Sustainability And Infrastructure Resource Allocation
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ABSTRACT

Sustainability implies using, developing and protecting resources in such a manner that enables society to meet current needs and provides that future generations will be able to meet their needs, from the joint perspective of economic, environmental and social objectives. Sustainable resource use implies a concern for intergenerational equity in the long-term decision making of society. The purpose of this paper is to evaluate the concepts of sustainable development from the perspective of infrastructure resource allocation, and in particular for sustainable transportation. The concept and methods of assessing sustainable transportation are discussed. Most state transportation agencies use performance measures to define specific transportation strategies rather than having a comprehensive sustainable transportation policy. Planning for transportation sustainability requires a paradigm shift changing the way people think about and solve transportation problems.

Keywords: Sustainability, Infrastructure, Transportation, Sustainable Development, Sustainable Transportation

INTRODUCTION – SUSTAINABILITY

Sustainability involves the concern for intergenerational equity or fairness in the long term decision making of an entire society. It is the recognition of the role of finite environmental resources in that decision making process. The concept of sustainability or sustainable development has been discussed by economists and researchers for hundreds of years. As far back as the 1700s, Malthus expressed concern about the growing population in Britain and whether there was enough land to feed and support the people (Malthus, 1798). Jevons, in 1865, was concerned about Britain’s energy consumption and if it could be sustained on the available supply of coal (Jevons, 1977). Classical economic themes emerge in the 1950’s exploring the relationship between economic growth and distribution (Kaldor, 1957). In 1960, Piero Sraffa, building on the framework of David Ricardo, wrote that the problems of an economy should be viewed in terms of the conditions it must satisfy in order to sustain itself and grow (Sraffa, 1960). In The Limits to Growth, Meadows and others (1972) evaluated the issue of sustainability of the entire industrialized world given the finite capacity of the planet to provide material inputs. The publication of this book prompted two additional later publications by Meadows, Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future (1993) and Limits to Growth: A 30-Year Update (2004), updating their estimates on the issue of sustainability.

The purpose of this paper is to analyze the concept of sustainable development from the perspective of infrastructure resource allocation and in particular, transportation systems. Sustainable transportation systems represent a vital aspect of infrastructure resource allocation. Most transportation agencies use only performance measures as a way to define specific transportation strategies rather than incorporating sustainability into their overall mission and vision statements. This manuscript is organized as follows: First, a brief discussion of sustainable development is provided. The next two sections discuss the concepts involved in sustainable transportation, how performance measures have been used to define specific transportation strategies, and how this approach does not always achieve sustainable transportation. The final section offers conclusions and implications.

SUSTAINABLE DEVELOPMENT

established the Brundland Commission to propose long-term strategies for achieving sustainable development. In 1987, this commission published a report, *Our Common Future*, that detailed issues related to sustainable development and the change of policies needed. Out of this report came one of the most commonly used definitions of sustainable development, that “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). Another early contribution to the literature of sustainable development was by Barbier in “The Concept of Sustainable Economic Development” (Barbier, 1987). In this article, Barbier emphasized the environmental, economic and social features of sustainability and goes on to emphasize that environmental sustainability, economic sustainability, and social sustainability are separate but interrelated concepts.

Thus, sustainable development can be considered to be development that improves the standard of living and quality of life, while at the same time protecting and enhancing the natural environment. Sustainable development is sensitive to environmental and social constraints, including indirect and long-term impacts. It is also concerned with intergenerational equity and ecological viability, ensuring that people living in the future receive a fair share of existing resources.

In the article, “Toward Some Operational Principles of Sustainable Development,” Daly discusses three principles of sustainable development:

- Harvest rates should equal regeneration rates (sustained yield).
- Waste emission rates should equal the natural assimilative capacities of the ecosystems into which the wastes are emitted.
- Renewable energy sources should be exploited in a quasi-sustainable manner by limiting their rate of depletion to the rate of creation of substitutes for those renewable resources.

Daly assumed that sustainability requires that total capital (human-made plus natural) be maintained intact, and that natural and human-made capital are complements rather than substitutes (Daly, 1990). Sustainable development maintains a distinction between growth (increased quantity) and development (increased quality). It focuses on social welfare outcomes rather than simply measuring material wealth, and questions common economic indicators such as Gross Domestic Product, which measures the quantity but not the quality of market activities.

