SUSTAINABLE TRANSPORTATION BALANCES ECONOMIC VIABILITY, ENVIRONMENTAL IMPACTS AND SOCIAL EQUITY: THE CASE OF BOGOTA COLUMBIA

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Summary

This article will discuss the strong and complex effects urban transportation has on the sustainability of urban activities. Transportation accounts for a significant share of noise, air, and water pollution in urban areas, and is therefore important in reducing the

environmental impacts of urban activities. Social equity is also affected by the spatial distribution of access to transportation, as well as the specific kinds and costs of transportation modes available. Transportation is a huge economic activity, and it is important for the employment of thousands of workers as well as the vitality of a myriad of private companies and public agencies. Economically viable, environmentally benign, and socially equitable, sustainable transportation is a solution to a puzzle, arrived upon through careful communication, understanding, and consensus-building among all affected parties, from grassroots community groups to the largest petroleum companies. The case of Bogotá, Columbia illustrates this process, and its results are promising. Some of the key operational aspects of their new urban transportation system are presented, along with the history behind the formation of the system. How this new system is a movement towards sustainability is then discussed, and important lessons for other urban areas are presented.

1. Introduction

Transportation activity accounts for a very large share of the effects urban areas have on the local and global environment. While this share varies from city to city, in general it can account for about half of all local air pollutants and greenhouse gas emissions. Transportation can also have huge social effects, increasing the mobility for certain populations, while possibly isolating others. Furthermore, poorly planned transportation can cost urban regions billions per year in accidents, traffic congestion, smog damage and health effects. Table 1 lists some of the more specific and important effects transportation has on the sustainability of urban activities.

Link	The Role of Transportation
1. Local air pollution	Emissions from motor vehicle use in general, increased emissions from vehicles caught in congestion, increased emissions from unnecessary travel due to poor land-use and transportation coordination
2. "Greenhouse Gas" emissions	CO_2 emissions from motor vehicle use in general, increased emissions from vehicles caught in congestion, increased emissions from unnecessary travel due to poor land-use and transportation coordination. About 30% of all energy use worldwide is for transportation (including non-urban transportation)
3. Fossil fuel use	Currently, about 97% of all energy for transportation is supplied by fossil fuels.
4. Local water pollution	Runoff during the construction of transportation infrastructure, runoff from roadway surfaces carry pollutants related to the operation of

	motor vehicles such as debris from brake and tire wear and oil and other fluids.
5. Increased demand for land by urban settlement	Sprawling, automobile-oriented urban development dedicate much space to roadways, freeways, and surface parking lots, increasing the footprint an urban area would otherwise make, given a more dense, mass transit oriented layout.
6. Accidents resulting in fatalities and injuries and property damage.	Traffic accidents are among the most significant sources of death and injury across the industrialized world, and are rapidly becoming important in the developing world as well. Each year in the US, nearly 50 000 people are killed and close to 500 000 are injured.
7. Loss of time and productivity and increased stress	Increasing traffic congestion means more person-hours are lost in traffic, decreasing workforce productivity and increasing stress and concomitant health effects
8. Social equity	Transportation supply is unequal across space, and is often deficient for marginalized populations. While it is rarely deliberate, transportation is a key part of the urban process which can neglect marginal groups, having significant effects on access to jobs and services.
9. Removal of urban space from public use	Streets were once public spaces for a variety of activities, like walking, cycling, and vending. Increased motorized vehicles have eliminated these important spaces from public use.
10. Noise pollution	An effect of motor vehicle use in general, increased with increased highway construction and travel.

Table 1. The links between transportation and sustainability

Due to its significance for sustainability, transportation is as an important platform for any effort to address the sustainability of urban activities. Understanding how these links between transportation and sustainability behave can be useful to develop strategies to make transportation more sustainable. These strategies can be grouped

loosely as focusing on the demand side, supply side, and the management side of transportation. Some specific actions within these three areas will now be introduced.

