

PERSPECTIVES ON SUSTAINABLE TRANSPORT

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ABSTRACT

Sustainability, also in transportation, is something that all reasonable and responsible authorities should aim for. The term is being used relatively loosely by many and the question is what is really meant by sustainability? The paper aims to firstly clarify the meaning and then provides some perspectives on the social, environmental and financial/economic consequences of transportation, and what it means in terms of transport sustainability.

1. INTRODUCTION

The concept of sustainability is considered vital for all aspects of life. In fact many environmentalists (e.g. Al Gore in Inconvenient Truth) argue that our existence on earth is threatened by consequences of our actions (e.g. CO² emissions, etc), which will have to change. In view of this, international conferences, such as COP17 which South Africa hosted in Durban in December 2011, are regularly held in an effort to get nations to agree on more sustainable ways forward. The transportation industry, being a consumer of energy (scarce resources), and a creator of some negative externalities (accidents, congestion, air pollution and also payment of subsidies), should understand what sustainability means.

Sustainability in transport nowadays is a popular term, often used by many – the question is whether the meaning is clearly understood. Statements regarding the sustainability of public transport services are often made, without recognising the financial (subsidy) consequences. So the first question has to be: what is understood by “**transportation sustainability**”? Secondly, if we know what it is about, which **transportation actions or sectors are not sustainable**?

The main objectives of this paper are to achieve some perspective on these questions. As is illustrated below, transport sustainability is a rather complex issue. The author does not claim to have all the answers, but if this paper contributes to the debate around sustainable transport, then it served its goal. It is widely agreed that sustainability has three main components, namely (generally referred to as triple bottom line):

- social
- environmental
- financial/economic

Any consideration of the concept should therefore address all three these components. A brief discussion of transportation impacts in these three areas is provided below. With respect to transportation, many questions with respect to sustainability can be asked, including:

- Is an increase in the per capita car ownership in South Africa, with the further demand on road space sustainable?
- Are the recently introduced BRT systems in our bigger cities sustainable?
- Are 300km/h trains sustainable in South Africa?

2. WHAT IS SUSTAINABLE TRANSPORT?

A number of definitions for sustainability exist. Six are discussed briefly below.

2.1 National Environmental Management: Biodiversity Act 2004

In terms of this act, the legal definition for sustainable is:

"sustainable", in relation to the use of a biological resource, means the use of such resource in a way and at a rate that:

- a) would not lead to its long-term decline;
- b) would not disrupt the ecological integrity of the ecosystem in which it occurs; and
- c) would ensure its continued use to meet the needs and aspirations of present and future generations of people.

The use of fossil fuels appears to be not sustainable according to this definition, as the use thereof leads to the decline in available sources in the long term. On the other hand, there are references⁹ claiming that "biogenic oil is not a finite resource and that known oil fields are being replenished continually by abiotic geological processes". The third part of the definition refers to the needs of future generations, which obviously is difficult to determine at this point – see below.

2.2 Brundtland Report

The more traditional definition comes from the Brundtland Report, i.e. "Development that meets the need of the present without compromising the ability of future generations to meet their needs". This is typically accompanied by the Venn diagram showing how sustainability is about balancing environmental, social and economic needs. Practical application of this definition is not easy in practice, as (i) how is it possible to determine now what the needs of future generations will be, and (ii) how can one determine now whether future generations will be able to meet their needs?

In general, there is difficulty in projecting into the future. One thing that is certain is that the future is not what it used to be. Many clever people underestimated the revolution brought about by personal computers in a relatively short period of time. The impact and enormous use of mobile telephones can be considered a "revolution" in communication. Are there similar inventions that can in a short time bring about more/other "revolutions", for example in transport? Current use of the internet is already contributing to less transport – many banking tasks for instance do not require a trip to the bank any more.

In some instances it might not be as complex as one can argue that when all fossil fuel reserves are depleted, then future generations will not have access to these reserves. What is not known is whether future generations will in fact have a need for fossil fuels. The huge concern at the beginning of the 20th century with respect to the amount of horse manure in cities, proved to be not that big a problem in the end with the arrival of the motor car and the disappearance of horse drawn carriages.

