

## SUSTAINABLE TRANSPORT AND INTER MODAL MIX

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### ABSTRACT

*The inclusion of transport sector across 17 goals of SDG, in many cases directly brings out the significant role that transport plays in facilitating development, alleviating poverty, arresting the rise in pollution and congestion. The high growth rate achieved in recent years by developing countries like India is not only to be accelerated but it must be accompanied by the development of all sections of society. This will require expansion of transport. The challenge before policy makers and planners is to augment the supply of transport infrastructure and services and ensure the establishment of a sustainable transport system.*

*Various modes of transport have its own characteristics and significantly different capital intensities as well as technical and operations capabilities. The crux of transport planning is to assess the transport demand, facilitate allocation of resources to various modes and identify policy measures to meet the requirements at minimum resource/ social costs. The paper makes reference to specific SDGs and supporting targets and reviews the economic, social and environmental aspects of SDGs with reference to transport and brings out as to how the realization of an optimal modal mix leads to achievement of SDGs and facilitate the establishment of a sustainable transport system.*

**Keywords:** Sustainable transport, Intermodal mix, SDGs, Transport policies

### INTRODUCTION

#### ***Sustainable Transport and Inter Modal Mix***

Mahatma Gandhi once mentioned that "The earth provides enough to satisfy every person's need but not every person's greed. When we take more than we need we are simply taking from each other, borrowing from the future, or destroying the environment and other species." Here he was supporting the cause for what we call today sustainable development.

The need to promote sustainability and sustainable development has been recognized since the early nineteen seventies when the United Nation Conference on the Human Environment debated on rights of the human family to a healthy and productive environment. But it was only in 1983 when the World Commission on Environment and Development set up by the United Nation defined sustainable development as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

Subsequent developments which include the first United Nation Conference on Environment and Development known as Earth Summit, Millennium Development Goals (MDGs), the Rio+20 which adopted resolution "Future We Want" highlighted the need for sustainable development. While the role of transport was recognized at the Earth Summit and in the resolution of the Rio+20, the reference to transport was missing in MDGs. A fifteen-year development framework, the Sustainable Development Goals adopted at United Nation Summit in September included transport as a significant contributor to sustainable development.

The sustainable development and sustainable transport have assumed greater significance as a large number of developing countries have embarked on high growth path. A number of countries have already experienced high growth rate. But the growth rate not only needs to be accelerated but it must be accompanied by the development of all regions, areas and all sections of

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society. Achievement of this objective will require massive expansion and improvement in the various modes of transport.

The challenge before policy makers and planners is not only to augment the supply of transport infrastructure and services but do so in a manner and ensure that the entire transport system becomes sustainable.

The definition of sustainable transport is slippery and difficult to pin down. Victoria Transport Policy Institute (TDM Encyclopedia) lists some definitions of Sustainable Transport. Some of them are reproduced as follows.

European Conference of Ministers of Transport (ECMT) has defined "A sustainable transport system is one that is accessible, safe, environmentally-friendly, and affordable" (OECD, 2005). According to European Union Council of Ministers of Transport (2004), a sustainable transportation system is one that:

- Allows the basic access and development needs of individuals, companies, and society 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 a 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 use renewable resources at or below their rates of generation and uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on the use of land and the generation of noise.

The Transportation Association of Canada is the view that a sustainable transportation system should have the following characteristics:

a) In the natural environment:

- Limit emissions and waste (that pollute air, soil, and water) within the urban area's ability to absorb/recycle/cleanse;
- Provide power to vehicles from renewable or inexhaustible energy sources. This implies solar power over the long run; and
- Recycle natural resources used in vehicles and infrastructure (such as steel, plastic, etc.).

b) In society:

- Provide equity of access for people and their goods, in this generation and in all future generations;
- Enhance human health;
- Help support the highest quality of life compatible with available wealth;
- Facilitate urban development at the human scale;
- Limit noise intrusion below levels accepted by communities; and
- Be safe for people and their property.

c) In the economy:

- Be financially affordable in each generation;
- Be designed and operated to maximize economic efficiency and minimize economic costs;
- Help support a strong, vibrant and diverse economy.