There are constraints to the sustainable development such as environmental issues and the need for conservation of natural resources. These constraints act as a driving force for addressing sustainability, and are broadly defined as:

- **Resource Constraints**: Non-renewable resources should not be used without enabling the production of substitutes, and renewable resources should not be used at a faster rate than they can be reproduced.
- **Ecological Constraints**: The ecological boundaries are exceeded if more waste is put into the ecological system than the system can safely absorb or if the system is damaged by taking excessive amounts of good arable land to provide transportation and other infrastructure needs.
- **Environmental Constraints**: Excessive pollution damages the environment and can result in health problems for humans and damage to plant species. Pollution can also result in climate changes, which can cause floods, droughts, and increased diseases.

The principles of sustainable development that are implied in the definition include intergenerational equity and multi-dimensionality. Intergenerational equity refers to ensuring that current and future generations enjoy an acceptable quality of life. There should also be an equitable distribution of resources between communities and generations. Assessment of sustainability should always be dynamic (adaptable to changes over time) and represent a continuum of varying degrees of sustainability, rather than a discrete assessment of what is sustainable or unsustainable.

There are three dimensions of sustainable development, social equity, economic development, and environmental stewardship. Each is interrelated and at the same time should be simultaneously evaluated. These dimensions can be described as:
Social Equity
- People must be able to interact with one another and nature.
- A safe and secure environment must be provided.
- There must be equity between societies and generations.
- There must be adequate access to employment and other opportunities.
- Important considerations also include equity, safety, security, human health, education and quality of life.

Economic Development
- Resources need to be adequately maintained.
- Financial and economic needs of current and future generations must be met.
- There must be adequate mobility to move people, goods, and services.
- Important considerations also include business activity, employment, productivity, tax issues and trade.

Environmental Stewardship
- Use renewable resources at below their rates of regeneration and nonrenewable resources at below the rates of development of renewable substitutes.
- Provide a clean environment for current and future generations.
- Important considerations also include pollution prevention, climate protection, habitat preservation and aesthetics.

SUSTAINABLE TRANSPORTATION

Special attention has recently been given in the literature to the concept of sustainable current and future land use and transportation patterns. This reflects the impacts that current patterns of transportation have on the environment and the often complex interactions between transportation, land use, and population activity. Sustainable transportation is thus seen as transportation that meets mobility needs while at the same time preserving and enhancing communities and their ecosystems (Litman, 2005). It is the provision of safe, effective, and efficient access and mobility into the future while considering the economic, social, and environmental needs of society (Jeon, 2005).

The concept of a sustainable transportation system has been discussed since the early 1990s. One of the early definitions proposed by the Organization for Economic Cooperation and Development (OECD) defined sustainable transportation as; “transportation that does not endanger public health or ecosystems and meets mobility needs consistent with (a) use of renewable resources at below their rates of regeneration and (b) use of non-renewable at below the rates of development of renewable substitutes” (OECD, 1994) However, this definition specifies what the transportation should not be rather than what it should be. This definition also fails to recognize one of the key features of sustainability, intergenerational equity.

In 2001, the Ministry of Transport of the 15 European Union countries adopted a resolution entitled, Strategy For Integrating Environment and Sustainable Development Into the Transport Policy. This April Resolution defined a sustainable transport system as one that:

- “Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;”
- Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- Limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and, uses nonrenewable resources at or below the rates of development of renewable substitutes while minimizing the impact on the use of land and production of noise” (EU, 2001).

The New Zealand Ministry for the Environment extended this definition to include the layout of cities and the balance of transport investments. Their policy states:
“Sustainable transport is about finding ways to move people, goods, and information in ways that reduce its impact on the environment, the economy, and society. Some options include:

- Improving transport choice by increasing the quality of public transport, cycling and walking facilities, services and environments
- Using cleaner fuels and techniques
- Using telecommunications to reduce or replace physical travel, such as tele-working or tele-shopping
- Planning the layout of our cities to bring people and their needs closer together
- Developing policies that allow and promote these options, such as the New Zealand Transport Strategy” (New Zealand, 2008)

In the United States, sustainable transportation has been the subject of research for over a decade (Black, 2002). However, sustainability has not been explicitly mentioned in the mission and vision statements of most transportation agencies, and they only touch upon sustainability concerns indirectly. Sustainable transportation should be seen as an expression of sustainable development in the transportation sector. Sustainability of transportation systems can be largely defined through the impacts of the system on the economy, environment, and general social well-being. It can thus be measured according to transportation system efficiency and its impact on the natural environment.