2.3 Wikipedia

Wikipedia defines sustainable transport as “any means of transport with low impact on the environment, and includes walking and cycling, transit oriented development, green vehicles, car sharing, and building or protecting urban transport systems that are fuel-efficient, space-saving and promote healthy lifestyles”. “Low impact on the environment”, “fuel-efficient”, “space saving”, as well as “healthy lifestyles” are not defined. These noble objectives can be quite complex and conflicting. One way of interpreting it would be to say that:

- the impact on the environment should not be higher (preferably be lower) than at present;
- ditto for the other requirements.

Even this interpretation could be difficult to translate to real world situations. As pointed out by Rachel Aldred in *Mobility* magazine, a bit more walking, cycling or use of rail, could lead to a broadly unsustainable system. High levels of cycling will not necessarily solve all environmental problems if everything else stays the same.

2.4 New Mobility

New mobility, also known as “sustainable transportation” – is defined as being about moving people, moving goods, and moving less, in ways that are cleaner, greener, safer, healthier, and more equitable (and more “hip” of course). This definition could be the closest to what is meant by sustainable transport. It makes two valid points that no one can argue with:

- i) Move less, i.e. be more effective, requiring less movement of people and goods;
- ii) Move in better ways, i.e. with less negative consequences.

The last requirement, namely move in a more equitable way, is more difficult to interpret as it may not mean the same to everyone.

2.5 Todd Littman

Todd Littman⁸ defines sustainability as “a condition in which economic, social and environmental factors are optimised, taking into account indirect and long term impacts. It balances economic, social and environmental objectives. Sustainability emphasises the integrated nature of human activities and therefore the need for coordinated planning among different sectors, groups and jurisdictions”.

2.6 Institute for Transportation and Development Policy (ITDP – New York)

In their Winter 2010 magazine, “Sustainable Transport”, the ITDP summarised ten principles that defines sustainable transport, as they see it. These are:

1. Walk the walk, i.e. design for pedestrians
2. Focus on cycling
3. Get on the bus (comfortable, safe, high speed transit)
4. Discourage car use (parking/congestion charging, remove highways)
5. Create and maintain a sense of place in communities
6. Design and create high quality, well managed public spaces
7. Make street blocks short and narrow
8. Densify rather than allow urban sprawl
9. Encourage mixed development
10. Manage goods delivery better (cleaner, smaller, slower, quieter, safer vehicles).

The first four are basically saying get away from cars, while five of the rest focus on land use. The importance of better land use practices in achieving sustainable transport cannot be emphasised enough. Tradition in South Africa, where most people have this apparent need for some plot (land) around his dwelling, makes densification quite difficult.

2.7 Discussion

It is concluded that, whilst the definitions of sustainability provide an idea what is meant by the concept, it is not simple to determine whether an action is indeed sustainable or not. One possible approach that could have merit is to divide transportation actions into (say) three categories, namely:

Sustainable

May be sustainable

Not sustainable

This might lead to a scale of sustainability, say 1 to 10, where 1 is considered sustainable and 10 totally unsustainable. This still will have to be done subjectively, as there is no method currently to determine the value on the scale for a specific action. With present knowledge it can be stated that walking should be close to 1, although for a ninety year old person, walking could be 10. Tourist travel to the moon currently appears to be close to 10 on such a sustainability scale.

The Federal Highway Administration of the US Department of Transportation, in a case study¹ on sustainability in Illinois, confirms this lack of a comprehensive guide to make decisions on sustainability on a project level. They developed the so-called I-LAST tool (manual) in January 2010, which is a guide and rating system for liveable and sustainable transportation infrastructure. The overall impact of the rating system has been to serve as an inventory of best practices and to provide a simple framework for evaluating transportation projects.

3. SOCIAL

The social implications of transport on people's lives are considered substantially more positive than negative. Was it not for transportation systems, then life on earth with its 7 billion inhabitants would, in all likelihood, not be sustainable. The transport systems of countries and the world make it possible for residents:

- to reach work opportunities and make a living;
- to access education, health, shops (food), recreation, entertainment, tourist attractions, etc.

