

# Sustainable Road Transport in Developed and Developing Countries: Framework and Future Research

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**Abstract** - The road transport sector is currently in an increasing globalization of the economy and is marked by three factors likely to destabilize: the need to reduce greenhouse gas emissions, the expected rise in oil prices, economic competition more and more strong. The sustainable transportation has emerged as an environmental innovation that integrates the environmental concerns in the management of the supply chain. This topic has gained in popularity among scientists as well as for practitioners. The purpose of this document is to briefly go a review of recent literature and determine the slopes of research of this emerging field. The review of the literature review is focused on the development of the sustainable transportation in developed and developing countries, including all the research which are in relation with sustainable development, the sustainable logistics, eco-transport and sustainable mobility. It shows that the absence of research for the adoption and implementation of sustainable transportation practices in particular in the developing countries such as Morocco. Thus, the authors put forward proposals for tracks of research for sustainable transportation.

**Key words:** *Sustainable Transportation, Developed Countries, Developing Countries.*

## I. INTRODUCTION

The road transport sector is a key activity in our daily lives. It directly contributes 5% to 10% of (GDP) in most countries, and indirectly allows the other sectors to contribute to the social and economic development. However, the transport also consumes resources and has negative side effects, including air pollution, congestion, and road accidents. Transport is already responsible for nearly a quarter of CO<sub>2</sub> emissions.

On the whole, the contribution of transport to sustainable development depends on the resources it consumes, and the negative side effects that it generates.

To confront the period of transformation, which opens in front of him, the sector must benefit, taking into account the significant failures of markets which the concern, a strong program of action on the part of the State, which however deserves to be rethought in depth both in its principles and in its modalities: the interventions of public power are today very many in the sector, but they often remain poorly adapted and little effective; on the other hand, even if it is necessary, this renewed action by the State, which must

enroll in a global perspective, will not suffice to solve the whole problems. The road transport sector will continue to play its role in Morocco and at the global level, that thanks to the action of the men and women who compose it, and to their dynamism which enable them to adapt to future developments.

In a first time, this article returns to the state of the art of sustainable transport at the level of developed and developing countries, to propose in a second time the recommendations of track of research to the Moroccan level which will be the backbone of the sector road transport 'sustainable' and which should guide the research in the short but also in the longer term.

## II. LITERATURE REVIEW

### *Sustainable road transport*

The transport sector is a major contributor to climate change. He is currently regarded as being responsible for 23% to 25% of global emissions of GHG (International Energy Agency, 2009), including 65% of discharges compared to the sector comes from road transport (Chapman, 2007). Taking into account the current trends of transport, energy consumption and CO<sub>2</sub> emissions are expected to increase by nearly 50% in 2030 and more than 80% of 2050.

There are several definitions of sustainable transportation we include the one who are the most cited in the literature:

- A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable. (ECMT 2004)
- Environmentally Sustainable Transportation (EST) is: Transportation that does not endanger public health or ecosystems and meets needs for access consistent with (a) use of renewable resources at below their rates of regeneration, and (b) use of non-renewable resources at below the rates of development of renewable substitutes. (OECD 1998)

The following definition of sustainable transportation will be our preference, because it is comprehensive and clearly indicates that the sustainable transport must balance the economic, social and environmental objectives following so-called "triple bottom line". At the same time, it has a

wider scope and recognizes the specificity of transport problems. According to this definition, a sustainable transport system (CST 2005):

- 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 minimising the impact on the use of land and the generation of noise.

*The pollution resulting from these transport is the main cause of environmental pollution. These pollutants include:*

- The noise, which is a source of embarrassment and discomfort and disturb sleep and communication. It is both a source of inconvenience and a health problem. It is noted in Europe a limited loss of the number of black dots along the major infrastructures, a quasi-stability of noise levels in town, an extension of the noisy areas intermediaries (geographical extension and temporal traffic), and a progressive reduction of quiet areas.
- Air pollution local or regional, that can be classified in a so-called pollution sensitive to our meaning (odors, smoke and dirt), direct impacts on the health of pollutants emitted, and photochemical pollution regional (secondary pollutants sources of pollution sensitive and effects on health). We note a decrease of the levels of lead, sulfur dioxide, carbon monoxide and volatile organic compounds, of the levels of nitrogen oxides fairly stable and rather decreasing in the short term, a rising trend of photochemical pollution (ozone...) and its geographical extension (the photochemical episodes now cover thousands of kilometers), and an increase of the levels of fine particles (Fangeat et al., 2003).
- The pollution of waters and soils which affects the groundwater, rivers and soils.
- The hydrological risks due to infrastructure playing the role of dam in floods, and the diversions of water following a highway development for example.
- The space problems: cut the territories of life of men and animals, quality problematic of peri-urban landscapes, impact of major transport infrastructures on the rural landscape. It is observed on the one hand an extension of infringements of landscapes by the growth of heavy infrastructure of land transport (motorways, train), and on the other hand a strong extension of the peri-urban areas which creates a situation of more and more problematic than the little is known treat today.
- The cultural heritage, which is as much the historical monuments, archaeological remains that the vernacular

architecture, likely to disappear when transport facilities.