Various other definitions tinker with this at the margin depending on what aspect of sustainable transport one wants to emphasize. But the broad agreement seems to be that the sustainable transport system is the one that is safe, environmentally cleaner, reliable, efficient, affordable, viable and adequate to serve the developmental requirements. Sustainable transport is, therefore, a system that creates economic, social and environmental benefits.

The above discussion on the definition of sustainable transport refers to the role and significance of transport while highlighting the need to contain negative externalities arising out of provision and development of transport sector. At this stage, it may be appropriate to dwell on role and importance of transport particularly in the socio-economic development process and the adverse impact of provision and operation of transport infrastructure and services.

### ***Transport and Development***

Transport economists would remind us that the demand for transport is derived from the demand for other goods and services. The production of any good would require transportation of raw material and other inputs and further consumption of the good that is produced would also need transportation. The human resource requirement in the development process and to make optimum use of these resources create demand for various modes of transport. However the derived nature of the demand does not mean that the causal relationship is one way. Causality flows another way too: the creation of transport infrastructure and facilities opens up new vistas and opportunities and strengthen markets for other goods and services.

The availability of adequate and efficient transport system has a favourable impact on promoting economic development in diverse ways. The investment tends to move in those locations that have adequate and efficient infrastructure facilities including transport. The availability of transport infrastructure leads to a reduction in the cost of production through an efficient and reliable delivery of inputs at a lower cost. The efficient transport network increases the size of the market and improves the accessibility to skilled labour. This leads to economies of scale and increase in productivity which results in more investment.

There are a number of examples that illustrate the link between transport and economic development. American railway and canal investments gave rise to entire cities and revitalized life in others. The Interstate highway network that crisscrosses America was an infrastructure idea conceived for other purposes and well before its time had come. These roads network which was developed with astonishing rapidity are now the pulsing arteries that knit together a vast country and effortlessly support the logistics of the world's largest economy.

Closer home, in India, the Eastern and Western Dedicated Rail Freight Corridors and the piggybacking Delhi-Mumbai Industrial Corridor will give rise to new industrial areas, inland ports, logistics parks, and rewire the economic landscape—from agricultural to industrial—of a catchment area that is expected to extend 100 km on either side of the corridor. The augmentation of capacity of National Highways under the National Highway Development Project has not only facilitated surging intercity travel and freight traffic but also contributed towards overall wellbeing of the rural population. The availability of transport improves the accessibility to health and education facilities. It is very difficult to visualize the success of various programme aimed at rural development and poverty alleviation without the provision of adequate road infrastructure.

### ***Adverse impacts of transport***

The development of transport system is vital but at the same time it consumes scarce natural resources such as land and energy and causes severe pollution. The heavy dependence of transport

on non-renewable sources of energy and its adverse impact on the environment may limit the growth of transport. The significance of scarce natural resources such as energy in transport is not only that it is one of the major users of energy but also different modes of transport use energy with varying efficiency and intensity.

The growth of transport not only leads to pressure on the limited availability of non-renewable energy sources but raises broader environmental issues. In fact, the form of energy consumption, operational pollution, land intrusion, and congestion are some of the areas of conflict between transport and environment.

Both the construction of transport infrastructure and the provision of transport services have also an adverse impact on the environment. There are four main modes of transport- Railways, Roadways, Aviation and Shipping-and there are three main natural resources -Land, Air, Water-which are liable to degradation in varying measures by the impact of development and operation of diverse modes of transport. If we add to these three natural resources one more factor called noise, we have in theory four types of pollution fallout of each of four modes of transport. The rail track and the roads use up scarce land and their construction has an adverse effect on the physical or the natural features of the areas, including a reduction in the vegetation cover. The road transport causes air and noise pollution, while the water transport poses the risk of marine pollution of the coastal waters. While there is a need to contain pollution and environmental degradation caused by all modes of transport, what is more urgently required is the need to tackle the environmental degradation including generation of emission by the road transport sector.

Another important adverse impact on transport development is the pain, grief, and loss of life and limbs caused by transport accidents. In the railways, human failure and lack of a proper man and machine interaction has affected safety. In road sector, the number of accidents and its severity has been increasing in developing countries. In the Civil Aviation sector, inadequate provision of infrastructure facilities and other support services compared to increase in air traffic may jeopardize the objective of providing safe air services. Country boats carrying men and material are often involved in accidents caused by overcrowding coupled with the use of unserviceable crafts, inadequate traffic regulation and total absence of safety equipment on board.