The value of the transportation system to the economy, enabling the movement of people and the distribution of goods in SA (the positive externalities), is enormous. It is estimated that the transport industry forms approximately 15% of the economy, so the positive externalities of transport should be worth around 15% of the GDP, which for South Africa means R450 billion per annum at present. As Gary Kendall⁸ puts it "transport is the economy".

For sure there are negative impacts. Some of the more important ones are considered to be:

- Fatalities and injuries related to accidents on all modes of transport. Road travel can be considered the most severe in this respect - whether a pedestrian, in a private car or in a public transport vehicle. Train, ship and aircraft accidents add to the picture.
- The consequences of air pollution on personal health and on climate change (Earth warming).
- Wastage of time in congestion.

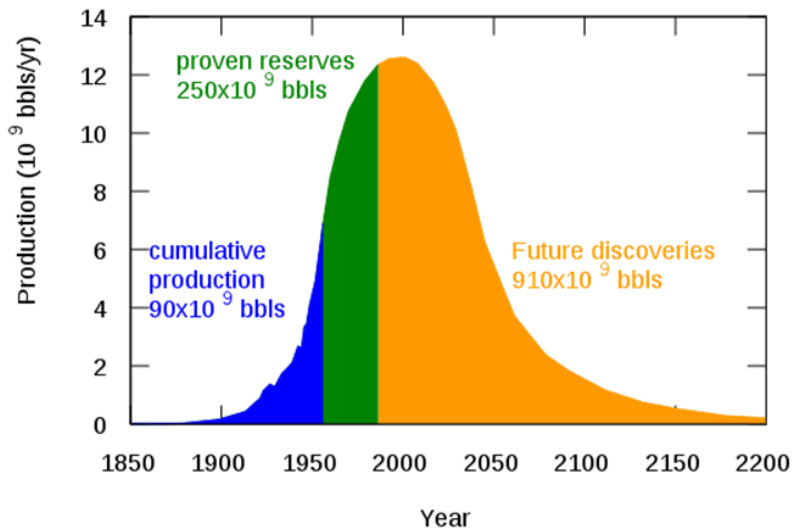
4. ENVIRONMENTAL

It is considered that there are three major environmental impacts from transportation on the environment, namely (i) the use of fossil fuels, (ii) the contribution to Earth warming through vehicle emissions and (iii) the impact on the physical environment (e.g. wetlands, animals, plants, visual pollution, noise, etc). These three impacts are discussed briefly below.

4.1 Fossil fuels

The International Energy Association indicated in 2010 that the transportation sector consumes just over one quarter (27.3%) of all energy being used on earth. Industry, residential uses and other services make up almost two thirds (63.8%) of all energy consumed. In 1999, petroleum, natural gas and coal accounted for nearly 85% of the world energy production. Worldwide energy consumption grew by approximately 20% (from 82 to 98 Terrawatt hour) between 2000 and 2008. So, whilst the transportation sector is an important user of fossil fuel energy, it is not the dominant user.

With respect to the use of fossil fuels, sources have changed through the years with respect to the amount of reserves that could be left for future generations. Hubbert⁷ (Wikipedia) estimated in 1956 that proven reserves and potential discoveries of petroleum could be equal to 1160 billion barrels, which was expected to last till somewhere between 2050 and 2100 (with steep reduction in consumption).



Source: Hirsch Report

More recent studies done in the USA⁷, estimated total petroleum reserves to be more than double those predicted by Hubbert, at 2686 billion barrels, which should last at an annual consumption rate of 27 billion barrels, for another 98 years. Other sources⁹ reckon that oil reserves are being replenished in a natural way, making the issue of limited petroleum smaller.

