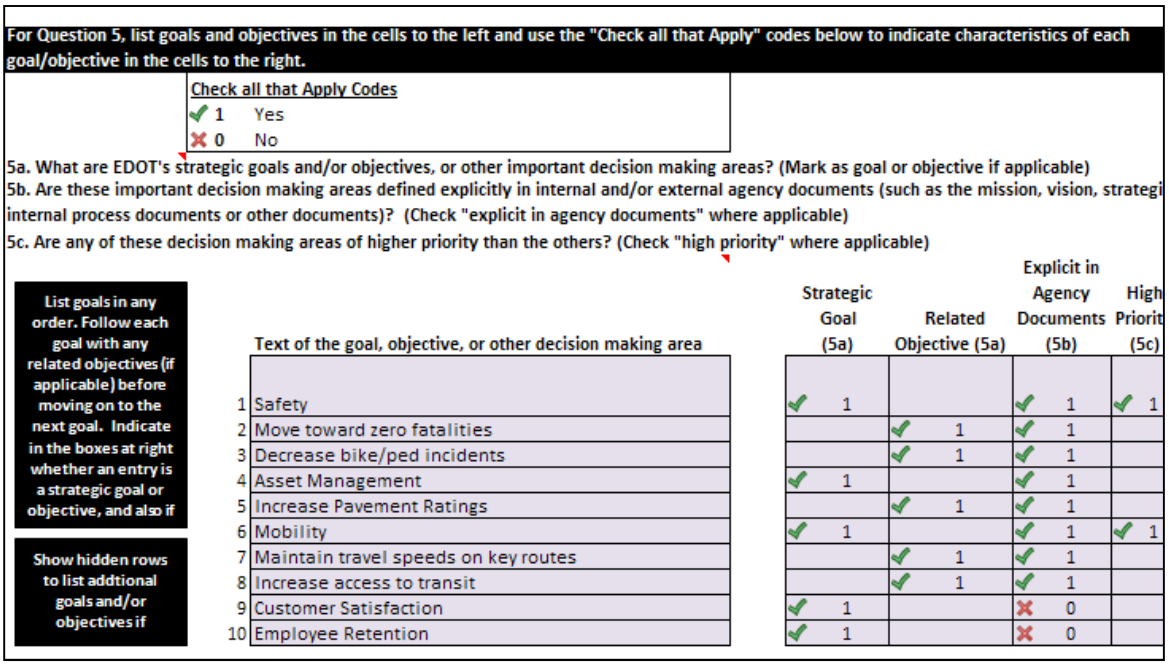
4. What are EDOT's major functional units?

List functional units in any order

Show hidden rows to list addtional Functional Units

	Functional Units	Division Level	Sub-unit
1	Division of Planning	✓ 1	
2	Division of Administration	✓ 1	
3	Performance Manager		✓ 1
4	Finance Office		✓ 1
5	Division of Engineering	✓ 1	
6	Highway Design		✓ 1
7	Highway Operations		✓ 1
8	Public Transit		✓ 1
9	Asset Management		✓ 1
10	Division of Construction	✓ 1	

Figure 24: Questions 1-4 on Input A: Agency Context



For Question 5, list goals and objectives in the cells to the left and use the "Check all that Apply" codes below to indicate characteristics of each goal/objective in the cells to the right.

Check all that Apply Codes		
✓	1	Yes
✗	0	No

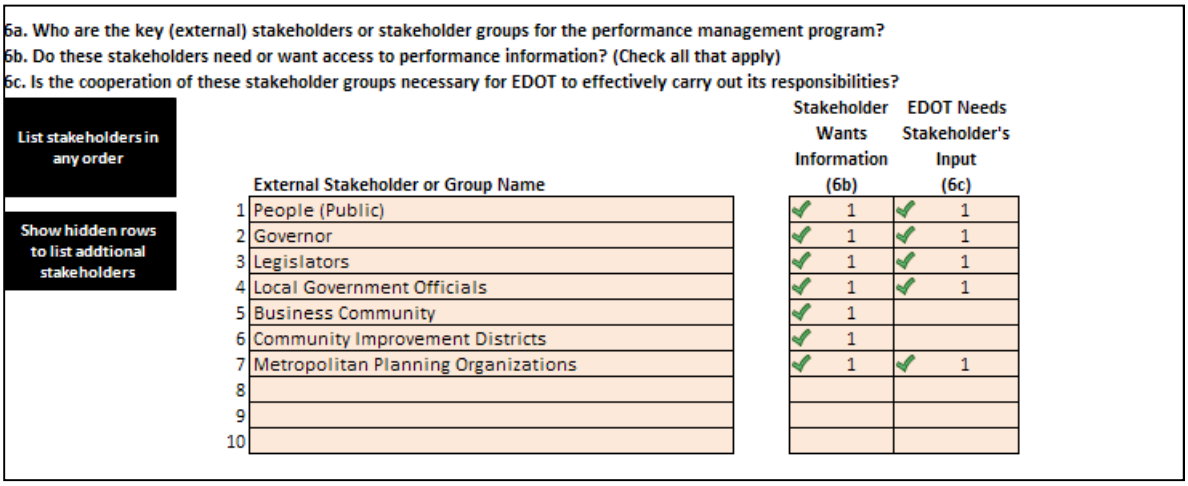
5a. What are EDOT's strategic goals and/or objectives, or other important decision making areas? (Mark as goal or objective if applicable)
5b. Are these important decision making areas defined explicitly in internal and/or external agency documents (such as the mission, vision, strategi
internal process documents or other documents)? (Check "explicit in agency documents" where applicable)
5c. Are any of these decision making areas of higher priority than the others? (Check "high priority" where applicable)

List goals in any order. Follow each goal with any related objectives (if applicable) before moving on to the next goal. Indicate in the boxes at right whether an entry is a strategic goal or objective, and also if

Show hidden rows to list addtional goals and/or objectives if

	Text of the goal, objective, or other decision making area	Strategic Goal (5a)	Related Objective (5a)	Explicit in Agency Documents (5b)	High Priorit (5c)
1	Safety	✓ 1		✓ 1	✓ 1
2	Move toward zero fatalities		✓ 1	✓ 1	
3	Decrease bike/ped incidents		✓ 1	✓ 1	
4	Asset Management	✓ 1		✓ 1	
5	Increase Pavement Ratings		✓ 1	✓ 1	
6	Mobility	✓ 1		✓ 1	✓ 1
7	Maintain travel speeds on key routes		✓ 1	✓ 1	
8	Increase access to transit		✓ 1	✓ 1	
9	Customer Satisfaction	✓ 1		✗ 0	
10	Employee Retention	✓ 1		✗ 0	

Figure 25: Question 5(a-c) on Input A: Agency Context


6a. Who are the key (external) stakeholders or stakeholder groups for the performance management program?
6b. Do these stakeholders need or want access to performance information? (Check all that apply)
6c. Is the cooperation of these stakeholder groups necessary for EDOT to effectively carry out its responsibilities?