In developing countries like India transport safety particularly road safety has become extremely challenging task considering its magnitude and consequent severe negative impact on the economy, public health and general welfare of the people. In 2015 road crashes in India resulted in 0.15 million deaths and 0.5 million injured (MoRTH, 2016). In economic terms, these crashes tantamount to a loss of 3 per cent of GDP (Planning Commission, 2001). About 47 percent of the fatalities occurred among vulnerable users, namely, motor cyclists, cyclists, and pedestrians (MoRTH, 2016). Most of the victims were in the age group 15 -34 years (MoRTH, 2016). This group forms the most productive and potential human capital.

### ***Sustainable Development Goals (SDGs)***

The role of transport in the development of a country and its adverse impact points to the need for the provision of transport infrastructure and services while minimizing the adverse impact of transport development. Some of the SDGs with supporting targets seem to aim at achieving this very desirable objective.

As pointed out earlier the transport sector would play a key role in the achievement of SDGs and its targets. The inclusion of transport across the SDGs, in many cases explicitly through supporting targets, highlights its significance as a key sector that also acts as a facilitator for achieving goals pertaining to other sectors. In many cases, the substantial benefits of measures taken in transport accrue to other sectors. For example, the major gains from investing in transport infrastructure and will get displayed more vividly in economic outcomes such as poverty alleviation.

### ***Transport Goals and Targets***

The Sustainable Development Goal structure has 17 goals supported by 169 targets. There are eight targets relating to 6 goals are directly pertains to the transport sector. These are as follows:

**Direct Transport Targets of the SDGs**

- SDG 2** End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- Target 2.a** Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries.
- SDG 3** Ensure healthy lives and promote well-being for all at all ages.
- Target 3.6** By 2020, halve the number of global deaths and injuries from road traffic accidents.
- SDG 7** Ensure access to affordable, reliable, sustainable and modern energy for all
- Target 7.3** By 2030, double the global rate of improvement in energy efficiency.
- SDG 9** Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- Target 9.1** Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
- Target 9.4** By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking action in accordance with their respective capabilities.
- Target 9.a** Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing States.
- SDG 11** Make cities and human settlements inclusive, safe, resilient and sustainable.
- Target 11.2** By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
- SDG 12** Ensure sustainable consumption and production patterns.
- Target 12.11** Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.

Transport is an important facilitator and it plays a crucial role in the achievement of targets for other sectors. As a matter of fact, the actions taken in transport would determine the extent of success in many of targets of SDGs. The targets of SDGs where adequacy and efficiency of transport would be critical are listed below:

**Indirect contribution of Transport towards achievement of SDGs Targets of other Sectors**

- SDG 1** End poverty in all its forms everywhere.
- Target 1.1** By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than \$1.25 a day.
- Target 1.2** By 2030, reduce at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions.
- SDG 2** End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

- Target 2.3** By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- SDG 3** Ensure healthy lives and promote well-being for all at all ages  
**Target 3.9** By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
- SDG 6** Ensure availability and sustainable management of water and sanitation for all  
**Target 6.1** By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
- SDG 11** Make cities and human settlements inclusive, safe, resilient and sustainable.  
**Target 11.6** By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
- SDG 12** Ensure sustainable consumption and production patterns.  
**Target 12.3** By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.
- SDG 13** Take urgent action to combat climate change and its impacts.  
**Target 13.1** Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries.  
**Target 13.2** Integrate climate change measures into national policies, strategies, and planning.
- SDG 16** Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.  
**Target 16.2** End abuse, exploitation, trafficking and all forms of violence against and torture of children.

### ***Link between Sustainable Development Goals and Transport***

Having to identify the direct transport targets of SDGs and those of other sectors where facilitating the role of transport in their achievement is critical. It may be in order now to discuss the inter linkage between transport on the one hand and SDGs and supporting targets on the other. SDGs have economic, social and environmental dimensions. In what follows we would attempt to highlight the significance of link of transport with these three dimensions and the crucial role of transport in achieving some of the SDGs and the significance. We may hasten to add that here no attempt is made nor is it possible to classify various SDGs under these three dimensions as one SDGs has more than one dimension. For example, eradication of poverty is the outcome of economic development and is also part of social development sector.

