



Sustainable transportation: the key to sustainable cities

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Abstract

Sustainable transportation is key to a sustainable city. Most indicators of sustainability reveal that the current patterns of urban travel are not sustainable. Thus the urban transportation systems must be modified and adapted before our cities can be made sustainable. Several approaches to achieving transportation sustainability are identified in this paper. These are grouped into technological, economic and behavioural, and planning and management approaches. Although there are definite viable and feasible options in each approach, their implementation requires strong political will and some not very popular decisions. Charging full costs of road travel to road users has been recommended as the most important and effective strategy for moving towards sustainable urban transportation systems.

The task of achieving sustainable transportation systems in our cities is, however, not easy or effortless. The stakes are high as the unsustainable trends in road transportation pose grave danger to the very existence and protection of life on the planet. This is a global challenge and it is unwise to ignore it. Achieving sustainability in urban transportation will significantly enhance the sustainability of cities. In fact, it is emphasised that sustainable urban transportation system is a pre-requisite to a sustainable city.

1 Introduction

Sustainable transportation system is one of the most important elements of a sustainable and livable city. Approaches to developing sustainable urban transportation systems will assist the achievement of a sustainable city. The current transportation systems all over the world are headed on an unsustainable



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path. This is evidenced by thousands of deaths and injuries in road accidents; human health impacts and materials and agricultural damage from ground level air pollution; climate change impacts of greenhouse gas emissions; use of land and non-renewable fuel resources; noise, vibration and water pollution impacts; time lost, inconvenience and environmental impacts of traffic congestion; increasing time and distance as well as the barrier effects of urban sprawl; and many other undesirable impacts of trends in transportation. It is inconceivable to achieve sustainability in our cities with the current and emerging urban transportation systems. It is premised that if the urban transportation systems could be adapted and put on a sustainable trend, it will greatly contribute to making our cities sustainable.

1.1 Sustainability

The most commonly cited definition of sustainability relates to the definition of sustainable development conceived by the Brundtland Commission in 1983. It defines sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs". Although few formal definitions of sustainable city and sustainable transportation exist, the above definition based on the futurity or inter-generational objective can be applied to define sustainable transportation.

1.2 The role of transportation in modern cities

The household activity patterns in the cities of the developed societies all over the world are centered around the private car and urban transportation is the key to the functioning of modern cities. The quality of life in an urban area is greatly influenced by the impacts of road transportation. The quality of the ambient environment in the cities including air quality and noise pollution has been deteriorating in most major urban centres. Several major cities in the world are becoming unlivable due to uncontrolled growth in their urban transportation systems. New Delhi in India is a striking example of a city with rapidly deteriorating quality of urban life. The ever-increasing levels of congestion in most large cities in the U.S. do not augur well for the cause of sustainable cities.

1.3 Current transportation systems are unsustainable

Transportation is headed on an unsustainable path. It is the fastest growing source of greenhouse gas emissions from human activity. Increases in the number of new vehicles, the average size of vehicle and the distance they are driven each year have continued increases in ground level ozone and particulates in urban areas, despite tighter vehicle emissions regulations. The apparent reasons for unsustainability include population growth, low-density urban settlement patterns, and the competitive advantage of energy-intensive modes of transport. The social values and lifestyles are the deep roots of the unsustainable transportation path. These include unlimited personal mobility, often in single-



occupant vehicles; cars especially sports car and recreational vehicles seen as status symbols; and the desire to live in a suburban home. However, by far the greatest threat to sustainability comes from the current pricing of transportation. Users do not pay the full social costs of transportation which results in an over-use of transportation from an efficiency viewpoint.

1.4 Sustainable Transportation

Sustainable transportation is a transportation system that is capable of delivering required capacity and performance, uses inexhaustible energy source, is compatible with the desired lifestyle, and is clean and affordable. The transportation decisions and investments made today should expand and not limit the economic, ecological and social choices available to future generations.

The Transportation Association of Canada has defined a sustainable transportation system as a system that

- 1 meets the access needs of the present generation
- 2 allows future generations to meet their own access needs (which will grow because of economic growth and rising populations)
- 3 is powered by renewable (inexhaustible) energy resources
- 4 does not pollute air, land or water beyond the planet's ability to absorb/cleanse (especially CO₂),
- 5 is technologically possible
- 6 is economically and financially affordable
- 7 supports a desired quality of life
- 8 supports local, national and global sustainable development goals

2. Nature of emerging urban transportation systems

2.1 Importance of road transport

Transportation is vital to any country's economy and a substantial contributor to its Gross Domestic Product. The insatiable growth in vehicle ownership levels and the growth in the number of vehicle-kilometers travelled each year have provided a kind of hyper-mobility to the car-dominated societies. The automobile dominated transportation system is perceived to be convenient, comfortable, fast, dependable, safe and affordable. It has provided car owners freedom and choice of opportunities scarcely imaginable a few decades ago. The expanding truck fleets have enabled industry to move goods quickly and conveniently to markets. As a matter of fact, car ownership levels and the amount of travel undertaken by a society are taken as an index of the affluence and development of a country.