List stakeholders in any order

Show hidden rows to list addtional stakeholders

	External Stakeholder or Group Name	Stakeholder Wants Information (6b)	EDOT Needs Stakeholder's Input (6c)
1	People (Public)	✓ 1	✓ 1
2	Governor	✓ 1	✓ 1
3	Legislators	✓ 1	✓ 1
4	Local Government Officials	✓ 1	✓ 1
5	Business Community	✓ 1	
6	Community Improvement Districts	✓ 1	
7	Metropolitan Planning Organizations	✓ 1	✓ 1
8			
9			
10			

Figure 26: Question 6(a-c) on Input A: Agency Context

Once the agency context is set in Input A, the following three worksheets ask detailed questions about performance measures and targets and organizational processes. The questions in Inputs B-D relate to the characteristics of performance management indicated in the maturity model developed for this study.

User Input B: Performance Measurement

Using a series of yes-or-no questions, the second input sheet accepts information about how the organization's performance measures and targets address "important areas of decision making," including the agency's strategic goals and objectives, and any other areas that the user specifies. The sheet also asks about whether strategic goals, objectives, and performance targets reflect the priorities and preferences of key stakeholder groups. For Input B, answers are given with numerical answer codes shown in Figure 27. Screenshots from Input B are shown in Figures 28 and 29.

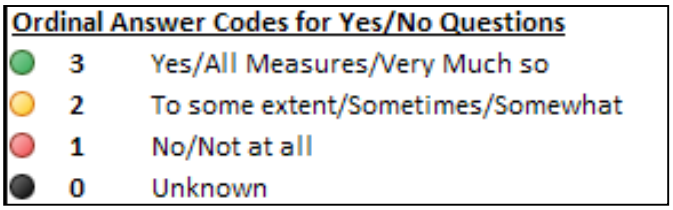
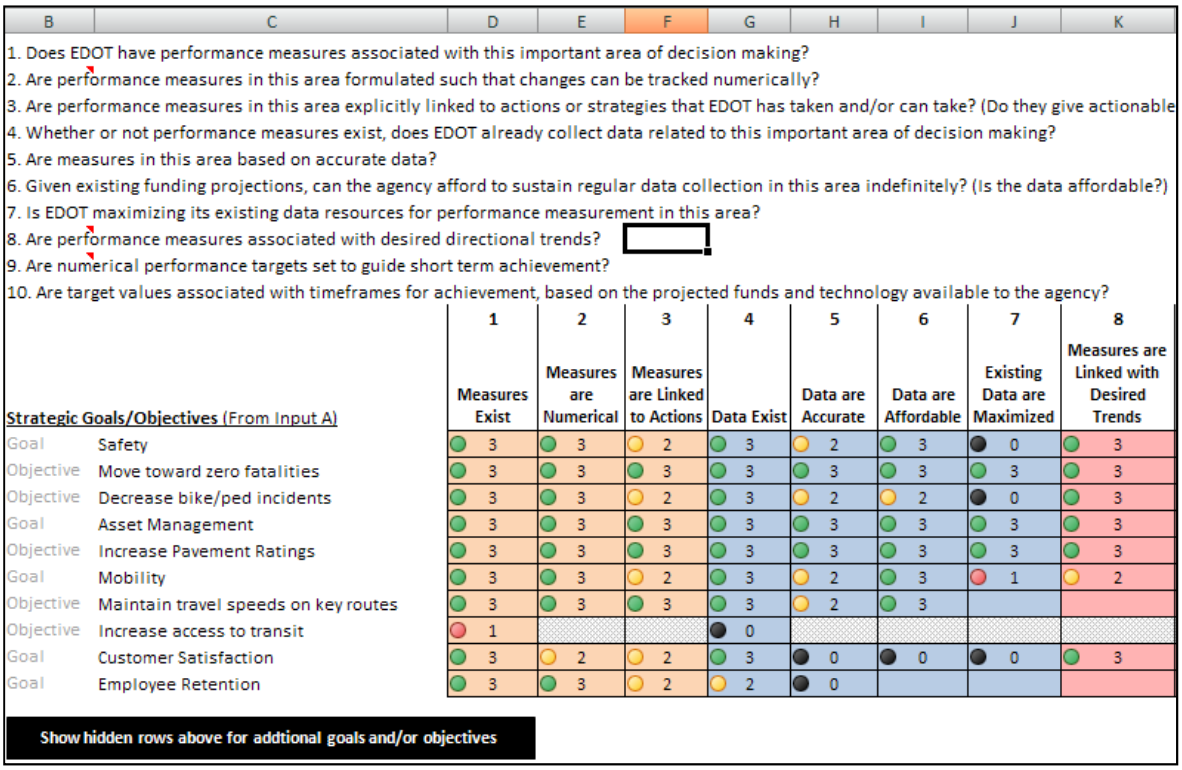


Figure 27: Ordinal answer codes used in the Interactive Self-Diagnostic Tool

In Input B, questions 1-10 ask about the suite of performance measures and targets that are associated with each area of decision making. The color coding of the input table for these ten questions (shown in Figure 28) is sensitive to a user's answers. For instance, the user from Example DOT (EDOT) has entered a "no" value in cell D29, indicating that the agency does not have performance measures associated with its "Increase access to transit" objective (part of the Mobility goal area). Once the "no" value was entered, all other input cells in row 29 were grayed-out, with the exception of G29. This change in color coding indicated to the user that only question 4 remained to be answered for that objective. As another example of sensitive color coding, the column of cells that accept answers for question 10 does not become activated unless a "somewhat" or "yes" value is input for question 9.



1. Does EDOT have performance measures associated with this important area of decision making?
2. Are performance measures in this area formulated such that changes can be tracked numerically?
3. Are performance measures in this area explicitly linked to actions or strategies that EDOT has taken and/or can take? (Do they give actionable
4. Whether or not performance measures exist, does EDOT already collect data related to this important area of decision making?
5. Are measures in this area based on accurate data?
6. Given existing funding projections, can the agency afford to sustain regular data collection in this area indefinitely? (Is the data affordable?)
7. Is EDOT maximizing its existing data resources for performance measurement in this area?
8. Are performance measures associated with desired directional trends?
9. Are numerical performance targets set to guide short term achievement?
10. Are target values associated with timeframes for achievement, based on the projected funds and technology available to the agency?