World Fossil Fuel Reserves and Projected Depletion

| <i>Global Fossil Fuel Reserves</i> | World Petroleum <i>(Billion Barrels)</i> | Natural Gas <i>(Trillion Cubic Feet)</i> | Coal <i>(Billion Short Tons)</i> |
|------------------------------------|--|--|--|
| World Reserves (Jan 1, 2000) | 1,017 | 5,150 | 1089* |
| World Potential Reserve Growth | 730 | 3,660 | -- |
| World Undiscovered Potential | 939 | 5,196 | -- |
| TOTAL RESERVES | 2,686 | 14,006 | 1,089 |
| ANNUAL WORLD CONSUMPTION | 27.340 | 84.196 | 4.740 |
| YEARS OF RESERVES LEFT** | 98 | 166 | 230 |

*World Estimated Recoverable Coal **Based on current levels of consumption and estimated total reserves

Table 1: World Fossil Fuel (Petroleum, Natural Gas, Coal) Assessment¹

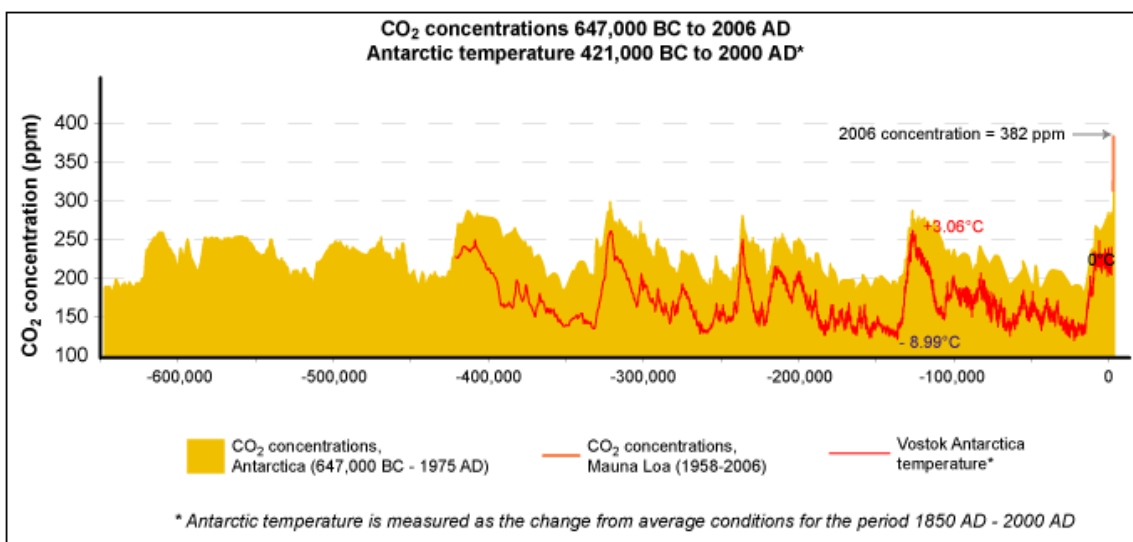
Even so, it can be concluded that fossil fuel sources will not last forever, in all likelihood another 50 to 100 years. Transportation modes are not the dominant user of these sources, but it is a significant one. Alternative sources of energy for transport vehicles are being developed and phased in already, even though the "ideal", abundant, environmentally friendly replacement for petroleum seems not to be invented yet.

4.2 Vehicle emissions

To understand the impact of vehicle emissions on the environment, some background on Earth warming and climate change is required. The dominant mechanisms (to which recent climate change has been attributed) are considered the result of human activity. They are accepted to be (An Inconvenient Truth):

- increasing atmospheric concentrations of greenhouse gases;
- global changes to land surface, such as deforestation;
- increasing atmospheric concentrations of aerosols.

There are also natural mechanisms causing climate change, such as periodical climate oscillations, changes in solar activity, variations in the earth's orbit and volcanic activity. Global warming is therefore caused by numerous human and natural influences, of which one is the emission of greenhouse gases. Note that carbon dioxide concentrations over more than 600 000 years indicate the cyclic variations as shown below. From this it can be concluded that peaking in CO² concentrations occurred numerous times before, although the recorded 2006 concentration of 382 ppm, is higher than the previous peaks. Whether natural mechanisms will bring about the cyclic reductions of the past, is not known, but possible.



