

SUSTAINABLE TRANSPORT: A REVIEW FROM A PRAGMATIC PERSPECTIVE

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1 INTRODUCTION

In recent years most societies committed themselves explicitly or implicitly to the principles of sustainable development preceded by the appearance of the Our Common Future report [WCED, 1987] and international agreement conform Agenda 21 [UNCED, 1992]. Nevertheless, beyond dispute quality-of-life, levels of basic freedom, health, education, access to/and distribution of resources etc. especially in urban areas in both the industrialised and industrialising world are in danger.

Reasons for this are inter alia the environmental and safety impacts of transportation, and the dependence of land-uses on the financial resources for construction and maintenance of its associated infrastructure.

Examples of these impacts are:

- Exhaust emissions from petrol and diesel engines (primary pollutants as carbon monoxide, nitrogen oxides, sulphur oxides, hydrocarbons and particulate matter), but also secondary pollutants due to chemical reaction of primary pollutants;
- Noise which mainly results from the growth of motorization, which can influence mood and reduces the performance of the cardio-vascular system, as well as affects intellectual and mechanical tasks [Haq, 1997];
- Congestion, from which major cities throughout the world are suffering;
- The large area of land for the construction of roads, railways, airports and ports, as well as the land-use of developments which are derived from these constructions;
- Traffic safety, with a majority of pedestrians, cyclists and motor cyclists as victims.

This is typically the conventional way of reasoning when discussing sustainability. This discussion usually ends up with the conclusion that it is urgent to reduce emissions, improve fuel efficiencies, promote public transport, improve traffic control, especially in the industrialising world [Opdam, 1994]. In first instance nothing is wrong with this argument, but it is questionable whether it is addressing the issue of sustainable development vs. transportation properly. The development problem is often seen as one merely dealing with for example fuel efficiency or emission control. Furthermore most literature deals with the environment only and not at all with development.

Therefore there is the need to see the benefits of transportation more explicit. It allows for the basic travel needs of individuals and groups of persons to be met. Socio-economic development is inextricable related with the quality of the living environment [Baggen, 1994]. Mobility is often regarded as a prerequisite for development. It is considered to allow for general availability of basic ingredients for a satisfactory life, but on the long-term it could as well be a threat for this same development, if not taken care of. Therefore, discussions related to the sustainability of transportation systems are within the centre of conflicts.

The discussion on sustainable development within transportation science relates to this (im)balance between 'costs' and 'benefits' of transportation systems. There is the need for transportation professionals to be more directly involved in this because of the commitment done by governments to develop transportation systems, which are compatible with this sustainable development. To do so, the concept needs to be internalised in transportation engineering and planning activities, i.e. operationalised for the development and operation of transportation systems.

This paper reviews current views on the concept of sustainable development and its application in transportation engineering. It discusses the different aspects that are important for operationalising sustainable development in transportation engineering and relates them to the existing definitions and views on sustainable transportation. The paper ends with recommendations for operationalising sustainable transportation system development.

For a more detailed discussion on the concept of sustainable development vs. transportation planning practice the reader is referred to another contribution to SATC 2000, [Zuidgeest and van Maarseveen, 2000].

2 DEFINING SUSTAINABLE TRANSPORTATION

2.1 Sustainable development

In order to define sustainable transportation a start has been made by studying definitions of sustainable development as well as searching for analogue definitions from other fields like ecology. A large body of literature has been published regarding sustainable development in the field of ecology-economy interactions, which obviously must have similarities with environment - transportation interactions, since transportation is often regarded as a prerequisite for economic development. Transportation is considered to be a means to an end. This opinion might however be discussed. It could as well be considered as a result of economic and social developments.

In the definition of sustainable development a number of aspects seem to be important:

- Sustainable development has to do with processes;
- Intergenerational justice should be borne in mind;
- The use of resources is a key aspect;
- Measurability of the definition seems to be problematic.

In the following these aspects will be elaborated.

Processes

Sustainable development is often referred to as being ‘a process of change in which the exploitation of resources, the direction of investments, the orientation of technological investment, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations¹’ as stated by the World Commission on the Environment and Development (WCED) (1987).