TRANSPORTATION STRATEGIES FOR SUSTAINABLE DEVELOPMENT

The assessment of sustainable transportation is generally discussed in three steps: conceptualization, operationalization, and utilization (Gudmundsson, 2004). Conceptualization deals with defining what sustainability refers to in a particular context. Operationalization involves the selection of parameters to measure sustainability. Utilization deals with actually using the findings to guide further development and policy. There are two main approaches that can be used to evaluate sustainable transportation. In the first approach, transportation policy is directed to address overarching sustainable development concerns. In the second, sustainable transportation is defined in a more limited sense, as having certain environmental and social constraints which are to be addressed.

With the implementation of the Government Performance and Results Act (GPRA) in 1993, all government agencies in the U.S. including transportation-related agencies were mandated to engage in project management tasks such as setting goals, measuring results, and reporting their progress. Performance measures are one method that can be used to define specific transportation strategies in the operationalization phase. Performance measures originated as a management tool used by private-sector organizations to evaluate progress toward goals using measurable results or targets. Performance measures translate data and statistics into succinct information that can be readily understood. They can be used across all aspects of an agency or department to help identify trends, predict problems, assess options, set performance targets, and evaluate the organization.

In 1997, a study was conducted in the U.S. of 36 states’ Department of Transportation agencies to review state-of-the-practice in performance measurement (Poister, 1997). It found that the most commonly used measures were in the areas of highway maintenance, safety, highway construction, public transit, and aviation. Fewer agencies used performance measures for rail and water transport, and for general administration and organizational effectiveness. This study suggested that performance measurement should undergo a paradigm shift to encompass measures of mobility, livability, accessibility, and sustainability.

There have been several research studies undertaken in the United States regarding the use of performance measures and their role in the transportation sector (NCHRP, 2000; NCHRP, 2006) (Rosa et al., 2008). One of the most important concepts to emerge from the use of performance measures is the need for public involvement. Sustainable development reflects a community’s values and as such they should be included in the planning process. Also, because sustainable transportation often involves changes in community infrastructure design, residents need to feel a stake in the decision making process. Oregon is one of the very few states to have incorporated sustainability as a specific goal in their state-wide transportation plan. Oregon’s sustainability goal states, “Meet present needs without compromising the ability of future generations to meet their needs from the perspective of the
environment, economy and communities. Encourage conservation and communities that integrate land use and transportation choice” (Oregon Transportation Commission, 2006).

CONCLUSION

In designing and carrying out sustainable transportation planning that can simultaneously support economic development, protect the environment, and improve social equity, there are many conflicting issues to be resolved. The transportation sector has been the focus of this paper since it plays such a prominent role in many issues that sustainable development aims to address, such as greenhouse gas emissions, urban sprawl and habitat destruction. With transportation being one of the largest contributors of greenhouse gas emissions and transportation-related air pollution, many uncertainties persist about the nature and severity of these environmental problems. State transportation agencies need to undertake a paradigm shift to incorporate sustainability in their long-range transportation plan. Planning for sustainability requires changing the way people think about and solve transportation problems. It demands a more comprehensive analysis of impacts and the consideration of a broader range of solutions. Integrated solutions are necessary and any optimal solution must include a balance between economic, social and ecological objectives.

AUTHOR INFORMATION

Dr. Duane J. Rosa is Professor Economics and Regional Division Director of the Texas Transportation Institute at West Texas A&M University. He has been with the university since 1984. Dr. Rosa holds a Ph.D. in economics from Texas Tech University and Master’s degrees in engineering and economics from the University of Oklahoma and the University of Nevada Las Vegas. He teaches courses in environmental economics, managerial economics, and microeconomic theory. Dr. Rosa was a Fulbright Professor at the University of Iceland in 1992 and 1994. His research and professional publications are in the areas of energy, water resources and transportation.

REFERENCES