- The consumption of non-renewable resources (fossil fuels, metals ...) which is incompatible with a sustainable development: the declining resources, and our level of consumption is not generalizable.
- The waste, during the life cycle of the infrastructure, vehicles and energies.
- The destruction of biotopes (animals and plants) by the cutting of their territories, the disappearance of protected species, the loss of biodiversity.
- The greenhouse effect which should be reflected in an increase in the average temperature of 1.4 to 5.8 °C in a century, the rise of the oceans, the turmoil of the regional climates and the increase of extreme events. There has been a continued growth, past, present and future, of the levels of greenhouse gases and therefore of the greenhouse effect in the long term. The problem is getting worse and therefore is without doubt the most worrying of impacts on the environment.

*The sustainable transportation in the developed countries*

At the level of the European Union, the transport sector is the largest end-consumer of energy (30 %). Movements are also responsible for a large proportion of greenhouse gas emissions. The increase in the quantity of CO<sub>2</sub> released is as amplifier of the climatic consequences due to the greenhouse effect. However, among the different modes of transport, road transport is largely responsible for environmental problems, generating by itself, nearly 84% of the CO<sub>2</sub> emitted by the sector as a whole.

In order to provide a substantial contribution to the achievement of the Kyoto targets, the European Commission is essentially fixed targets for average emissions for the whole of new cars sold in the European Union through the conclusion of agreements with the major car manufacturers. Yet, if the vehicles consume less and pollute less, the responsibility of the transport sector in the deterioration of the environment remains not less significant; the decrease of consumption and unit emissions of vehicles is, in effect, largely offset by the continued growth in road traffic.

Instead of assigning a monetary value to the costs and returns in a cost-benefit analysis, a more integrated approach includes, in addition to the monetary values traditional, of social and environmental values non-monetary which reflect the epistemology of sustainability (Jones et al., 2000; Deakin, 2002). This sustainable vision "requires that the elaboration of policies . . . Must be considered in a holistic sense: that there will be no more take insulation transport planning, land use and the environment" (Geerlings et al., 2003). Researchers who adopt the amendment of the current transportation system in a more sustainable system often identify as mandatory the use of the method of the full cost (Jones et al., 2000; Schipper, 2002).

Most of the work is focused on the means to be used in the green transport. Themes such as the transportation multi modal stand out often enough, this last allows to reduce the emissions of greenhouse gases, using the railway and inland

water transport. This mode of transport has been stressed as beneficial in several studies such as the study carried out jointly by the ministry of ecology and one of recovery productive in France. Other researchers are dedicated to the technologies which should equip the vehicles of tomorrow: electricity, hydrogen, the hybrid ! (Louvet et al, 2013) develop the opportunities for innovation, not technology, but of the social dimension in transport, based on solidarity and the strategies of mutual assistance, to council and mutual information between communities of practice (carpooling, car sharing between individuals) who offer to the user a postage of such or such mode and allow him a greater flexibility.

#### *The sustainable transportation in developing countries*

In developing countries, the situation is different, because the consumption of natural capital due to transportation is, on average and per capita, well below what it is in developed countries. But it is without doubt equivalent or even superior to a fringe group of their population, and that request to clearly differentiate the problems according to the social class, thus responding to the second requirement of sustainable development, social equity. Developing countries cannot also afford to reduce their greenhouse gas emissions and to systematically reduce their impacts on the environment at the expense of their development. This does not mean that the environmental and social impacts of the development of transport are negligible or secondary, but rather that the balance between the economic, social and environmental aspects may be different from the objective in the developed countries. This balance depends, inter alia, on the relevance of the different environmental problems and of the responsibility of Transport

The control of transport impacts on the environment must be the opportunity to develop the transport of intelligently using all their potential. The taking into account of the externalities when making a decision allows you to reduce the overall cost and thus optimize the transportation system, to make it economically, socially, and environmentally more efficient.

The issue of eco-transport still remains little studied in developing countries even if most of the major cities are experiencing many difficulties related to transportation. In effect, the importance of the parks real estate often has adverse consequences on the quality of the air.

This is the case of Mexico City, the capital of Mexico, which has 6 million vehicles for 18 million inhabitants and 600 put into circulation each day. The city has carried out an ambitious program of eco-transport (improvement of the fleets of buses ...) which has enabled him to move from good 8 days per year in terms of quality in 1992 to 248 days in 2012.

Also in Africa, the studies are rare as the initiatives. However, South Africa has just put on feet a center, the national institute of energy development in South Africa SANEDI, in order to explore ways and means to reduce the use of energy in the country.

#### *The sustainable transportation in Morocco*

In Morocco, the transport sector all modes confused contributed to height of 6 per cent to the GDP and 9% of the value added by the tertiary sector, participated in reason of 15 per cent to the revenue of the State budget, absorbed 35 per cent of the domestic consumption of energy whose 50 per cent of petroleum products, employs approximately 10 per cent of the urban labor force (National Council of the Environment).