Strategic Goals/Objectives (From Input A)		1 Measures Exist	2 Measures are Numerical	3 Measures are Linked to Actions	4 Data Exist	5 Data are Accurate	6 Data are Affordable	7 Existing Data are Maximized	8 Measures are Linked with Desired Trends
Goal	Safety	3	3	2	3	2	3	0	3
Objective	Move toward zero fatalities	3	3	3	3	3	3	3	3
Objective	Decrease bike/ped incidents	3	3	2	3	2	2	0	3
Goal	Asset Management	3	3	3	3	3	3	3	3
Objective	Increase Pavement Ratings	3	3	3	3	3	3	3	3
Goal	Mobility	3	3	2	3	2	3	1	2
Objective	Maintain travel speeds on key routes	3	3	3	3	2	3		
Objective	Increase access to transit	1			0				
Goal	Customer Satisfaction	3	2	2	3	0	0	0	3
Goal	Employee Retention	3	3	2	2	0			

Show hidden rows above for addtional goals and/or objectives

Figure 28: Questions 1-10 and the associated input table (partially filled in) from Input B: Performance Measurement

Following question 10, Input B includes two more questions. Question 11 asks whether or not the agency uses additional performance measures that are not associated with the strategic goals and objectives addressed in questions 1-10. If the answer to question 11 is "yes," then a message appears, as follows:

> *"If these measures are associated with additional decision-making areas that are very important to EDOT, then consider adding the other areas to the list on Input A so that you can answer questions 1-10."*

Then, question 12 asks, "To what extent do EDOT's stated goals and objectives, desired trends and targets reflect the needs and priorities of each stakeholder group. Users input their answers to question12 in the table shown in Figure 29.

	Key Stakeholders	Goals and Objectives	Desired Trends and Targets
	Internal EDOT Decision Makers	3	3
	EDOT Technical Staff	3	3
1	People (Public)	3	0
2	Governor	3	0
3	Legislators	3	0
4	Local Government Officials	3	0
5	Business Community	3	0
6	Community Improvement Districts	3	0
7	Metropolitan Planning Organizations	3	0

Figure 29: Input table for Question 12 of Input B: Performance Measurement

User Input C: Review and Decision Making

Using a series of "check-all-that-apply" and yes-or-no questions, the third input sheet accepts information about how the organization and its functional units define and revise performance management structures and procedures, and how they use performance information. Screenshots from Input C are shown in Figures 30 -32.

INPUT C - ORGANIZATIONAL PROCESSES: This sheet includes questions about agency procedures and inputs related to performance manageme information within the agency, how often it is reviewed, what the information is used for, and how performance-based decision making is i decision making and functional units within the agency structure. Input answer codes to each question in the associated colored boxes.

Organizational Structure, Policies and Procedures: Answer Questions 1-5 using the "Check All that Apply" Codes.

1. How often, on average, are EDOT's strategic goals/objectives, related performance measures, and targets, reviewed for potential revision?

	Goals and Objectives	Performance Measures	Performance Targets
With the Strategic Plan Update			
Annually	✓ 1		
Quarterly			
Another frequency (describe)		✓ 1	✓ 1
They have never been revised			

Check ✓ ✗

Describe →

Describe other frequency below (i

On a rolling basis, with 2 meas examined each month

Figure 30: Screenshot of Input C showing Question 1 and related answer cells

2a. To what extent are EDOT's performance management procedures defined externally?

2b. Which elements or inputs of are defined externally? (If applic

	Complete External Control	Considerable External Influence	Minor External Influence	EDOT is Autonomous
Check all that apply		✓ 1		

Long-range Planning/ Visioning	Project Selection or Programming	Bu H Re
✓ 1	✓ 1	✓

Make sure that all external entities that influence EDOT's performance management procedures are listed as external stakeholders on Input A: Agency Context.

3. What processes support EDOT to revise its performance management structure and procedures, as needed, in order to address new contexts or needs?

	Periodic Review by PM	Periodic Surveys of Staff	Occasional Suggestions	Another Process	No Process Exists	(Describe other pr
Check all that apply	✓ 1	✓ 1				

4. (Vertical Integration) How does EDOT ensure that performance information and relevant decisions are shared in a timely and effective fashion across i

	Regular in-person meetings	Regular internal reports	Shared Database(s) or Dashboards	Another Process	No Process Exists	(Describe other pr
Check all that apply	✓ 1	✓ 1				

5. (Horizontal Integration) How does EDOT ensure that performance information is shared, as necessary, across and among its functional units?

	Regular in-person meetings	Regular internal reports	Shared Database(s)	Another Process	No Process Exists	(Describe other pr
Check all that apply	✓ 1	✓ 1	✓ 1			

Figure 31: Screenshot of Input C showing questions 2-5 and the associated answer cells

Performance-Related Responsibilities and Outcomes: Answer questions 5-14 below for each of the given groups (locations within the organiza by using the "Answer Codes for Yes/No Questions." Note that questions 11 and 14 may be answered with alternative codes (see pop-ups).

6. Does the staff in this group understand and value the concept of performance management?
7. Does this group help define EDOT's strategic goals and/or objectives?
8. Does this group help define performance measures and/or targets that are tracked by PM and reported to external stakeholders?
9. Does this group define performance measures and/or targets that are for internal use only (that is, NOT tracked by PM or reported to externa
10. Does this group collect data inputs for performance measurement?
11. Does this group perform analysis using performance information?
12. Does this group use performance information to make decisions on a regular basis?
13. Does this group require information from any of EDOT's other groups in order to perform its functions?
14. In this group, is up-to-date performance information readily available to those who need it, when they need it?
15. Overall, or on average, has this group demonstrated desirable performance outcomes over the last 1 to 3 years?