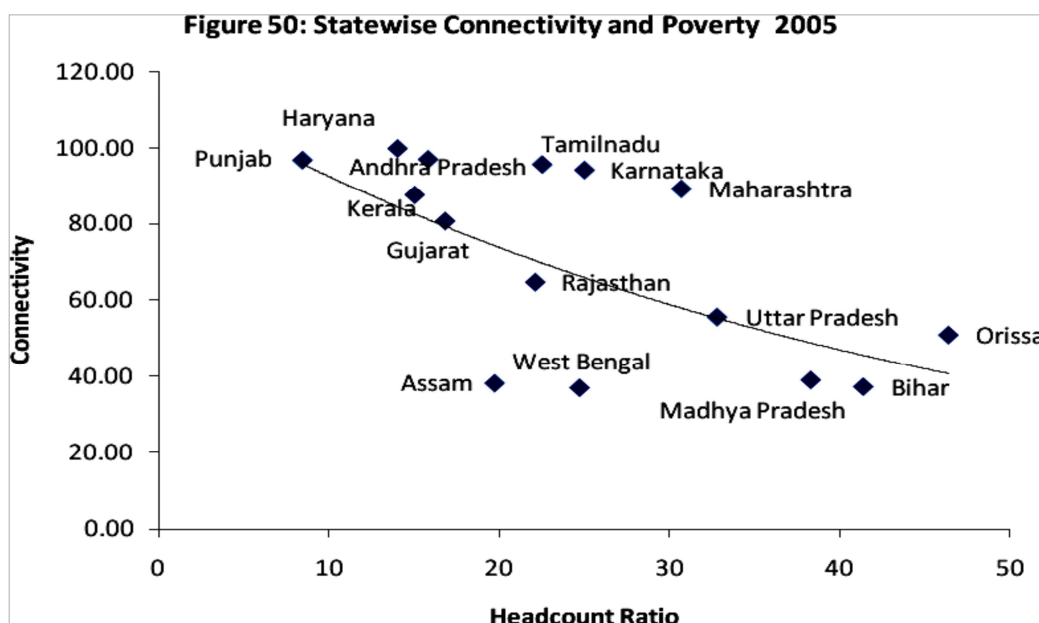
### ***Economic Dimension***

One of the important Sustainable Development Goals relates to end poverty in all forms (SDG 1). The main objective of development is to achieve higher growth rate. This objective is pursued by the planners and policy makers. It follows that the development policies may be guided by this objective. However, the question arises as to whether economic growth is a potent instrument for reducing and eliminating poverty. In other words, to what extent the growth process is pro poor and inclusive.

While economic growth and acceleration of growth rate are important for reducing poverty, it is recognized that the benefits of economic development may not trickle down to the poor. Therefore, it may be necessary to introduce targeted poverty alleviation programmes.

Earlier, we have elaborated that adequate and efficient transport infrastructure and services are required to facilitate economic development. It is the availability, adequacy and efficient transport infrastructure and services that to large extent determine the disparity in economic growth across the regions and sub regions. There are some studies that indicate that physical access may lead to pro poor growth and investments in transport contribute towards poverty reduction. While Ali and Pernia (2003) point out that the infrastructure development has a positive impact on poverty reduction in rural areas; Fan, Hazel and Thorat (1999) and Fan, Zhang and Zhang (2002) brings out the contribution of roads in bringing down rural poverty. A study carried out by The Asian Institute of Transport Development (AITD) clearly indicates a strong inverse relationship between connectivity and poverty on the basis of data on State-Specific Poverty Ratio for 2004-05 and State-wise connectivity for 2005 (AITD, 2011).

Figure 1. Statewide Connectivity and Poverty in India, 2005



Source: AITD, 2011, Socio-economic Impact of National Highway on Rural Population

It is clear from the above figure that generally the States with a low level of connectivity have higher poverty ratio.

AITD (2011) confirms that the development of highways promote economic and human development and has a favourable impact on alleviating poverty. The study also brought out the role in the success of targeted poverty alleviation programmes of other sectors.