In contrast with many (most?) applications of the concept it must be clear that sustainable development includes more than just concern for environment and ecology. It is the interaction between an ecological, economic and social-cultural (community) system, as illustrated in figure 1. In a conservative development process there is the concern for economic growth and at the same time respect for ecological resources. Economy is allowed to grow within the limits of the carrying capacity of the environment. Besides there is the utopian development process which puts emphasis on community aspects like satisfying basic human needs together with respect for the use of resources. A third process type is one that strives for maximum communal economic development, ignoring care for ecological aspects. Sustainable development now comes where these three types of development interact

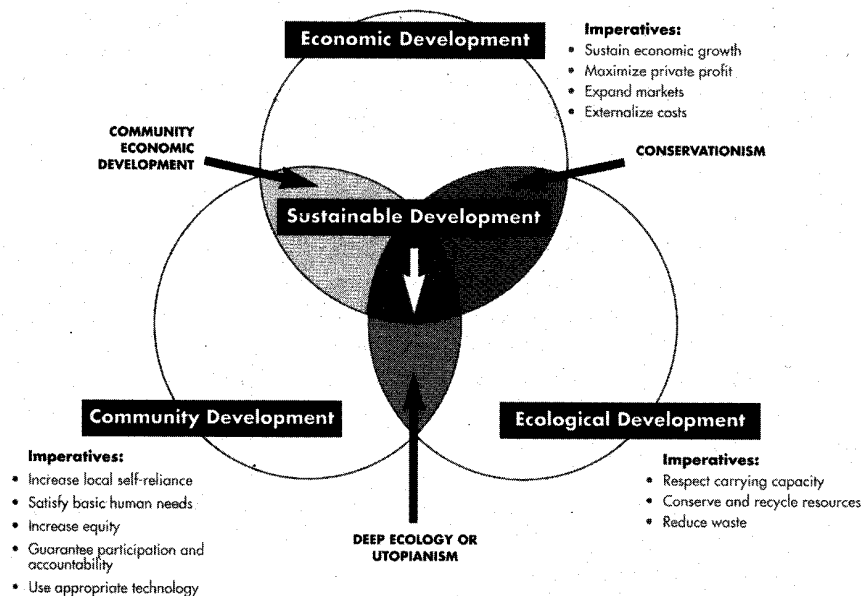


Figure 1 Three development processes, with possible interaction schemes [ICLEI, 1996]

Intergenerational justice

Distinct problems with the notion of sustainable development as proposed by the WCED are the issue of the anthropocentric objective of intergenerational justice, i.e. the long term horizon for planning and evaluation. What length of planning horizon should we consider? How can we justify choices for future potentials and needs? Furthermore, the issue of an ecocentric perspective of concern for ‘Nature’ as van den Bergh (1991) mentions, which to some extent may obstruct development, especially when considering industrialising cities.

The most important aspect of sustainable development must be that it is a process of change where the needs of the present and abilities of future generations are met within available and/or affordable resources capacities (both the present and future generations), and is therefore more than

¹ Also referred to as ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’.

preserving nature. As van den Bergh and van der Straaten (1994) state sustainable development refers to system-wide and (very) long-term processes and conditions.

The use of resources

The notion of intergenerational equity raises a difficult point, i.e. that of resource-use. Different opinions on the use of resources, especially those, which are non-renewable, have resulted in two groups of views, i.e. strong and weak definitions of sustainability.

The first group implies the non-substitutability between natural capital and artificial capital [Camagni, 1998], or no reduction in the availability of a non-renewable resource can be compensated by the increased availability of another one. This basically implies that for example every use of oil as a fuel for vehicles isn't allowed, since the rate of regeneration of oil is regarded nil, implying the search for alternative fuels.

The second group allows more or less ample substitution between various elements of the utility function or the production function (with the replacement of artificial for natural capital, taking care of future use of alternative fuels for engines instead of oil via for example R&D investment or natural capital as greenfield land, which is being replaced by overhead capital).

Measurability

Another important issue is the question whether sustainability is measurable. In order to do this terms like carrying capacity or maximum sustainable yield (MSY) have been introduced. MSY is the quantity of resources which may be 'harvested' without exceeding the replacement value or growth (due to regeneration). MSY can be placed between, hard 'objective' natural laws (known or unknown), like the second law of thermodynamics and weak 'subjective' social conventions to be maintained using respect and/or sanctions for exceeding norms [Hengel, 1997]. MSY is of special importance when considering the environmental aspects related with sustainable development. In transportation terms resources capacities have to be defined, for example environmental capacity (e.g. emissions CO₂), financial capacity (e.g. available budgets) and a 'social' capacity (e.g. safety).

Besides, there is the issue of identifying sets of indicators ([RMNO, 1994], [Houghton, 1998]), which can be used to measure 'sustainability' as well as 'development'. Performance indicators may be used to monitor a country's or cities performance in achieving sustainable development goals. Examples are policy indicators referring to a negotiated policy target (as for example stated in national transport plans, as [Dutch Ministry of Transportation, 1990]), for example an environmental sustainability indicator can be the national or regional carbon dioxide emission.

