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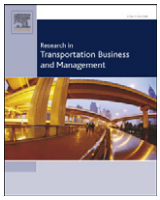

Guidelines on developing performance metrics for evaluating transportation sustainability

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ABSTRACT

Transportation systems have a significant impact on environmental, social, and economic sustainability. Traditional transportation performance metrics, which tend to focus on vehicle mobility and congestion, fail to assess the degree to which transportation planning leads to sustainable outcomes. Lacking appropriate metrics, transportation managers and policy-makers often do not have sufficient information to make decisions that consider sustainability as an outcome. Accordingly, this paper focuses on the process for developing such metrics in the form of a composite index. The intent of this paper is not to provide a singular, definitive index; rather, the goal is to provide guidance into the issues of selecting an appropriate index or developing their own.
We begin by reviewing the existing literature on indicator selection criteria, examining the construction of composite indices, and exploring existing rating systems. Building on this knowledge, we describe the process for creating a systematic tool for assessing sustainable transportation called the Transportation Index for Sustainable Places (TISP). We also provide an example of one element of the TISP to illustrate the necessary steps involved in the ranking process.

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1. Introduction

There is growing interest in sustainability planning in the United States due to an increased awareness of global environmental concerns in combination with the nation's dependence on oil imports. Sustainability is a concept that can be difficult to operationalize because it involves goals that are often in conflict with one another, such as environmental conservation, social responsibility, and economic viability (Hart, 2006; Litman, 2012). Transportation is widely recognized as a major component of sustainability (Litman, 2012). Sustainability in the context of transportation does not simply refer to the act of sustaining a transportation system; transportation sustainability is about understanding the broader impacts of the transportation system.

Achieving sustainability goals through transportation systems has become an important objective of policy makers and public initiatives. Demand for such metrics are evident in the latest authorization of the United States federal transportation bill, Moving Ahead for Progress in the 21st Century (MAP-21), which includes language such as:

> *"…begin development of new tools and improvement of existing tools or improve existing tools to support an outcome-oriented, performance-based approach to evaluate proposed freight-related and other transportation projects…could consider safety, economic competitiveness, environmental sustainability…"* (United States, 2012).

While the United States is still in the infancy of this process, transportation sustainability has received global attention as shown in the works of Litman and Marsden. Some international examples of metrics are the Environmental Sustainable Transport (EST) metrics developed by the Organization for Economic Cooperation and Development (OECD) and the Transport and Environment Reporting Mechanism (TERM) developed by the European Union.

Developing metrics for sustainable transportation is the subject of numerous publications (CST, 2005; Gilbert & Tanguay, 2000; Hart, 2006; Jeon & Amekudzi, 2005; Litman, 2012; Marsden & Snell, 2009; Patrick, 2002). As described by Marsden, metrics are critical in the decision-making process, but the relationships between sustainability goals and policy-decisions are complex (Marsden & Snell, 2009). For example, human health is an indicator of sustainability and many

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metrics support initiatives that increase the walking and bicycling mode shares of transportation; however, there are many factors beyond these that affect human health (Marsden & Snell, 2009). Despite this complex relationship, it is still important to "count what counts" because the acknowledgment and recognition of the issues bring attention to those issues (Marsden & Snell, 2009). In other words, the classic adage "what gets measured gets managed" applies. In this case, if the issue of transportation sustainability is not quantitatively addressed, transportation systems often develop in a manner that poses serious challenges for sustainability.

The problem at hand is that there is currently no widely recognized, consistently implemented, standard set of sustainable transportation indicators in the United States. The goals for transportation sustainability can best be achieved if we have appropriate metrics to determine what problems exist, where they exist, and consequently, what actions need to be taken. This research is motivated by the need for a tool that could be systematically applied for assessing the sustainability of places. Our research attempts to describe the knowledge that must be considered in developing such an index and the various steps involved in its calculation. We present the development of the Transportation Index for Sustainable Places (TISP) as an example and illustrate the process of selecting measures, data compilation, and interpretation of results. In addition to the analysis of the results, we evaluate the framework itself and identify some future considerations. Lastly, we review the implications of such a tool for managerial practice.

2. Literature review

The literature review composes of two sections. The first section investigates the various ways of conceptualizing sustainability, many of which are useful in developing a more detailed definition that can be used to guide planning policies. The second section evaluates how performance metrics – in the form of a composite index – function. Such an understanding is an essential first step in developing an appropriate index.