### Box 1. Main Findings of Study on Socio-Economic Impact of Highways

Proximity to the highway has significant influence on major aspects of socio-economic well-being of the rural population. Greater opportunities of employment and earnings in non-farm activities are generated. Access to education and health facilities improves. Household incomes rise and so do asset holdings. Poor rural households living in its vicinity thus also derive considerable benefits.

The immediate net benefits of the upgraded highway mostly relate to improvement in access to work and educational opportunities. This is borne out by: three-fold increase in the share of income from non-agricultural activities; 85 percent increase in female labour participation; two-fold increase in per capita trip rate for education; and about 50 percent increase in school enrolment.

The temporal shifts in the level of well-being, as revealed by the pre and post project surveys, indicate strong and mostly inclusive growth impulses in the economy. The post-project analysis has shown improvement in almost all aspects of household well-being including poverty reduction. The benefits are, however, not uniformly spread either spatially or across economic classes. The differences have remained but have substantially narrowed.

There has been a distinct structural shift in the rural economy in terms of an increase in non-farm activities, higher workforce participation, an increase in school enrolment and better literacy levels. There is a noticeable increase in female participation in the workforce as also the school enrolment of girls. These beneficial changes help in the empowerment of women, a development of considerable importance for the country.

Contrary to the traditional view that a national highway mainly facilitates intercity travel and transport of goods, the results firmly bring out that it is also an integral part of the road network serving the rural areas. This is borne out by the fact that almost 50 percent of the total trips originating from the selected villages involve the use of the national highway.

Source: Asian Institute of Transport Development (AITD), 2011, Socio-economic Impact of National Highway on Rural Population, AITD, New Delhi

It is clear from above discussion that transport apart from supporting economic development (Goal 9) also facilitate achievement of other SDGs including Goal 1.

### **Social Dimension**

While discussing economic dimension of SDGs and transport in the preceding sub section we mention the significance of transport in reducing poverty, improvement in access to education and health facilities leading to increasing in school enrolment and better literacy levels as also in almost all aspects of household well-being and greater opportunities for employment. These elements are parts of social sector as well.

One of the important negative externalities relates to loss of life and limbs and consequent economic deprivation and mental trauma caused by transport accidents. The situation is particularly alarming in case of road accidents. It becomes grimmer when one considers that it is the poor and disadvantaged section of the society which suffers the most in developing countries. As pointed out by the National Transport Development Policy Committee (NDTPC 2014)

*"Since each accident is a result of a combination of human, technology and environmental factors, one cannot understand the risk factors associated with an event unless sophisticated systems approach is followed. This understanding was behind the Zero Vision of the Road Safety Bill adopted by the Swedish Parliament in October 1997. The vision states that 'the entire transport system must be designed to accommodate the individual who has the worst protection and the lowest tolerance of violence'".*