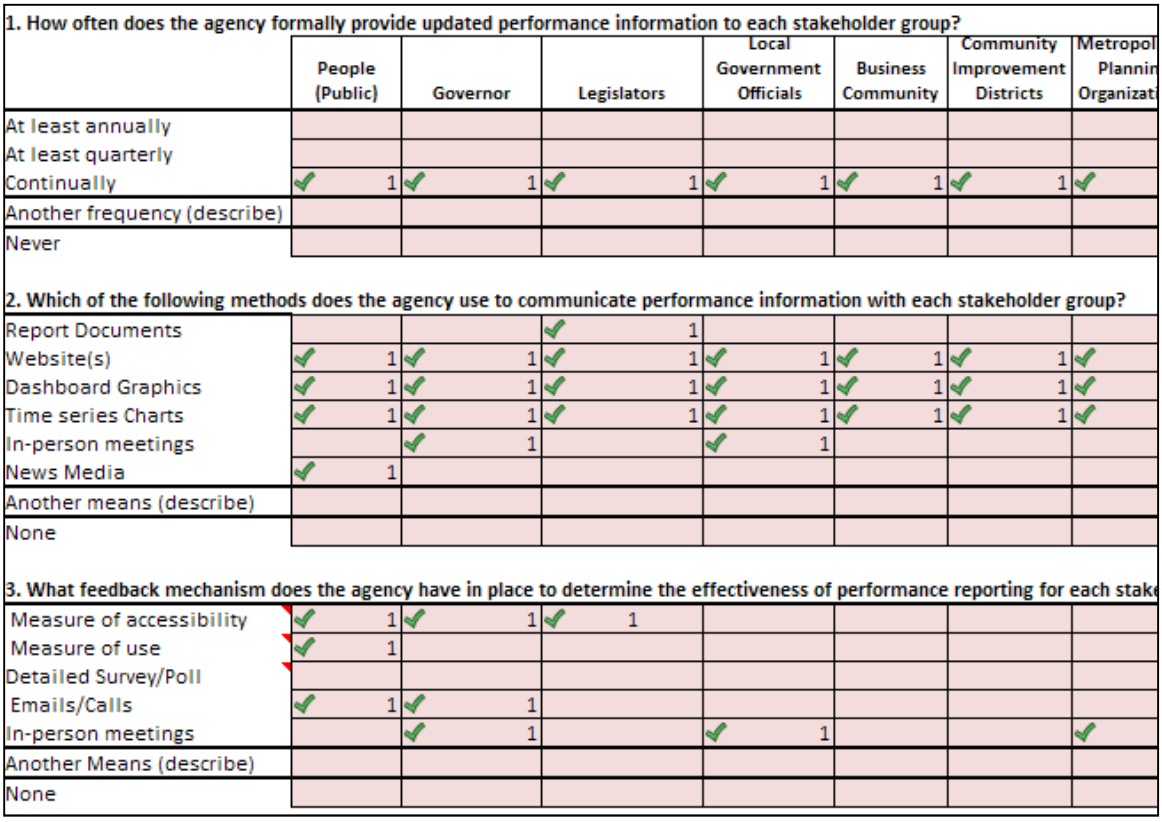
Numerical Answer	
3	Yes
2	Some
1	No/No
0	Unkno

Functional Unit or other group within Agency	6 Values Performance Management	7 Helps to Define Strategic Goals/Objectives	8 Defines Externally-Reported Measures and Targets	9 Defines Measures and Targets for Internal-Only Use	10 Collects Data	11 Performs Analysis	Re M Perfo b Dec
Top Management	3	3	3	1	1	1	
Mid-level Management	3	2	2	2	2	2	
"Front-Lines" Employees	2	2	2	2	3	3	
Division of Planning	3	3	1	3	2	3	
Division of Administration	3	3	2	0	2	0	
Performance Manager	3	3	2	3	2	3	

Figure 32: Screenshot of Input C showing questions 6-15 and the associated answer cells

User Input D: Reporting and Feedback

Using a series of "check-all-that-apply" and yes-or-no questions, this sheet accepts information about how the organization reports to external stakeholders. Screenshots are shown in Figures 33 and 34

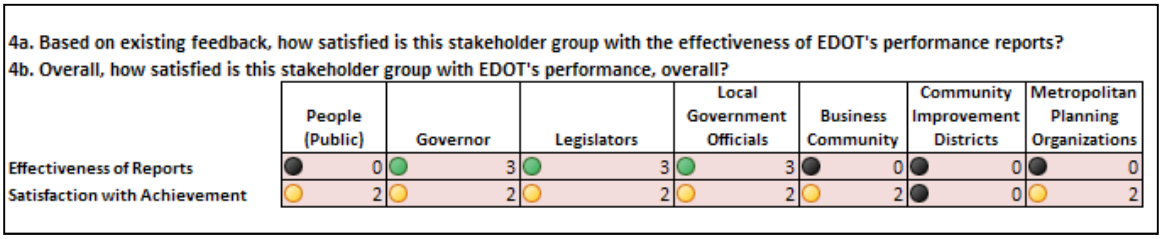


1. How often does the agency formally provide updated performance information to each stakeholder group?	People (Public)	Governor	Legislators	Local Government Officials	Business Community	Community Improvement Districts	Metropol Plannin Organizati
At least annually							
At least quarterly							
Continually	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓
Another frequency (describe)							
Never							

2. Which of the following methods does the agency use to communicate performance information with each stakeholder group?							
Report Documents			✓ 1				
Website(s)	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓
Dashboard Graphics	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓
Time series Charts	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓ 1	✓
In-person meetings		✓ 1		✓ 1			
News Media	✓ 1						
Another means (describe)							
None							

3. What feedback mechanism does the agency have in place to determine the effectiveness of performance reporting for each stake							
Measure of accessibility	✓ 1	✓ 1	✓ 1				
Measure of use	✓ 1						
Detailed Survey/Poll							
Emails/Calls	✓ 1	✓ 1					
In-person meetings		✓ 1		✓ 1			✓
Another Means (describe)							
None							

Figure 33: Screenshot of Input D showing questions 1-3 and the associated answer cells



4a. Based on existing feedback, how satisfied is this stakeholder group with the effectiveness of EDOT's performance reports?
4b. Overall, how satisfied is this stakeholder group with EDOT's performance, overall?

	People (Public)	Governor	Legislators	Local Government Officials	Business Community	Community Improvement Districts	Metropolitan Planning Organizations
Effectiveness of Reports	0	3	3	3	0	0	0
Satisfaction with Achievement	2	2	2	2	2	0	2

Figure 34: Screenshot of Input D showing question 4 (a and b)

Diagnostic Report

This Interactive Self-Diagnostic Tool was developed as part of a larger project, which identified leading practices in transportation performance management. The larger project included an extensive literature review, eighteen in-depth case studies of State DOTs, and two expert panel discussions. The Interactive Self-Diagnostic Tool uses the findings of the larger project to inform recommendations in its Diagnostic Report.

The Diagnostic Report characterizes the subject agency's performance management program based on the information entered into User Inputs A-D. Furthermore, it uses the entered data to identify opportunities for enhancing the agency's performance management practices, and it makes recommendations for enhancement.

Existing conditions are characterized, and recommendations offered, in five content areas: strategic management practices, performance measurement practices, tracking and managing performance trends, organizational structure and processes, and external stakeholder relations. As a demonstration, Figure 35 provides an excerpt of the diagnostic report for the fictional agency EDOT. As with this excerpt for the content area of performance measurement practices, all other content areas have subcategories of content, and they provide diagnostic results in terms of "Existing Conditions" and "Recommendations."