1.1. Supply Side

Transportation system design can affect the efficiency of travel by altering the physical transportation infrastructure and vehicles. Changes in the physical design could make routes less circuitous or remove bottlenecks. Advanced concepts in public transit systems can increase the effectiveness of the entire system and reduce bottlenecks. Walking and cycling, the most space- and energy-efficient modes, can be fostered with the addition of cycleways and pedestrian-friendly facilities. It is important to recognize that these policies effectively add capacity to the transportation system and will, in turn, increase demand for travel, causing more congestion. *Vehicle and fuel technology* can directly affect fuel efficiency or the pollutant emissions from the vehicles. Advanced engine technology and alternative fuels can make vehicles much more fuel-efficient, reducing fuel use, CO_2 emissions, and local pollution. Some technologies also lower noise pollution and can reduce debris from tires and brakes. Using renewable alternative fuels is a way to reduce the reliance on non-renewable fuel sources and also reduce effective greenhouse gas emissions.

1.2. Demand Side

Land use and spatial planning have the largest effects on the demand for travel, and are an integral part of any regime of measures addressing transportation and sustainability. More compact physical development results in less demand for travel, increased use of non-motorized modes, and makes providing public transit more effective and less costly. Merely changing the physical design of urban areas, such as making entranceways to buildings closer to streets (instead of across parking lots), widening sidewalks, changing the street grid design and street width can make walking and cycling more attractive and decrease car use. Urban growth boundaries and other strict land-use controls can channel growth into more efficient corridors making transportation more efficient. The mixing of residential, industrial, and other land uses can make the use of infrastructure more efficient as directional flows are more balanced within regions, instead of having residential and industrial activities segregated, with unidirectional congestion. The city of Curitiba, Brazil uses strict land-use controls to increase land-use density near transit lines, which increases transit use, and decreases car use, parking and road expenditures, etc. *Transportation demand management* (TDM) affects the demand for travel through the pricing and regulation of the different modes of transport. Changing the price of parking at a workplace is an example of a TDM measure which affects whether people decide to car pool or take public transit to work.

Increasing alternatives to travel or automobile use can change the way and amount people travel. Adding bike lanes or expanding bus services can add transport mode choices which previously might not have been reasonable. Furthermore, the increased use of fax and computers, especially in the workplace, can decrease the need to make certain trips.

1.3. Management Side

Indicators of performance of the transportation system should be developed and presented, such as measures of delay, emissions, or energy use. Innes feels these help the public, decision makers and key actors in transportation have a common language through which to discuss problems and priorities. *Regionalism* in the governance of the transportation and land-use system should override local jurisdictions. Transportation and land use, like pollution, are regional issues where decisions made in one part of a region can have profound effects on the performance of the entire system. Progress made in one part of the region can be completely negated by failures in another.
Consensus among users, suppliers, and regulators of the transportation system is essential to make progress sustainable for the future. Projects must be met with approval from all interested parties through a careful process of communication and understanding. Some of the most important parties, and how they affect transportation, are described here:

1. Political forces can be aligned by certain personalities or along party lines. These forces can affect the transport system by having development ambitions that might not be coordinated with the regional transportation plan or with the plans of neighboring cities.
2. Transportation planning agencies can sometimes take on lives of their own and might not coordinate with other actors or regional transportation plans, and can have a poorly developed long range plan, or are subordinate to political forces which do not follow good long range transportation planning.
3. Land use and physical planning can have a huge effect on the demand for transportation, and it is essential that transportation plans and land-use controls are coordinated. Most often they are not, which can make many transportation improvements ineffective.
4. Actors controlling the road system (such as state highway departments in the United States) can work with, or disrupt, other transportation or land-use planning efforts. The coordination of road management with other actors is essential.
5. Owners, operators, and regulators of the public transportation system can have regional influence or be small local operators with distinct boundaries. Small fragmented jurisdictions make it difficult to coordinate services, and can make services less efficient for users. Travel is increasingly regional and inter-municipal, and these various actors need to be more cooperative under these changing conditions.
6. The mass of private vehicle (both freight and passenger) owners and operators each have individual interests in the operation of their investments.
7. Non-motorized transportation users (cyclists and pedestrians) are in many places the most overlooked, and are in the most danger of being killed or injured. Ironically, these groups consume the least urban space and resources and create little or no emissions, noise, or other externalities.
8. All citizens of the urban region benefit from the transportation of goods, services, information, and people. Likewise, they all pay when the system is run inefficiently or ineffectively.

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Bibliography

Cervero, R. (1998). *The Transit Metropolis—A Global Inquiry*. Washington, D.C.: Island Press. [This is an international survey of cities which have established public transit as an important element of their transportation systems, and which have effectively bucked the trend of declining public transit use. This is an important text for understanding successful public transportation policies and implementation].