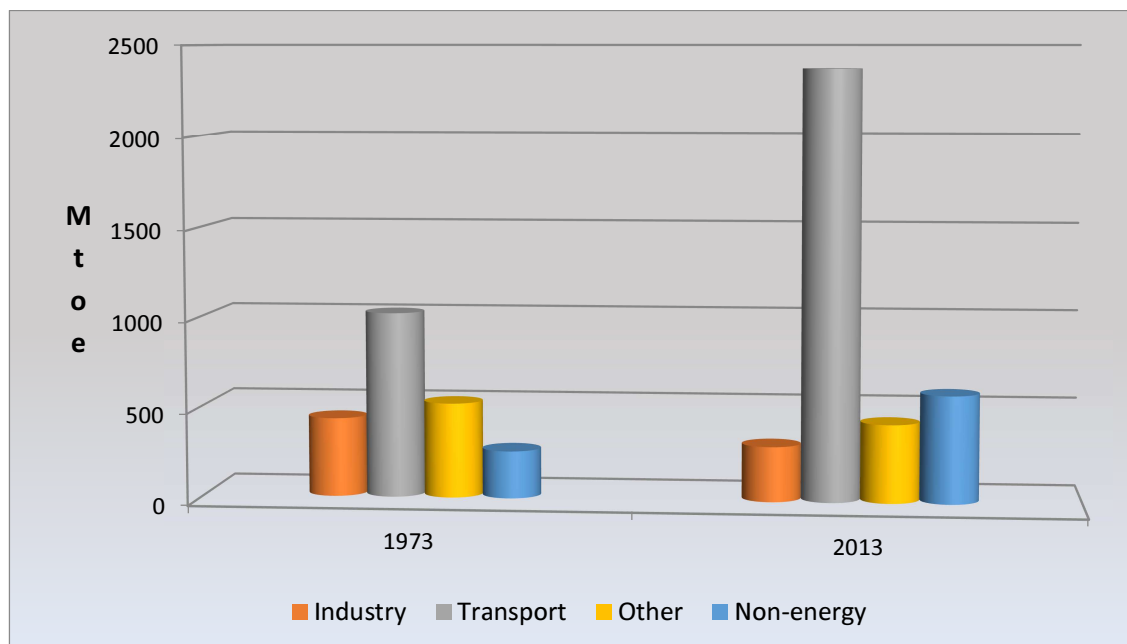


It is only through a comprehensive strategy covering all aspects which include Road Safety Management, Safer Roads and Mobility, Safer Vehicles, Safer Road Users and Post-Crash Response and using a proven and effective method right from the beginning that an inclusive sustainable road transport system can be created and the targets relating to road safety included in SDG may be achieved.

**Environmental Dimension**

Ever increasing carbon emissions are considered to be the main source of global warming and transport has been identified as one of the main culprits. According to international energy agency (IEA) in 2013 world total consumption of oil was 3694 million tonne equivalent (Mtoe) registering an increase of 65.6 per cent in the period between 1973-2013. During this period share of the transport sector in total consumption increased from 45.8 per cent to 64.3 per cent. (Figure 2)

**Figure 2. Total Final Oil consumption from 1973 to 2013 by Sector (Mtoe)**

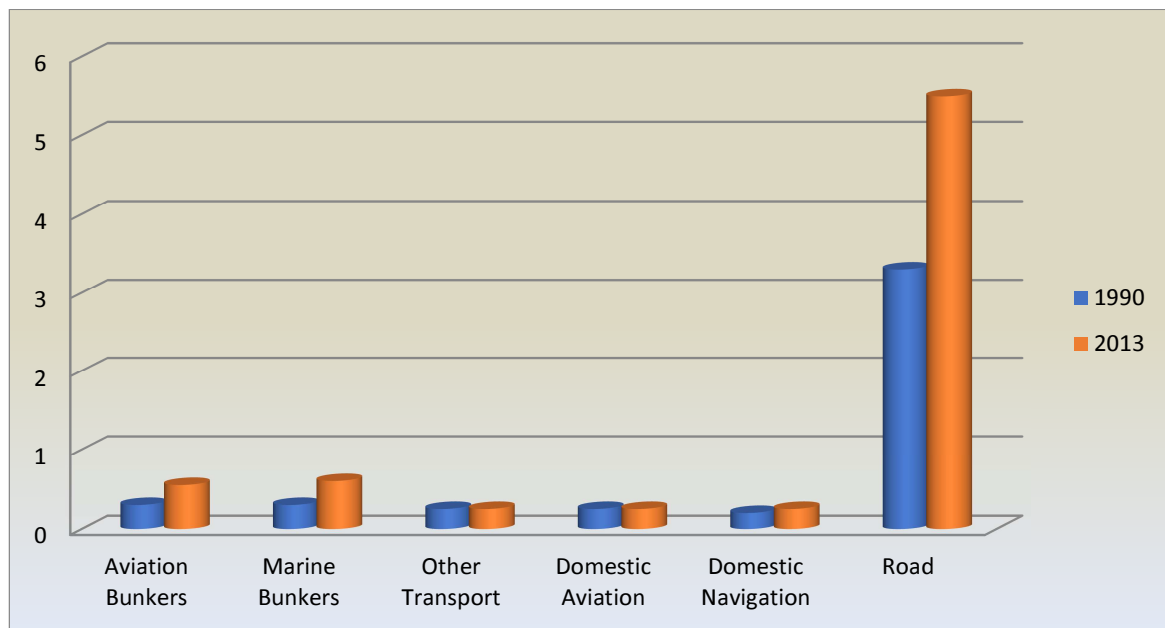


Source: International Energy Agency,  
 Other: Includes agriculture, commercial and public services, residential and non-specified other

Thus in 2013 transport consumed two third of global oil consumption.