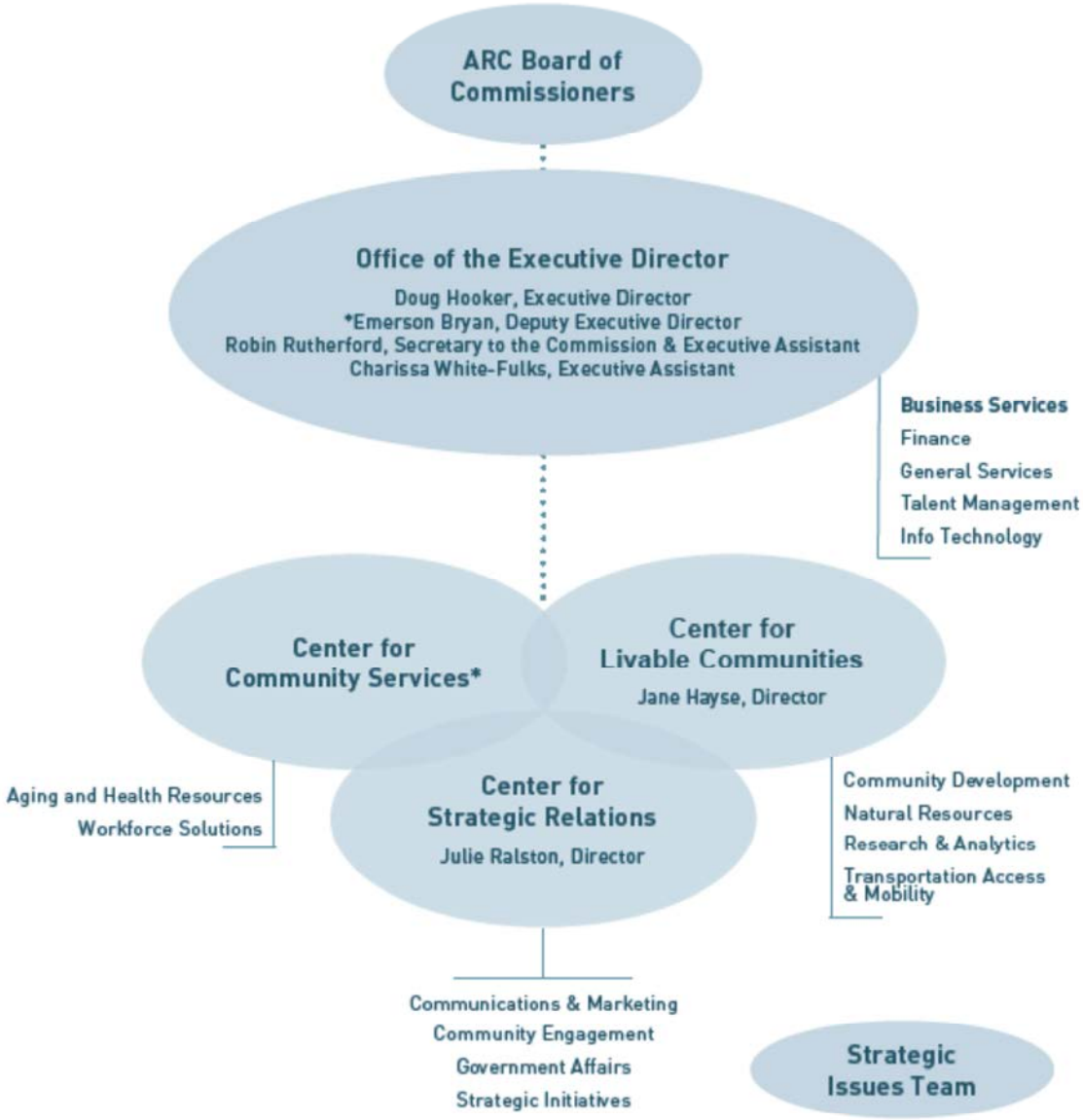
	Performance Measurement Practices	
	Existing Conditions	Recommendations
Developing Performance Measures	EDOT has created performance measures for all of its strategic goals and 80% of its strategic objectives. The 1 objectives missing performance measures are 'Increase access to transit'. Performance measures are re-evaluated on a rolling basis, with 2 measures being examined each month.	Develop performance measures for those objectives without them ('Increase access to transit'). Moving forward, continue to review EDOT's suite of performance measures regularly. This ongoing process will help to keep strategic management and performance management aligned, thereby enhancing both efficiency and effectiveness.
	Performance measures tend to be numerical; all of EDOT's strategic goals and all of its strategic objectives that have performance measures also have numerical measures.	Consider the following important decision making areas: 'Safety', 'Decrease bike/ped incidents', 'Mobility', 'Customer Satisfaction' and 'Employee Retention'. Identify important outcomes related to each area. Ensure that EDOT has information about these outcomes in order to define the 'context' for desired performance. Next determine how EDOT directly or indirectly influences each or any of these outcomes. Redevelop existing performance measures or develop new performance measures that track important inputs, outputs, and possibly the efficiency of EDOT's functions and processes, which have verifiable influence on the identified outcomes. Finally, identify existing or needed data to evaluate performance according to the newly defined measures.
	Performance measures tend to provide actionable information; all of the goals and all of the strategic objectives (for which EDOT has developed performance measures) are also linked with at least some strategies or actions that can be taken to improve measured performance. There is room for improvement in 5 decision making areas: 5 for which performance measures are only sometimes or somewhat linked with actions.	
Data Availability	Although all of the goal areas and all of the objectives for which EDOT has created performance measures are supported with data, accuracy is uncertain or insufficient in some areas.	Performance management requires that important decisions are informed by reliable information. Review the availability and sustainability of data each time that performance measures are re-evaluated.
Collecting Data	EDOT currently collects more data related to 'Mobility' and 'Employee Retention' than it uses for performance measures. Based on expected funding projections, EDOT will be able to continue collecting some of its currently available data indefinitely. However, data availability may be at risk for 'Decrease bike/ped incidents'	Determine whether or not EDOT may be able to conserve resources by decreasing data collection efforts related to 'Mobility' and 'Employee Retention'. Next time performance measures are reviewed in these areas, determine if the unutilized data can be used for actionable performance measures. If not, consider reducing data collection if this can save costs.

Figure 35: Diagnostic Report Excerpt for EDOT, showing Existing Conditions and Recommendations related to Performance Measurement Practices.