Summarising it can be stated that:

- Sustainable development is a bipartite concept. It involves sustainability as well as development, which is too often bypassed by merely focussing on the sustainability aspects;
- Sustainable development involves satisfying human needs as well as complying with resource availability or affordability, and deals therefore with more than the environment only;
- The concept of sustainable development is even extra complicated by the requirement of intergenerational justice;
- Although providing a very solid basis for the sustainable development discussion, most definitions of the concept are very general and descriptive, and doesn't give 'hands-on' possibilities for engineers and planners to apply the notion of sustainable development in their activities. A theoretical and operational analysis of sustainable development is not available (yet).

2.2 Sustainable transportation

Many attempts have been made to relate the concept of sustainable development to transportation. Alike definitions of sustainable development a large body of literature exists on this topic. Most views on sustainable transportation are also descriptive and quite general. Most often they are outcome instead of process focussed. Their emphasis is on the elements of sustainability in transportation, or what constitutes a sustainable transportation system, rather than on the development process of getting one. Three types of definitions may be distinguished:

- Ecology-oriented definitions;
- Integral definitions;
- Process definitions.

A few examples of these different types are given and discussed below.

Ecology-oriented definitions

Black (2000) suggests, in view of the Our Common Future definition, that a sustainable transportation system is one that would be functional today as well as by future generations. It is defined as 'satisfying current transport and mobility needs without compromising the ability of future generations to meet these needs' [Black, 1996]. Black argues that as transport sustainability initially only focussed on the environmental issues it is nowadays broadened by including other externalities as congestion, accidents, etc. Black stresses the importance of having instruments for measuring levels of sustainability, like summation of certain (indexed) indicators for different transport systems. The definition is rather general, descriptive and outcome focussed. The elements of a sustainable transportation system are discussed, but for example an actual description on how the balance between the current and future needs and resources should be achieved is omitted as well as a description on what these needs actually are.

An often-cited definition is that of Daly (1991), who argues that a physically sustainable society, from which a transportation system takes up a big share, should satisfy three basic conditions:

- Its rates of use of renewable resources do not exceed their rates of regeneration;
- Its rates of use of non-renewable resources do not exceed the rate at which sustainable renewable substitutes are developed;
- Its rates of pollution emission do not exceed the assimilative capacity of the environment.

Daly's definition is long-term environmentally focussed (short-term local air pollution for example is omitted) and lacks other important elements of sustainable development as discussed before. Because of that, it is often used in combination with other definitions like Black's.

The Centre for Sustainable Transportation Canada (CSTC) (1996) integrates a sustainable transportation strategy with a sustainable development strategy, i.e.: sustainable transportation will support the evolution of sustainable development through provision of safe, efficient, affordable transportation services developed and operated in a manner which minimises the environmental impacts of transportation. Here, elements of transportation system needs are given, furthermore a sort of weak definition is used, which merely strives for minimum use of resources. The requirement for intergenerational justice is therefore not necessarily complied with.

Integral definitions

The World Bank (1996) defines sustainable transportation as embodying three main components, figure 2 (compare figure 1):

- The economic and financial component, which includes issues of adequacy of transportation infrastructure funding, organisation, and scale;
- The environmental and ecological component, which includes issues of how transportation investments and mode options influence travel and land-use patterns and how these in turn influence energy consumption, emissions, air and water quality, and habitats; and
- The social component, which emphasises adequate access to transportation services by all segments of society.

To be effective, transportation policy must satisfy these three components.