**Carbon Emission**

Transport is one of the major contributors to carbon emissions. The sector accounts for almost one fourth of world's total CO<sub>2</sub> emission. Road transport is not only heavy on fuel but also emits higher emission compared to marine and rail transport per unit of throughput. Out of total global CO<sub>2</sub> emission, 18 per cent is accounted by road transport sector alone.

Figure 3. CO<sub>2</sub> Emission from Transport Sector

Source- International Energy Agency

Key point: CO<sub>2</sub> emissions from road are driving the growth of transport emissions.

According to IEA, the CO<sub>2</sub> emissions from road transport system has been increasing at a rapid rate which experienced 68 percent growth during 1990-2013 and accounted for three-quarter emission in 2013 (Figure 3).

It is clear from the above discussion that greening of transportation would require less use of road transport and encouragement of movement of passenger and freight by other modes of transport that are light on energy and emit minimum carbon emissions. It would also be necessary to take policy measures which ensure the safety of pedestrians and bicyclist so that more and more people prefer this mode of transport. The most important measures for greening passenger transport is to make provision for affordable adequate, comfortable and easily accessible public transport.

Greening of transport should not end with addressing the issues relating to pollution caused by carbon emissions. The transport community including policy makers must consider factors like the comparative efficiency of use of land by various modes of transport, issues relating to safety and noise pollution, health effects, etc. while determining the intermodal mix for establishing integrated intermodal transport and logistics system in the country. It is only then the process of the greening of transport would be comprehensive and complete. The environment-friendly transport system would be sustainable and contribute towards achievement of SDGs.

### ***Inter Modal Mix***

We have discussed the transport linkage with development and transport as a key contributor to sustainable development. While deliberating on the economic, social and environmental dimension of SDGs, it is clear that there is a need to formulate transport policies, plans, and programmes and implement them with a view to maximise economic, social and environmental benefits. Determination and realisation of optimal inter modal mix may be one instrument through which this objective may be achieved.

Various modes of transport differ significantly from one another in terms of capital intensity as well as technical and operations capabilities. While railways and water transport are high capacity modes and suitable for movement of heavy and bulky loads over long hauls at low cost, road transport is mainly linked to high value and low volume commodities where rapid movements of freight in small batches are the norm. It is the more flexible mode of transport that can reach remote

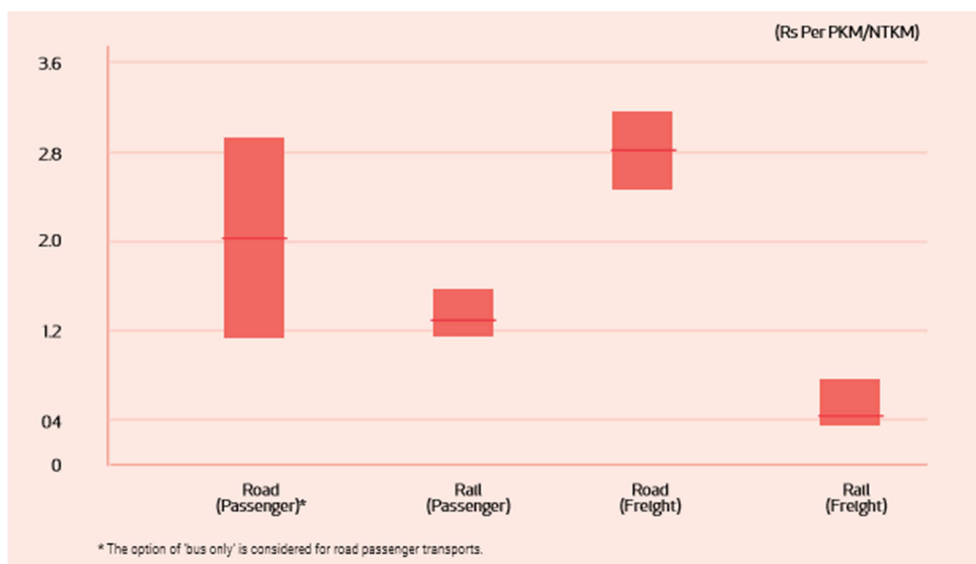
and difficult areas. On the other railway is a more environment-friendly safer mode of transport. The main advantage of air transport lies in speed, but it is heavy on fuel and causes pollution.