Committee for a Study on Transportation and a Sustainable Environment. (1997). Sustainability and Transportation. *Towards a Sustainable Future: Addressing the Long Term Effects of Motor Vehicle Transportation on Climate and Ecology, Special Report 251*, 15-36. Washington, D.C.: Transportation Research Board. [This report includes a general discussion as well as specific issues concerning motor vehicle use and sustainability. Covers both local and global issues and includes a section on future research needs].

Companhia de Engenharia de Tráfego (Traffic Engineering Company of São Paulo) (1979). COMONOR - Comboios de Ônibus Ordenados. *Boletim Técnico* 22. São Paulo: Companhia de Engenharia de Tráfego. [This article introduces the basic engineering concepts behind high-capacity bus systems, including how to manage buses similarly to the operation of metros].

Diaz, O. (2001). Awake at the Wheel: Bogotá's Response to the Transportation Challenge. *Encompass Magazine* **5**(3), 1-5. Retrieved May 14, 2001 from the World Wide Web: http://www.encompass.org/5-3/awake.htm [This article summarizes the main goals and accomplishments of the Transmilenio project, with good background on Bogotá and the referenda].

Germani, E. (1992). Troncal Caracas: Um Corredor de Onibus de Alta Capacidade. *Revista dos Transportes Públicos*, **14**(1), 59-65. [Relates the first experience with a corridor in Bogotá city in the 1990s. Avenida Caracas is the main corridor of TransMilenio project].

Gibson, J., Baeza, I. and Willumsen L. (1989). Bus-stops, Congestion, and Congested Bus-stops. *Traffic Engineering + Control*, **30**(6), 291-302. [This article investigates congestion at bus stops for several levels of bus flows. It develops a framework for optimizing bus flow capacity through bus stop design].

Innes, J. and Booher, D. (1999). Metropolitan Development as a Complex System: A New Approach to Sustainability. *Economic Development Quarterly* **13**(2), 141-156. [This article argues that complexity of metropolitan areas makes goals of sustainability and economic development compatible and achievable with the right strategies].

Litman, T. (2001) Generated traffic: Implications for Transport Planning. *ITE Journal—Institute of Transportation Engineers* **71**(4), 38-47. [This article discusses the complex relationship between new highway construction and increased demand for travel].

Projeto Transmilenio. (1999). *Relatórios Técnicos*. Bogotá: Secretaria de Trânsito e Transportes. [Various technical documents outlining the operations, planning and engineering of the Transmilenio transit system].

Pucher, J. and Lefèvre, C. (1996). *The Urban Transport Crisis in Europe and North America*. 226 pp. London: MacMiliian Press Ltd. [This book traces the transportation crisis in the United States and Europe, looking specifically at the shift from public transport systems to private vehicles].

Biographical Sketches

Eric Amaral Ferreira is a Ph.D. candidate in the Transport Engineering Program at the Federal University of Rio de Janeiro, Brazil. His dissertation deals with the costs of production and competition between formal, highly regulated bus systems, and the informal transport sector, characterized by small vehicles working without regulation or authorization. During his 10-year career as a consulting engineer, he has worked in both the public and private sectors. He worked on several master plans for cities like Curitiba (population 1 500 000), Londrina (400 000), Ourinhos (90 000), Leon, Mexico (1 100 000), and Bogotá, Colombia (6 000 000), where there was much focus on the integration of various forms of public transportation. Eric has a Bachelor of Science degree in Agricultural Engineering from the Federal University of Paraná, and a Master of Science degree in Civil Engineering from University of São Paulo, where his studies focused on public transportation. He was born and raised in the city of São Paulo, Brazil.

Aaron Golub received his Ph.D. from the Institute of Transportation Studies, in the College of Civil and Environmental Engineering at the University of California at Berkeley. His dissertation dealt with the regulation of informal transportation modes in Brazil and the impacts of regulation on riders' economic welfare. He is now working with the Institute for Transportation and Development Policy on various projects in Brazil, as well as other projects in Colombia and the United States. His other interests include emissions and energy use in transportation, bicycle transportation issues, and a fascination with the history of transportation in United States. Aaron has a Bachelor of Science degree in Mechanical Engineering from Virginia Polytechnic Institute and State University, and a Master of Science degree in Mechanical Engineering from MIT. His studies focused on engine emissions and alternative fuels and he worked as a mechanical engineer in the combustion science area before returning to school to study transportation. He was born in the state of New York and raised in Baltimore, Maryland.