The three most important greenhouse gases are carbon dioxide (CO² – 72% of total), methane (18%) and nitrous oxide (NO_x – 9%). Carbon dioxide emissions, produced from the burning of fossil fuels, grew from 21.6 to 27 billion tons per annum between 1991 and 2005 – an increase of 25% over fourteen years (<http://timeforchange.org>). Note that the world population grew with 20% over this period (from 5.4 billion to 6.5 billion).

When vehicle emissions are considered, the transportation sector contributes 19% to the carbon dioxide production, but only 14% (or about one seventh) of all greenhouse gases⁸ - see table below.

ANNUAL GREENHOUSE GAS EMISSIONS BY SECTOR (2002)

| Sector | Contribution To | | | |
|---|-----------------|---------|---------------|----------------------|
| | Carbon Dioxide | Methane | Nitrous Oxide | Total Greenhouse Gas |
| Industrial processes | 20.6% | 0.9% | 5.9% | 16.8% |
| Power stations | 29.5% | - | 1.1% | 21.3% |
| Waste disposal and treatment | - | 18.1% | 2.3% | 3.4% |
| Land use and biomass burning | 9.1% | 6.6% | 26.0% | 10.0% |
| Residential, commercial, and other sources | 12.9% | 4.8% | 1.5% | 10.3% |
| Fossil fuel retrieval, processing, and distribution | 8.4% | 29.6% | - | 11.3% |
| Agricultural byproducts | - | 40.0% | 62.0% | 12.5% |
| Transportation fuels | 19.2% | - | 1.2% | 14.0% |

Source: Robert A.Rohde, http://en.wikipedia.org/wiki/Greenhouse_gas

Based on the relatively low contribution of transportation fuels (note cars form a portion of this) to the total greenhouse gases, at least three conclusions are made:

- i) previous natural phenomenon caused peaking of CO² levels to values that are of the same order as those measured today;
- ii) the impact of transport vehicle emissions on Earth warming is low, and while there is merit to reduce it, other contributors (industry, power stations) are the more important ones to attend to;
- iii) the CO² taxation on road vehicles appear to be a money making scheme by governments and the sincerity of really reducing greenhouse gases can be questioned.

4.3 Physical environment

The National Environmental Management Act, as amended (NEMA - Act 107 of 1998), has as goal the balancing of the population's social needs and their impact on the environment. It therefore says that "environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably". It is added that "development must be socially, environmentally and economically sustainable". Sustainable development is then defined to require inter alia the following:

- That the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied;
- That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;

- That the development, use and exploitation of renewable resources and the ecosystems of which they are part, do not exceed the level beyond which their integrity is jeopardised;
- That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.

The construction of roads, rail lines, airports and ports mostly has a considerable impact on the physical environment, and this act clearly is in place to limit the impact thereof to acceptable levels. Complying with all of these requirements in many cases (e.g. mining activities) must be difficult (if not impossible), but it is concluded that at least the intention is there to limit the impact on the physical environment.

5. FINANCIAL

With respect to the financial sustainability of the different transport modes/services, the following is considered of importance with respect to road users, public transport, rail freight services and air services.

5.1 Road users

The financial situation relating to road users is often (apparently) misunderstood by politicians and others. It has been shown in the past^{2,3} that this group represents an extremely profitable business case for government, and has been and still are tax milk cows par excellence. They are contributing much more in taxes than what government is spending on them. They carry their external costs largely themselves³ and from this viewpoint can be considered highly sustainable.