However, the benefits of road transportation are achieved at a significant cost to society. These costs are measured in damages, injuries and death due to road accidents, delays, energy dependence and above all, the collateral damage to the environment. These effects can hardly lead to sustainable cities.



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2.2 Impacts of road transportation

It is now well recognized that road transportation is a major source of greenhouse gases, is responsible for thousands of deaths and serious injuries in road accidents, is depleting scarce and non-renewable fossil fuel, causes delays and stress for travelers due to congestion, and is the cause of certain health problems, frustration, and environmental degradation.

The impacts of road transportation are enormous and affect users as well as non-users. With over 7 trillion passenger kilometers and 5.6 trillion ton-kilometers of freight transported by road, the expenditure on transportation services in the U.S. exceeds a trillion dollars annually (Bureau of Transportation Statistics [1]).

In the 25 years between 1970 and 1995, 1.2 million Americans died in traffic accidents. Over a third of traffic fatalities in U.S. are pedestrians and cyclists, killed by car and truck drivers. Worldwide, there have been about one million traffic fatalities in 1990, and WHO projects 1.4 million fatalities in the year 2000 and 2.3 million in 2020 (Harvard School of Public Health [2]).

Car-based lifestyle leads to high incidence of obesity and serious health problems and is the cause of many premature deaths.

Hours of congestion delay in metropolitan areas in the U.S. have tripled since 1980. The daily commute to work, for many commuters has become an endless nightmare.

Air, water and noise pollution remain serious problems of the auto-highway transportation system. Cars and trucks are a major source of noise and air pollution in spite of significant technological improvements. The benefits of these breakthroughs have been largely offset by huge increases in vehicle kilometers traveled.

The automobile is the primary source of carbon dioxide emissions which is the main greenhouse gas causing global warming. Over three-quarters of total U.S. emissions of carbon dioxide were generated by transportation which is also responsible for 40% of all fine particulates, 45% of nitrogen oxides and over one-third of all hydrocarbons emissions. Although the timing and long-term impact of greenhouse gases are unknown, virtually all OECD countries have agreed to curtail greenhouse gas emissions over the next two decades (Kyoto agreement, 1997)

Over 65% of US petroleum products were consumed by the transportation sector which is almost wholly reliant on petroleum energy (over 97%). This has serious strategic as well as economic implications.

The social impacts of automobile dominated transportation systems are enormous. Such a society discriminates against the disadvantaged. These include

- i. Those who cannot afford a car or who are physically or mentally unable to drive a car
- ii. Suburban children whose mobility dependence results in waste of time, energy and resources
- iii. Loss of sense of community and social coherence



- iv. Suburban sprawl and the ugliness of auto-based strip development along highways
- v. Loss of inner city vitality
- vi. Atomization and segregation of society by income, race and ethnicity.

In effect, the community cost of road transportation is tremendous. Yet, the motorists do not bear many of these costs directly.

2.3 Costs of road travel

A growing number of researchers have tried to measure the indirect cost or the external cost not borne by auto users directly. The estimates range widely and are controversial. The range for United States is between \$500 billion per year to \$1,500 billion per year (Delucchi [3]; MacKanzie et al [4]; Holtzclaw [5]; Litman [6]).

Irrespective of the wide diversity and controversy about the magnitude of the true costs of road transportation, the cost to the society is colossal.

2.4 Summary of urban transportation systems

The transportation impacts summarised in section 2.2 clearly point towards the unsustainability of current trends in road transportation. The current transportation pricing policies all over the world are such that road users do not pay the full cost of travel (infrastructure, environmental damage, health impacts, accidents, etc.) and hence over-use the subsidised road transportation systems. It must be understood that our current trends in car ownership, amount of travel, and almost total dependence on private car are not due to our inherent love for solo travel in cars but are the result of the political and economic policies of various governments which are not committed to recovering the full costs of travel. Since motorists pay only a fraction of the true cost of travel, road use is inefficient and non-optimal. It is believed that if road users were required to pay the full cost of travel, they will travel less and use more efficient travel modes. This is an important step in moving towards sustainability in urban transportation systems and the cities.

3. Approaches to sustainable transportation systems

There are several approaches to move the current urban transportation systems towards sustainability. These may be grouped under technological, economic-behavioural, and planning and management type solutions. Figure 1 shows a broad classification of approaches for sustainability in urban transportation.