APPENDIX B

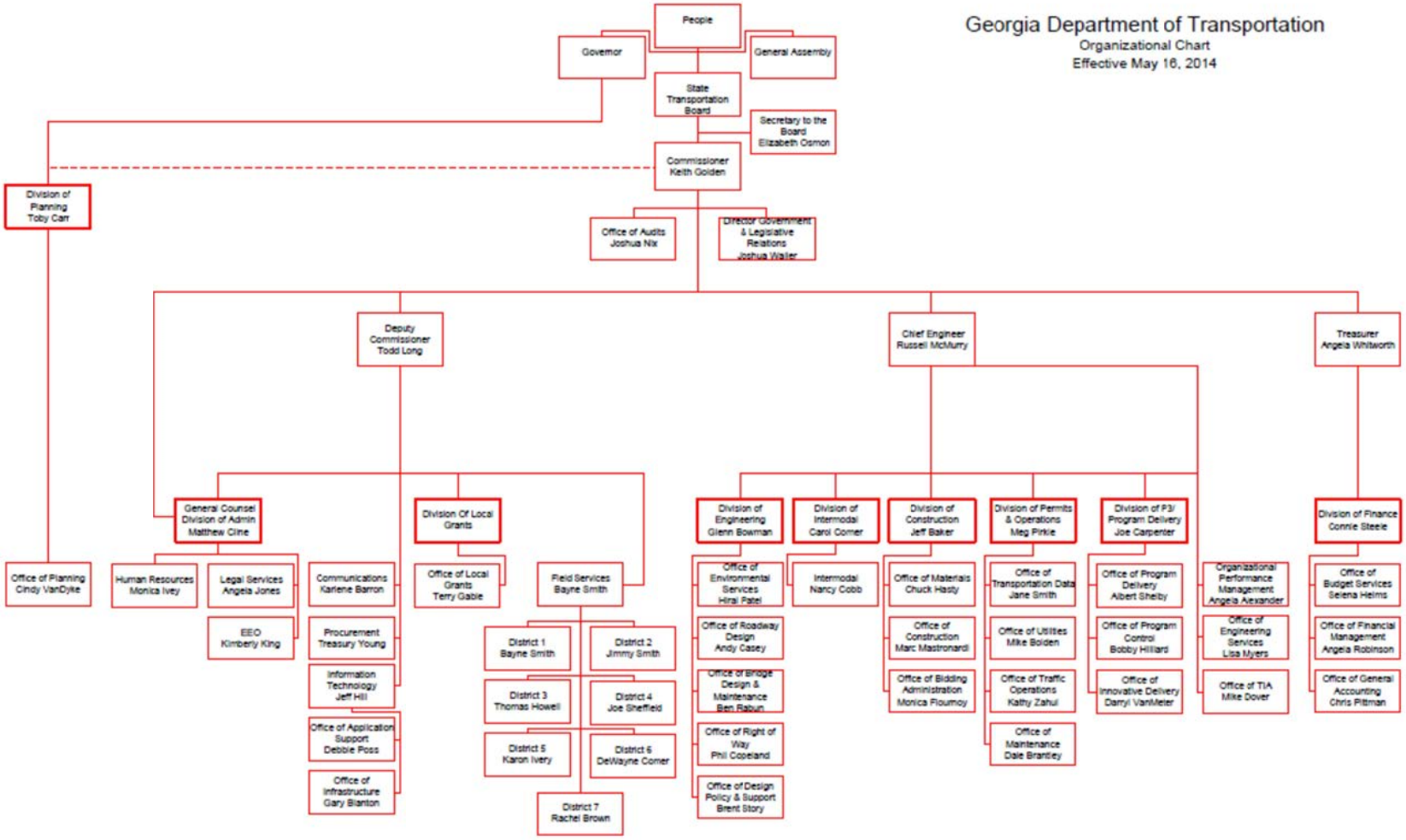
Metro Atlanta Transportation Executors Organizational Charts