Recent **direct taxes** (user charges) paid by road users in South Africa are (R billion per annum 2010/11):

| | |
|---------------------------|--|
| Fuel levy | 34.5 (p71, SARS Annual Report 10/11) |
| Licence fees | 4.0 (author's estimate for 10/11 – 8 million vehicles at R500) |
| Toll fees | 1.7 (SANRAL Annual Report 10/11) |
| TOTAL direct taxes | R40 billion+ (for 2012/13 this amounts to approx R50 billion) |

Other more **indirect taxes/charges** paid by road users included (2010/11):

| | |
|-----------------------------------|---------------------------------------|
| Road Accident Fund | 15.7 (p71, SARS Annual Report 10/11) |
| Customs on fuel | 1.0 (author's estimate based on 4c/l) |
| VAT on vehicles and parts | 15 to 20 (author's estimate) |
| Import duties on vehicles/parts | 2 (author's estimate) |
| Income Tax from freight operators | unknown |
| TOTAL indirect taxes | R35 billion+ (for 2010/11) |

The **expenditure** on roads for the same year has been (R billion per annum 2010/11)⁴:

| | |
|------------------------------|----------------------|
| National Department of Roads | 10.3 |
| SANRAL | 7.5 |
| Provincial Roads Departments | 14.8 |
| TOTAL | R32.6 billion |

In addition it was estimated that the metropolitan municipalities spent R10.6 billion in 2010/11 on road capital and maintenance costs⁴. It is difficult to estimate what portion of

this came from the national fiscus, rather than from their own sources - property and other taxes.

In conclusion, as before, it has to be said that the road users as a group makes business sense for government and therefore are highly sustainable from this viewpoint. An increase in per capita vehicle ownership therefore should be financially sustainable. In view of the recent relatively widespread opposition to the proposed Gauteng e-toll scheme, it has to be concluded that consumers/road users have apparently reached a saturation level with respect to taxation levels.

5.2 Public transport

Worldwide bus and commuter rail services, are considered social services, and are not financially independent. It has to be subsidised to varying degrees by governments. Whilst these services are generally considered more sustainable than car transport, due to less energy consumption and air pollution per passenger trip, they have a substantial external cost in terms of subsidy required. The recent introduction of Bus Rapid Transit (BRT) services in South African metropolitan services has been welcomed by most, but there is a huge question regarding its financial sustainability (see below).

In general, approximately 50% of all person trips in the metropolitan areas, are made daily on public transport. The transport system cannot work without both private and public transport fulfilling their roles. Whilst many people are advocating a larger role for public transport, largely from environmental considerations, it has to be acknowledged that it will come at a cost. Minibus taxis have, in recent years, grown their market share and the reported modal split in Cape Town (daily basis – 2004 Current Public Transport Record) for the transit modes was:

| | | | | | |
|---------------|-----|---------------|-----|-------|-----|
| Minibus taxis | 29% | Commuter rail | 54% | Buses | 17% |
|---------------|-----|---------------|-----|-------|-----|

Minibus taxi services are not directly subsidised, but they are subsidised to a degree through the facilities that are made available to them. According to the Estimates of National Expenditure (2012 Budget, Vote 37, Transport), the transfers with respect to public transport currently are (2012/13):

| | |
|--|---------------|
| Passenger Rail Agency of SA | R10.3 billion |
| Public Transport (bus infrastructure and operations) | R 9.8 billion |

Approximately R20 billion is therefore currently paid per year for bus and rail subsidies. The magnitude of these numbers is interesting if one considers that in 2009, the bus subsidy level of around R4 billion developed into a sustainability issue and led to a change from ticket based subsidies to kilometre based subsidies (Government Gazette 32142, 17 April 2009, p165). One of the responsibilities of the National Department of Transport, indicated in this Gazette, was to “improve efficiencies of public transport spending”.

The financial implications of the Bus Rapid Transit (BRT) services implemented in Cape Town raise questions when viewed from a sustainability angle. The operational costs are not covered by the fare revenue and coarse calculations (Die Burger, 27 April 2012) indicate that the operational subsidy at present amounts to at least R30 per passenger trip (300 000 person trips/month, operating shortfall around R10 million/month). Should the capital cost of the first phase (more than R4 billion) have to be paid back over 20 years at 6% p.a., then the total subsidy per passenger trip is more than R100 per passenger trip.

In simple terms this means that while every user currently pays R10 per passenger trip, the tax payers (in SA at present roughly 10% of the population) pay a further more than R100 for the trip. Even though this situation will improve with increased ridership, the financial sustainability has to be questioned. The cost consequences of BRT systems as applied in South Africa need serious reconsideration.