3.1 Technological approaches

These approaches include technological advances in the automobile, road infrastructure, and traffic management. Advancements in all these areas are continuing with the objective of improving vehicle fuel efficiency, emission



TECHNOLOGICAL	BEHAVIORAL & ECONOMIC	PLANNING & MANAGEMENT
Ψ VEHICLE PERFORMANCE	Ψ DRIVER BEHAVIOR	Ψ LAND-USE PLANNING
Ψ TRAFFIC FLOW	Ψ PRICING, TAXATION, CHARGES	Ψ TRANSPORTATION PLANNING
Ψ INFRA-STRUCTURE	Ψ SOCIAL ACCEPTANCE	Ψ SYSTEMS MANAGEMENT

Figure 1: Approaches to Sustainable Transportation Systems

control, noise reduction, congestion management, highway safety audits, etc. All of these areas will also benefit significantly with the developments in intelligent transportation systems.

3.1.1 Vehicle technology

Development and use of greener cars which are fuel efficient, environmentally clean, and have better safety standards is considered to be a significant contributor towards a move to sustainable urban road transportation. Vehicles powered by alternative inexhaustible fuel sources can lead to sustainability but market forces are unfavourable for such developments. Regulatory policies will be required to produce greener cars, which should contribute significantly towards sustainable urban road transportation.

3.1.2 Traffic management

It is widely recognised that traffic congestion, manifested in frequent stops, braking and accelerating, results in higher fuel consumption and increased emissions. Hence the smoother traffic flow which is expected to result from advanced traffic management systems will reduce the adverse impacts of road transportation driving it towards sustainability. Improvements in traffic flows have been known to generate induced traffic, which must be controlled through appropriate policies.

3.1.3 Infrastructure

Construction and maintenance of infrastructure should make use of advanced technologies and greener recyclable materials. The safety design features and management of environmental impacts should incorporate sustainable and efficient strategies. The desired advancements in infrastructure provision are taking place too slowly. Not only should the construction and maintenance techniques adopt sustainable approaches, the design stage should aim at mitigating all undesirable impacts. Environmental impacts including



biodiversity, protection of sensitive areas, safety, aesthetics, noise impacts etc. must be minimised through appropriate enforceable regulations.

3.2 Economic and behavioural approaches

The governments must commit to full cost recovery principle. It is premised that if road users had to pay full costs of travel, it would result in economic efficiency and reduce demand. It will result in optimal use of various transportation modes moving the system towards sustainability.

3.2.1 Infrastructure costs

The costs of infrastructure should be estimated on the basis of amortisation of the investment, appropriate depreciation models and useful lives of pavements and bridges. These costs should be fully recovered from road users on the basis of the respective damage caused by various vehicles.

3.2.2 Accident costs

Although a significant proportion of costs associated with loss of productivity and pain and suffering by victims and their families are currently borne either by victims or paid by insurance companies, premiums should be reset to fully recover all costs associated with the accidents and their management. Safe drivers should not subsidise unsafe drivers.

3.2.3 Environmental costs

One of the major costs of car travel, which is not paid by road users, is the collateral damage to environment as well as the long-term effects of global climatic change. The damage to human health, property, agriculture, etc. can be estimated by damage cost and prevention cost methods. These costs can be quite substantial and should be charged on the basis of "polluter pays" principle through the imposition of carbon tax or other similar instruments.

3.2.4 Other costs

Costs associated with depletion of non-renewable and scarce fossil fuel resources as well as with mitigating other impacts such as noise and water pollution, delays, etc. which are currently borne by the society should also be estimated and levied to the road users.

3.2.5 Summary of travel costs

It is recommended that road users should be required to fully bear all the cost of travel through the imposition of appropriate level of fuel taxes, environmental levies such as carbon tax, full infrastructure cost, and suitable levels of insurance premiums. Such policies may not be popular with the electorate but are deemed essential for efficient use of roads. The taxes collected from the proposed policies should be earmarked to mitigate the undesirable impacts of road transportation. This is believed to be a powerful approach to making the urban road transportation more sustainable.



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3.3 Planning and management

Perhaps the single most important contributor to sustainable urban transportation is the reduction in the need for travel, and the most effective approach towards reducing travel is through land use planning, and mixed development.

Other strategies should be developed which encourage the use of environmental and energy friendly modes. The use of solo driving should be discouraged through traffic management and parking strategies. There are several effective and low-cost solutions in the planning and management of road transportation in our cities.

4. Discussion and conclusions

Our cities are progressively moving towards unsustainability. One of the major contributors to unsustainability is the pervasiveness of road transportation for movements of goods and people which is the cause of air, water and noise pollution, traffic congestion, delays, accidents, stress and frustration.

Efforts to direct the urban transportation on a sustainable path will greatly make cities more livable and sustainable. A transportation system, which allows high level of accessibility and mobility without the negative impacts, is not only desirable but also essential if the human survival is to be assured. Fortunately it is technologically feasible but government policies and social attitudes would require significant changes if the vision of sustainability has to be turned to accomplishment.

It is, therefore, premised that technological approaches in association with appropriate economic policies and management practices should be put in place to achieve sustainability in transportation and derivatively in our cities. There must, however, be a political will to proceed with the tough pricing policies. The policy makers must be prepared to withstand any opposition to removing subsidies to road users.

5. References

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