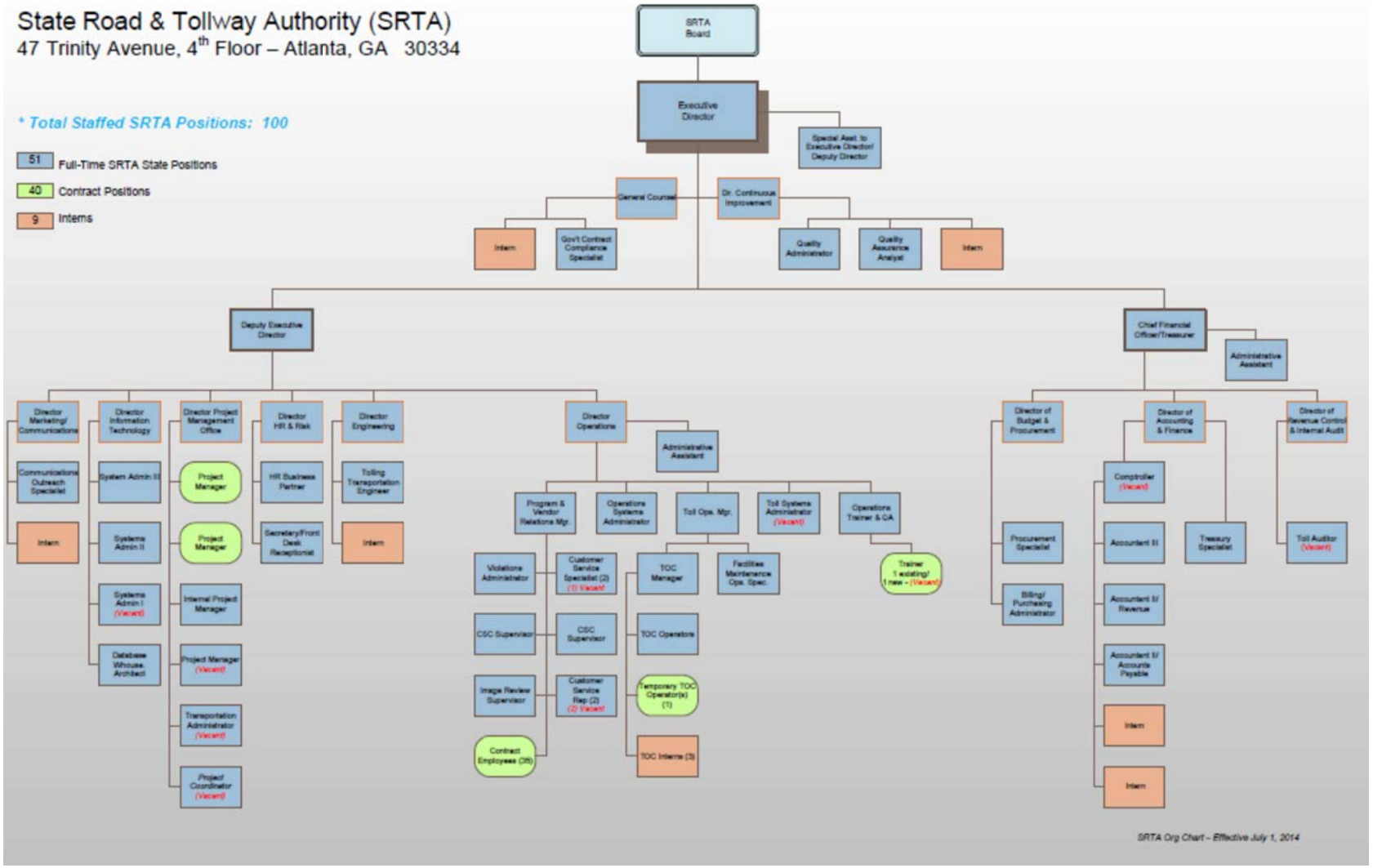
ARC Staff Organization Chart



* Interim Center Director

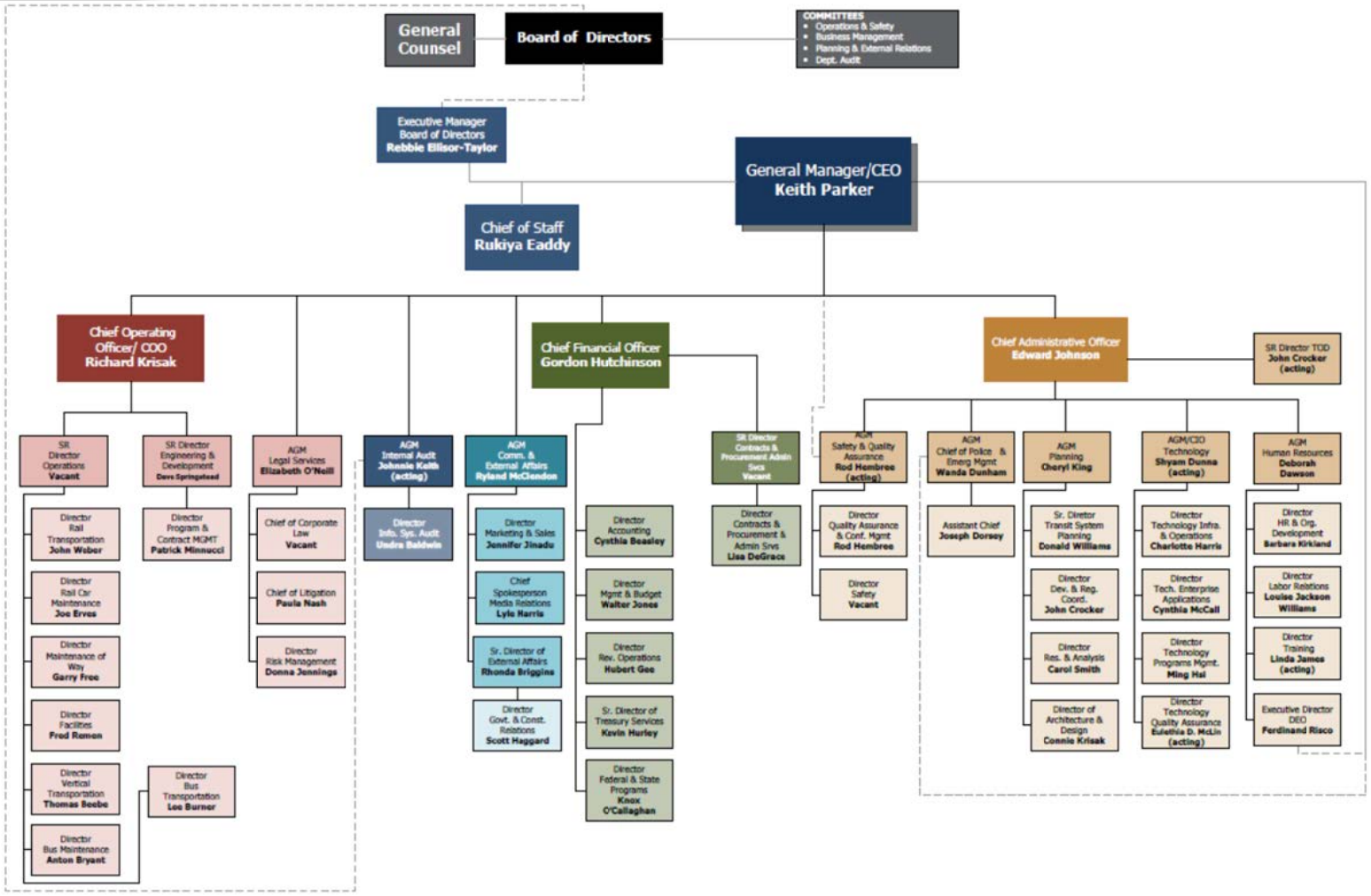
January 2014

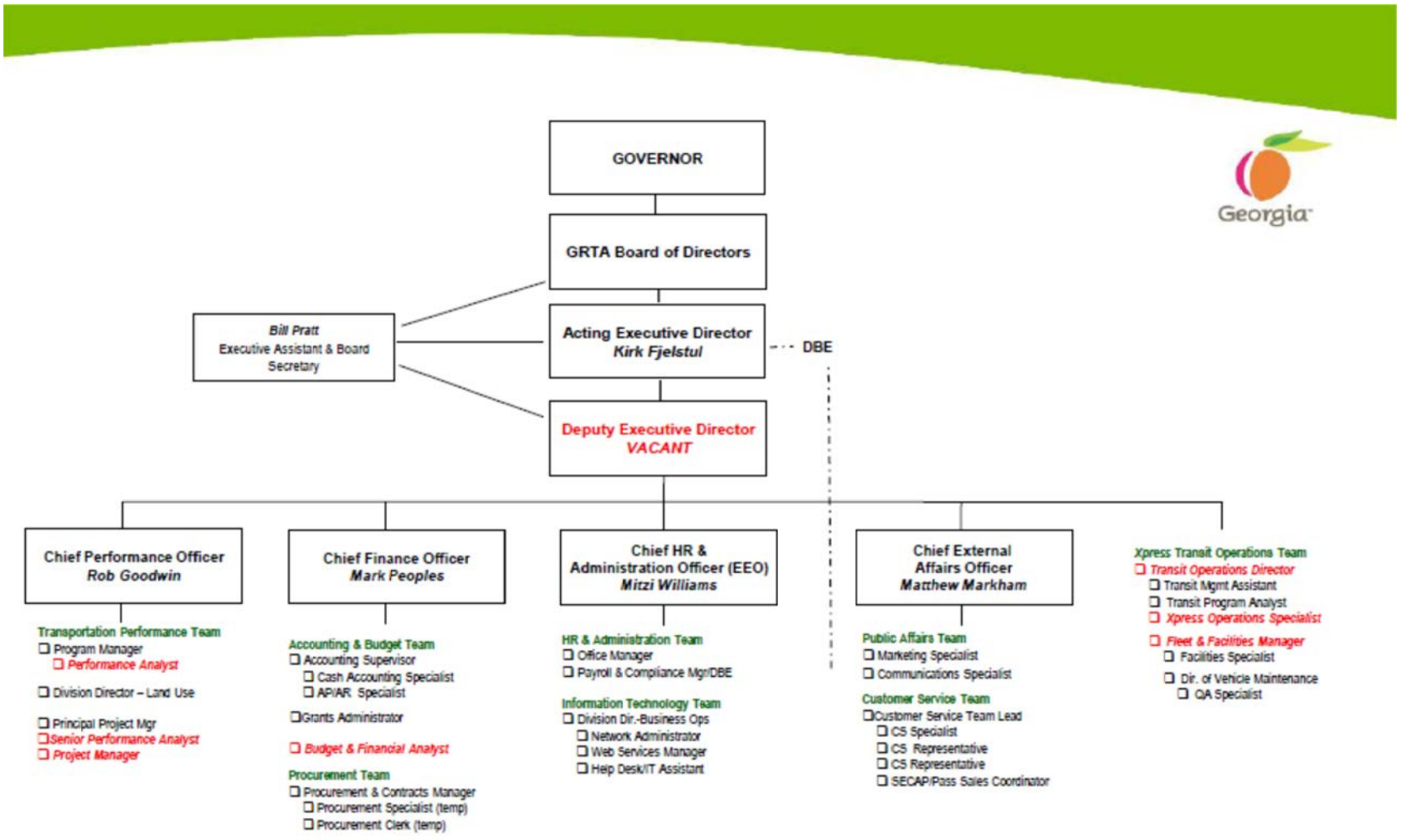

Georgia Department of Transportation
Organizational Chart
Effective May 16, 2014
People
Governor
General Assembly
State Transportation Board
Secretary to the Board
Elizabeth Osmon
Commissioner
Keith Golden
Division of Planning
Toby Carr
Office of Audits
Joshua Nix
Director Government & Legislative Relations
Joshua Waller
Deputy Commissioner
Todd Long
Chief Engineer
Russell McMurry
Treasurer
Angela Whitworth
General Counsel
Division of Admin
Matthew Cline
Division Of Local Grants
Division of Engineering
Glenn Bowman
Division of Intermodal
Carol Comer
Division of Construction
Jeff Baker
Division of Permits & Operations
Meg Pirkle
Division of P3/ Program Delivery
Joe Carpenter
Division of Finance
Connie Steele
Office of Planning
Cindy VanDyke
Human Resources
Monica Ivey
Legal Services
Angela Jones
EEO
Kimberly King
Communications
Karlene Barron
Procurement
Treasury Young
Information Technology
Jeff Hill
Office of Application Support
Debbie Poss
Office of Infrastructure
Gary Blanton
Office of Local Grants
Terry Gable
Field Services
Bayne Smith
District 1
Bayne Smith
District 2
Jimmy Smith
District 3
Thomas Howell
District 4
Joe Sheffield
District 5
Karon Ivery
District 6
DeWayne Comer
District 7
Rachel Brown
Office of Environmental Services
Hiral Patel
Office of Roadway Design
Andy Casey
Office of Bridge Design & Maintenance
Ben Rabun
Office of Right of Way
Phil Copeland
Office of Design Policy & Support
Brent Story
Intermodal
Nancy Cobb
Office of Materials
Chuck Hasty
Office of Construction
Marc Mastronardi
Office of Bidding Administration
Monica Flournoy
Office of Transportation Data
Jane Smith
Office of Utilities
Mike Bolden
Office of Traffic Operations
Kathy Zahul
Office of Maintenance
Dale Brantley
Office of Program Delivery
Albert Shelby
Office of Program Control
Bobby Hilliard
Office of Innovative Delivery
Darryl VanMeter
Organizational Performance Management
Angela Alexander
Office of Engineering Services
Lisa Myers
Office of TIA
Mike Dover
Office of Budget Services
Selena Helms
Office of Financial Management
Angela Robinson
Office of General Accounting
Chris Pittman


State Road & Tollway Authority (SRTA)
47 Trinity Avenue, 4th Floor – Atlanta, GA 30334
* Total Staffed SRTA Positions: 100
51 Full-Time SRTA State Positions
40 Contract Positions
9 Interns
SRTA Board
Executive Director
Special Asst. to Executive Director/ Deputy Director
General Counsel
Dir. Continuous Improvement
Intern
Gov't Contract Compliance Specialist
Quality Administrator
Quality Assurance Analyst
Intern
Deputy Executive Director
Director Marketing/ Communications
Director Information Technology