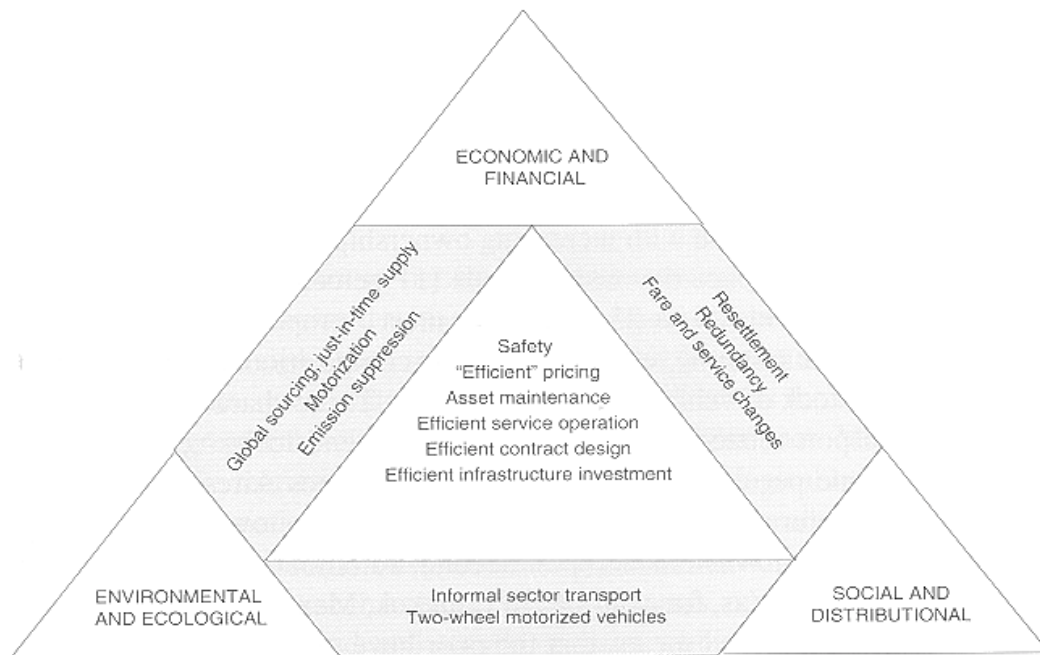


Figure 2 Three dimensions of sustainable development [World Bank, 1996]

This definition is written from a donor's point of view. It is descriptive, general at an aggregated level, and outcome related, but strives explicitly for a harmony between the people's needs and use of resources.

The US Federal Highway Administration (FHA) (1997) defines a sustainable transportation system as a system that meets short and long term social, economic and environmental goals while incorporating technological, institutional and political considerations into planning, programming and implementation processes. It's an outcome-focussed definition, which is descriptive at an aggregated level.

Process definitions

Kågeson (1994) formulates that policies for sustainable transportation can only be sustainably valid when addressing the basic needs for mobility today, the environment and the resources for the future as well as the health hazards (short-term local air pollution) of today. Camagni (1998) adds the importance for an emphasis on the 'process' and change. Therefore there is the need for 'process type' of definitions.

Such a type of definition is typified by Deen and Skinner (1994). It is a transportation system and a process for modifying or adapting the system that can accommodate expected population changes, growth in economic activity and changes in resource availability and (yet) meet environmental standards. Their definition is clearly process related, and therefore more focussed on the development aspect. Furthermore, it gives some operational aspects that should be satisfied in order to achieve a sustainable transportation system.

Akinyemi and Zuidgeest (2000) discuss a sustainably developed transportation system, i.e. a transportation system that meets the people's needs, i.e. in terms of mobility, accessibility and safety within the available or affordable environmental, financial and social resources. The available or affordable resources are determined based on an intergenerational objective. Sustainable transportation development is accordingly defined as a process of improving a transportation system towards a sustainably developed system. This process type definition strives for a harmony between transportation related needs and resources and therefore seems to be operational.

Summarising it can be stated that:

- Definitions of sustainable transportation differ in their focus;
- Most previously discussed definitions of the ecological or integral type are rather descriptive and outcome oriented, often at an aggregated level, which can lead to a wide variety of interpretations and uses. Some ignore the fact that sustainable development by definition is bipartite and focus merely on the (long-term) environmental aspects of sustainability, while others omit the requirement for intergenerational justice;
- Sustainable transportation development is an ambiguous phrase. It points out a process of transportation system development that will eventually comply with the aims for sustainable development;
- Consequently, an operational definition of sustainable transportation needs to indicate what aspects of sustainability as well as development (duality!) need to be taken into account. Furthermore, it reckons on the requirement for intergenerational equity. A definition in accordance with these demands will assist planners and engineers in their attempts to plan within the framework of sustainable development.

3 CONCLUSIONS AND RECOMMENDATIONS

From this review it should be clear that many aspects complicate the application of sustainable development idea to transportation. The current interpretations do not sufficiently address development and how sustainability and development objectives can or should be harmonised. Furthermore, criteria for sustainability are defined in terms of general principles and requirements, which can lead to a wide variety of interpretations and uses. In order to operationalise the concept one should be aware of the different elements of sustainability. These are amongst others concern for both the transportation related needs as well as the use of available or affordable resources (environmental, financial, social ...). Moreover the importance of intergenerational justice should not be neglected. This pleads for the use of strong definitions as long as it isn't clear at what pace resource substitutes are developed.

Sustainable development is a process. It is a development towards sustainability and should therefore be seen as a process of collective learning in which maximum synergy between the transportation-related needs and available resources is reached.

In order to operationalise sustainable transportation development research should be conducted towards:

- Quantifying the different elements of a sustainable transportation system, i.e. finding out the basic movement needs and aspirations of people in an urban environment as well describing the resources which are consumed by transportation systems as well as their accompanying resource capacities;
- Harmonising the elements of sustainability and development (with the aid of a modelling technique) for use in the planning and design of sustainable transportation systems.

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