In view of above, it is necessary that the modal choices should be made more prudently. The central issue is the determination of optimal inter-modal mix. This requires the adoption of an integrated approach to a devising strategy for the development transport infrastructure and service delivery. This integrated approach to transport planning advocates considerations that go beyond ensuring the availability of a variety of transport modes and beyond accommodating easy intermodal transfers of passengers and freight, though these are important in their own right.

Instead, the integrated philosophy is about more than the simpler choices over intermodal transport. Choices within each transport mode—intra-modal or trans-modal choices—are also brought to the forefront of the planning exercise. While making such choices, a number of factors need to be considered. These include (a) quantum of traffic (b) length of haul (c) nature of commodity (d) characteristic of modes and (e) technology developments. The primary objective of such an approach with regard to the development of transport is that the resource cost of providing transport infrastructure and services is minimum. The resource cost of a particular mode of transport or a transport service would include (a) cost to the operator (b) cost to the user and (c) cost to the society which includes cost involved in externalities such as accident, pollution, and congestion.

AITD (2002) highlighted the significance of resource cost which they termed as a social cost. According to the study "social cost is a valuable tool in developing efficient and sustainable transport system and in facilitating an optimal mix of different modes of transport." The study also compared the social cost of two main modes of transport in India i.e. rail and road taking in to account the fact that there is a large variation in external costs of various modes of transport (see box 2).

**Box 2. Social Cost-Ranges in Passenger and Freight Transport (Base Year 2000)**



Source: AITD (2002)

\*In terms of social costs, railways have a huge cost advantage over road transport. The advantage is greater in freight traffic than in passenger traffic. \* Policy changes can induce shift of modal choice in favour of rail and in favour of public road transport over personalized transport.

The broad areas that are studied for integrated approach include:

- Generation and analysis of inter-regional and intra-regional origin-destination, mode-wise traffic flows, both freight and passenger traffic.
- Determination and analysis of modal transport costs in terms of both resource cost and financial cost for each mode of transport, incorporating existing as well as future transport technological advancement.
- Compilation of a 'comparative analysis' of the past growth in freight and passenger traffic for each mode of transport.
- Assessment of the total transport demand and share of each mode of transport as it exists today and likely to be for the horizon years.
- Determination of the desirable share of a mode of transport on the basis of resource cost consideration.

A study commissioned by Planning Commission (now NITI Aayog), Government of India carried out analysis for optimal modal mix through optimization on traffic flows. The result has been encouraging which indicated that while the overall throughput increased by around 3 per cent the cost to the economy decreased by more than 16 per cent. (RITES, 2010). The optimization of traffic was carried out for two modes of transport viz. rail and road. It may be mentioned that if coastal shipping and inland water transport is included in the picture, the savings in the cost of transportation to the economy would be substantial. These savings occur not only in terms of user cost but also in terms of accident and environmental cost.

## CONCLUSION

It is axiomatic that the economic development requires adequate, effective, efficient and balanced transport infrastructure and services. But transportation is not entirely harmless activity. It consumes scarce natural resources, emits injurious pollutants, generates undesirable wastes and causes loss of life and limbs. In the process, it endangers the sustainability. While recognizing the significance of transport in development process SDGs framework highlights the need for reducing its adverse consequences. Transport is to play a critical role not only in realizing the SDGs' targets directly related to the sector but also act as a facilitator in achieving the targets of other sectors to promote sustainability.

Different modes of transport cause varying levels of stress and consequent damage. Hence, there is growing recognition that the transport systems and modal choices should take into account cost of environmental degradation and social damage in the interest of promoting sustainable development and establishment of a sustainable transport system. This can be achieved by following an integrated approach to transport development. This will facilitate in realizing optimal inter modal mix that will establish transport system-- a system in which each mode of transport play its role for which it is best suited on the basis of total cost (including social costs) advantage.

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