Director Project Management Office
Director HR & Risk
Director Engineering
Director Operations
Chief Financial Officer/Treasurer
Administrative Assistant
Director of Budget & Procurement
Director of Accounting & Finance
Director of Revenue Control & Internal Audit
Communications Outreach Specialist
System Admin III
Project Manager
HR Business Partner
Tolling Transportation Engineer
Administrative Assistant
Program & Vendor Relations Mgr.
Operations Systems Administrator
Toll Ops. Mgr.
Toll Systems Administrator (Vacant)
Operations Trainer & QA
Procurement Specialist
Controller (Vacant)
Treasury Specialist
Toll Auditor (Vacant)
Intern
Systems Admin II
Project Manager
Secretary/Front Desk Receptionist
Intern
Violations Administrator
Customer Service Specialist (2) (1) Vacant
TOC Manager
Facilities Maintenance Ops. Spec.
Trainer 1 existing/ 1 new - (Vacant)
Billing/ Purchasing Administrator
Accountant II
Accountant II/ Revenue
Systems Admin I (Vacant)
Internal Project Manager
CSC Supervisor
CSC Supervisor
TOC Operators
Accountant II/ Accounts Payable
Database Whouse. Architect
Project Manager (Vacant)
Image Review Supervisor
Customer Service Rep (2) (2) Vacant
Temporary TOC Operator(s) (1)
Intern
Transportation Administrator (Vacant)
Contract Employees (35)
TOC Interns (3)
Intern
Project Coordinator (Vacant)
SRTA Org Chart – Effective July 1, 2014

Organizational Chart

As of June 30, 2013




GOVERNOR
GRTA Board of Directors
Bill Pratt
Executive Assistant & Board Secretary
Acting Executive Director
Kirk Fjelstul
DBE
Deputy Executive Director
VACANT
Chief Performance Officer
Rob Goodwin
Transportation Performance Team
Program Manager
Performance Analyst
Division Director – Land Use
Principal Project Mgr
Senior Performance Analyst
Project Manager
Chief Finance Officer
Mark Peoples
Accounting & Budget Team
Accounting Supervisor
Cash Accounting Specialist
AP/AR Specialist
Grants Administrator
Budget & Financial Analyst
Procurement Team
Procurement & Contracts Manager
Procurement Specialist (temp)
Procurement Clerk (temp)
Chief HR & Administration Officer (EEO)
Mitzi Williams
HR & Administration Team
Office Manager
Payroll & Compliance Mgr/DBE
Information Technology Team
Division Dir.-Business Ops
Network Administrator
Web Services Manager
Help Desk/IT Assistant
Chief External Affairs Officer
Matthew Markham
Public Affairs Team
Marketing Specialist
Communications Specialist
Customer Service Team
Customer Service Team Lead
CS Specialist
CS Representative
CS Representative
SECAP/Pass Sales Coordinator
Xpress Transit Operations Team
Transit Operations Director
Transit Mgmt Assistant
Transit Program Analyst
Xpress Operations Specialist
Fleet & Facilities Manager
Facilities Specialist
Dir. of Vehicle Maintenance
QA Specialist
Georgia
GRTA
July 2014

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