Should the Johannesburg/Durban corridor be considered for high speed rail, it has to be acknowledged that at least five passenger services exist in the corridor, namely:

- airlines;
- passenger rail services;
- minibus taxis on roads;
- long distance buses on roads;
- private cars on roads.

The first two are subsidised to an extent. Should the enormous cost of such a system (estimated at least to be R250 billion in view of cost of Gautrain), be considered in relation to the potential ridership of say 90 000 persons/month, it is clear that it cannot be financially sustainable. To redeem capital cost alone would mean approximately R20 000 per person trip.

5.3 Rail freight services

It has been shown before⁵ that rail freight services have traditionally been subsidised by government through direct grants, exemption of certain taxes, writing off of loans, low interest rates and even profits on the oil pipe lines (note transportation of oil was and still is being paid for by road users).

The importance of rail freight services in South Africa, especially with respect to the haulage of relatively low value, heavy goods (largely coal, iron ore, etc), cannot be underestimated and the services should be protected – even if it is requiring some government financial assistance. Without any analysis, it is concluded that the relatively low subsidisation of rail freight is sustainable. The main motivation is the consideration that the alternative (moving these goods by road), will not be sustainable from an environmental viewpoint.

5.4 Air Services

With respect to air travel, at least three major government owned organisations are involved, namely the Airports Company of South Africa (ACSA), South African Airways (SAA) and Air Traffic and Navigation Services (ATNS). All of them are expected to operate on business principles.

ACSA made good profits in its initial years of operation, but has recently basically been braking even – according to their 2011 Annual Report a small loss has been made in 2011. As far as is known, the capital for the world class extensions/upgradings at the major airports, has not been subsidised, but are financed by ACSA themselves.

SAA operates in a highly competitive environment with expensive equipment (aircraft), where rising fuel prices are making profits difficult. SAA had to be assisted by taxpayer money on a number of occasions in the past, and recently had to request a R6 billion “recapitalisation” subsidy. This assistance to a “loss-making entity” has been questioned⁶.

Taxes on air tickets have increased drastically in the past five years and now form a noticeable portion of the cost of flying. In perspective to the other modes, air travel has been subsidised to a limited degree, but it will have to get much more expensive to be financially sustainable.

The services of ATNS are vital for the provision of safe air travel and all air travellers would agree that their services cannot be compromised. According to their 2011 Annual Report, the company made profits during the last five years (R182 million in 2011), and it is therefore concluded that they are financially sustainable.

6. CONCLUSIONS

The following conclusions are made:

- 6.1. It is not simple to determine whether an action is indeed sustainable or not. One possible approach for practical application could be to develop a rating system, as was done overseas. The best and short way to define sustainable transport appears to be: *Move less in a better way, and achieve a balance between economic, social and environmental objectives in the process.*
- 6.2. The social value of the transportation system to the economy (the positive externalities), is enormous. It is estimated that the transport industry forms approximately 15% of the economy, so the value of transport should be around 15% of the GDP, which for South Africa means R450 billion per annum at present. Transport is the economy.
- 6.3. Fossil fuel sources will not last forever, in all likelihood another 50 to 100 years. Transportation modes are not the dominant user of these sources, but it is a significant one. Alternative and environmentally friendly sources of energy for transport vehicles have to be developed.
- 6.4. Previous natural phenomenon caused peaking of CO² levels to values that are of the same order as those measured today. The impact of transport vehicle emissions on earth warming is low (14% contribution), and while there is merit to reduce it, other contributors are the more important ones to attend to. The CO² taxation on road vehicles appears to be a money making scheme by governments.
- 6.5. From a financial viewpoint, road users as a group makes business sense for government and can be considered highly sustainable. Public transport has been and will have to be subsidised – this could be considered the price to be paid for a balanced person movement system. The same can be said of rail freight and air travel services. The financial sustainability of recent BRT systems is questionable and the way it is being implemented locally needs serious reconsideration.

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