The road transport in Morocco provides 90% of the mobility of people and more than 75% of the flow of goods out phosphate, on a road network of 57,500 Km of which 32,100 coated, and nearly 1,416 km of motorways. This network supports the circulation of nearly 50 million vehicles km/day performed by a fleet of 1.5 million vehicles.

In Morocco, the objective is to reduce these emissions by 35 %. The actions that have been put in place by the state:

Table 1: Actions undertaken by the government in the objective of GHG reduction

Action	Period	attenuation Potential
Strengthening of the technical inspection of vehicles in circulation by the technical visit centers	2008 - 2012	54 kt CO2/year
Renewal of the fleet of vehicles of road transport of goods and taxis, at a premium of renewal of vehicles	2008 - 2012	501 kt CO2/year
Promotion and development of rail transport, by the realization of the High Speed Train service Tanger-Casablanca and electrification Fes-Oujda		In the course of assessment
Project for the development of urban transportation: regional express network of Casablanca	2009 - 2014	880 kt CO2/year
Commissioning of the tram of rabat	2010	119 kt CO2/year
Commissioning of the tram of Casablanca	2012	In the course of assessment
Implementation of plans for moving city and intercity, while ensuring consistency with the plans of communal facilities		In the course of assessment

In the framework of these guidelines. The logistics strategy in Morocco, has set goals related to the environmental issue, through the contribution of the sector in the sustainable development of the country. It is obvious that the bet of the competitiveness is a very important issue for a sector in the development phase, but do not integrate the departure the impact costs of social and environmental harms the ability of the sector to maintain a sustainable competitive position (Jami et al, 2013).

The analytical approach and partial is therefore largely inoperative. An integrated approach, so-called systemic is necessary: it is not to focus on isolated segments of the sector, but to analyze all of the components of the transport sector, of course in a view of reduction of impacts and development of the supply in transport for all. This past first by a diagnosis of the system that do in neglected any element, whether it is the analysis of the mobility of persons and goods, traffic flows and sources of impacts, the control of the quality of the environment, policies to reduce emissions (in the broad sense) of vehicles, or to the promotion of sustainable modes. The consistency of the analysis is thus acting as a guarantor of the effectiveness of potential solutions that will be deducted, to improve the quality of the environment, develop urban space and improve the efficiency of the transport system, with convincing results in the short term.

### III. FUTURE RESEARCH

In the light of all the work, sustainable transportation continues to be an important program of research among researchers. However, the work is still very limited in developing countries. Therefore, our research axis placing on the environmental dimension of sustainable transportation in the Moroccan context in order to have a database as well as relevant statistics on the sector for power developed models, methods, recommendations ...

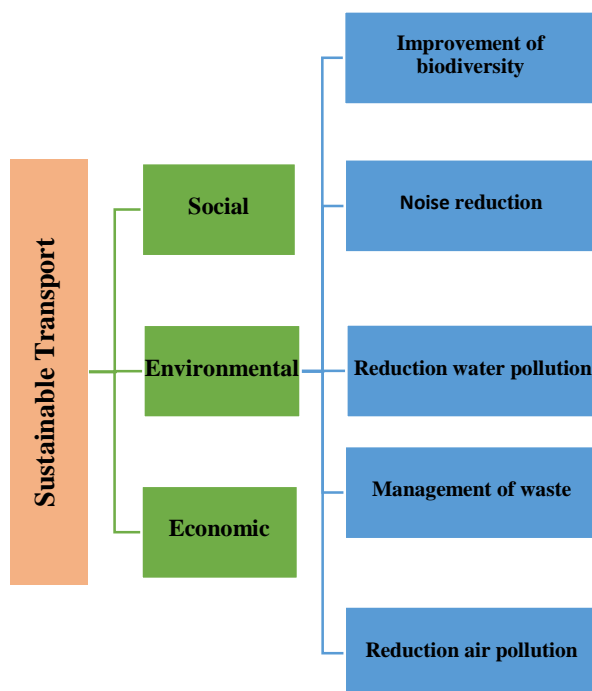


Fig 1: Future research

### IV. CONCLUSION

The establishment of a space or the free movement of persons, goods, services and capital are priority objectives led to a development of mobility. However, this mobility is largely responsible for degradation of the environment. While the European Union has integrated a dimension of sustainable development into its policies, Africa is trying to take example, but for the moment it is only the development phase of its infrastructure.

With all the projects completed and those in progress to achieve the standards of developed countries in terms of sustainable development, more precisely "sustainable transport", the path is still long at the Moroccan level. The sustainable transport has proved to be more than necessary and urgent, in view of the rapid developments and the growing need for mobility on one side, and the increase of the attention to assign to environmental issues and ecological on the other side.

In conclusion, our scientific initiative, involves all researchers to develop methods, models, surveys, recommendations etc. on sustainable transportation in the three pillars of sustainable development (economic, environmental, social), in order to provide a basis for stakeholders Moroccan to be able to press it on the medium and long term.

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