2.1. Conceptualizations of sustainability

The fundamental concepts of sustainability are often illustrated through the three spheres of sustainability, which refers to the integrated nature of environmental, social, and economic sustainability (Hart, 2006; MacDonald, 2000; Newman & Kenworthy, 1999; Nichols, Garrick, & Atkinson-Palombo, 2008; Patrick, 2002). Such existing frameworks of sustainability typically have no inherent means of prioritizing the social, economic, and environmental issues. This problem is noteworthy because sustainability issues are often in conflict with one another. For example, building a new highway can increase economic growth – in the short-term with planning and construction jobs and in the long-term with land development – but can also have negative environmental and social impacts. What is needed is a definition of sustainability that helps prioritize social, economic, and environmental concerns because valuing them equally makes quantifying overall sustainability very difficult.

Low describes these issues of sustainability's conflicting goals as the "paradox of sustainability" (Low & Gleeson, 2003). Most definitions of sustainability conceive a stable triangle of social, economic, and environmental concerns working together. Low contends that in order to achieve true sustainability, a paradigm shift must take place in our social and economic beliefs. In other words, the long-term breaching environmental sustainability makes the attainment of social and/or economic sustainability a moot point. Based on such incongruities, Low proposes a nested box model of sustainability. The nested box model is a representation of sustainability that explains why the environmental sphere should be considered with greater weight than the economic and social spheres. The economic sphere is nested within the social sphere, which is in turned nested within the environmental sphere. Low's conceptual model argues that our economy is only valuable as a creation of society, since society determines the value of things. However, both the society and the economy are ultimately held to the limitations and carrying capacity of the environment. Although the goals are often consistent with one another, Low argues that environmental sustainability should be the priority and not be conditional upon economic or social sustainability. Such nested box models could help transportation managers and policy-makers in clarifying sustainability priorities as well as the ability to better measure and compare sustainability outcomes in different cities, regions, and countries (Hart, 2006; Low & Gleeson, 2003; Nichols et al., 2008).

Another definition of sustainability that could help improve our ability to prioritize often conflicting sustainability goals can be seen in Graham Haughton's five interconnected equity principles (Haughton, 1999). The equity principles could be useful in helping to dissect the nested box definition of sustainability into more manageable and more definitive components. The five equity principles are:

1. Intragenerational equity
2. Procedural equity
3. Geographical equity
4. Intergenerational equity
5. Interspecies equity

McGranahan and Satterthwaite describe Haughton's equity principles in the context of the brown and green agendas. The brown agenda focuses on short-term and local issues such as access to clean water, and the green agenda focuses on long-term and global issues such as resource consumption (McGranahan & Satterthwaite, 2000). Framing the brown and green agendas in the context of equity principles provides a better understanding of each agenda as well as the potential conflicts between the two (McGranahan & Satterthwaite, 2000). For instance, intragenerational equity is a brown agenda issue because intragenerational equity can be a measure of social justice that concerns itself with the basic needs of humans. Procedural equity is primarily a brown agenda issue that focuses on fair treatment and providing people with a democratic voice in the management of how they live. Geographical equity is both a green and brown agenda issue. As a green agenda issue, geographical equity is about preventing people from transferring their environmental costs to others — such as greenhouse gas emissions from one country affecting all other countries. Geographical equity is a brown agenda issue when the transference of environmental costs is at a localized level. Intergenerational equity falls under the green agenda because it concentrates on maintaining the finite resources of the planet for future generations. Interspecies equity is a similar green agenda issue, but it focuses on the survival rights of other species (Haughton, 1999).

The equity principles and green/brown agendas can help move a transportation agency closer to building a better framework for measuring sustainability. For example, take the question of whether a person who drives more miles in a cleaner-fuel, energy efficient car is more or less sustainable than the person who drives less miles in a gas-guzzling SUV. Without the framework in place, a simple list of indicators might lead one to believe that the lower fuel consumption and air pollution emissions of the energy efficient vehicle equate to greater sustainability. However, the answer might be different when you begin to account for geographical equity concerns such as the land required to accommodate long-distance commuters (whether through the sprawl of land uses or the actual land required for the road system) or intragenerational equity concerns such as facility and maintenance costs, congestion, and the reduction of walking and biking mode shares with respect to issues such as health. Even without getting into actual numbers, the value of a better framework for sustainable transportation becomes apparent.

Such conceptualizations of sustainability can help transportation managers and policy-makers better understand local and global sustainability issues and the potential conflicts that arise between them. In turn, this knowledge can guide the development of a more comprehensive sustainability framework and indicator set (Nichols et al., 2008).