Preface

Transportation and environment in developing countries

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In the 21st century, energy security and energy independence have been the issues considered important equally by both developed and developing countries. While industrial activities have dominated both energy and environmental issues for long time in the past, the transport sector has been emerging as another major player in energy and environmental issues worldwide. Though this behaviour holds well from east to west, the peculiarity in trajectory of growth in Asia brings out issues which are different from the west (Imura et al., 2005; IGES, 2005). With the increasing concern for global environmental issues along with the concerns for local pollution, the transport sector which is growing as a major GHG contributor is gaining in importance both at home and internationally. With an estimated 50% of population globally will soon be living in cities, transportation will essentially be a central nervous system of cities and their economic development.

Ever increasing population trends in Asia linked with severe urbanisation lead to urban sprawl. Unlike Europe, Asia has been experiencing considerable urban sprawl which has a strong linkage with an increased share of unauthorised residents (slum dwellers) and hence the related distributional problems. Urban sprawl results in both increased travel time and number of trips. While the increasing travel activity leaves the world with a concern of limited energy resources, poor energy performance and fuels, congestion on arterial roads lead to increased environmental implications such as local pollution and GHG emissions. As a rapidly growing region, Asia is facing the brunt of these implications at a much higher intensity and over a short span of time compared to that of the west. Hence, the response strategies for Asian cities need to be innovative and suitable for the local conditions.

The interaction between environment and transportation and the possible response strategies may be seen in terms of short and long term. Whereas the improvements in technology, energy performance, urban and transportation planning and alternative fuels do provide short-term relief, controlling the travel activity per se would provide much needed long-term perspective to both transportation and the related environmental concerns in Asia. This special issue addresses some of such short and long term response strategies while presenting the environmental concerns resulting from the growing transportation activity in Asia.

In the first paper in this Special Issue, Patrick Moriarty addresses issues of environmental and resources constraints and their importance while attempting to develop long-term transportation planning with an objective of sustainable development. It is a common understanding that in industrialising countries, personal income has been the main constraint on widespread car ownership. However, with the rapidly rising incomes in many Asian cities, traffic congestion and air pollution are replacing income as barriers to higher car ownership. As a result, Asian car ownership levels, with the exception of Japan, are low. Further potential barriers to higher car ownership are global oil depletion and supply security, which could well be the leading constraint within a decade, and regional/global climate change. More energy-efficient vehicles, alternative fuels and propulsion systems, and more reliance on alternative transport modes may well be suggested as solutions to the problems of urban transport. However, based on his research findings, Moriarty opines that feasible improvements in energy efficiency would soon be swamped by growth in vehicle numbers, and alternative fuels, including hydrogen, would have their own resource or environmental limitations. Thus, it was observed that private car travel is unlikely to ever be the dominant mode in Asia's large

cities. Instead, a combination of public transport and non-motorised travel seems the only feasible means of meeting the growing transport needs of congested Asian cities.[1]

Among the issues that are considered while taking up long term transportation planning, CO_2 emissions play important criteria. It is widely argued that provision of better infrastructure may become a determinant for increasing CO_2 emissions. In an effort to examine such implications, Marcotullio and Williams have tried to explore the question of how provision of road infrastructure and economic growth relate to increases in CO_2 emissions from road vehicles. The basic premise is that many developing nations have achieved sufficient wealth to generate substantial demand for road vehicles, but that actual use is constrained by limited provision of surfaced roads. The prediction, "if you build it, the cars will come" might thus play a major role in determining emissions from motor vehicles for the next few decades in these economies. With an empirical analysis of trends in surface road length, changes in GDP per capita, and road-related CO_2 emissions in seven rapidly developing Asian countries compared with historical experiences of the USA, Marcotullio and Williams have found that road-based CO_2 emissions for rapidly developing countries are lower than those of the USA for similar levels of income. However, road CO_2 emissions per km surfaced road increases are far higher for developing countries compared to the USA and Japan. By reporting that USA shows a higher level of paved road length per capita than nations in the Asia Pacific at similar levels of income, Marcotullio and Williams have opened up a debate on to what extent these two features balance in the final CO_2 emission levels. While more work is needed to further explore these issues, these findings suggest that a high level of 'latent demand' for road transport in rapidly developing Asia will influence the trajectory of road transport CO_2 emissions into the future.

While the above two papers explain the long-term issues in urban transportation and their possible implications to environment, the following papers address issues that demand immediate attention and relatively short term response strategies. Among such issues is the promotion of cleaner and efficient technologies, cleaner fuels, application of GIS in transportation planning, controlling technicalities like drag of vehicles, vehicle wake factors, developing car driving cycles etc.

Usefulness of cleaner fuels and the other cleaner transportation options has been demonstrated and well documented in different parts of the world. However, their adaptation in the developing countries of Asia has not been impressive. In the paper 'Strategies for the promotion of cleaner and energy efficient technologies in the urban transport system in selected Asian cities' Shrestha et al. have made an effort to identify potential alternative options to control GHG and other harmful emissions, barriers to such alternatives and development of strategies for their implementation in eight major cities in Asia. Least-cost options were identified to meet the projected transportation (travel) demands in eight Asian cities viz. Beijing, Hangzhou, Delhi, Mumbai, Jakarta, Bandung, Manila and Ho Chi Minh City. CNG (Compressed natural gas) cars and buses were found to be the cost-effective transport options in most of the cities. Mass rapid transit systems were found to be cost-effective in Beijing, Hangzhou and Ho Chi Minh City whereas biofuels operated vehicles are found to be cost-effective transport options in Manila, Jakarta and Bandung. High initial cost and lack of infrastructure (especially for compressed natural gas operated vehicles and mass rapid transit system) are found to be the major barriers for the implementation of the selected transport options.

In an attempt to identify various policy measures in order to overcome the above identified barriers, Shrestha et al. found that financial incentives (e.g., high tax on conventional vehicles, tax on gasoline etc), subsidy on the initial cost, stricter emission standards and other incentives like parking facility are potential policies and measures to overcome the barrier of high initial cost. The results reveal that an establishment of dedicated and exclusive institutions to coordinate and mobilise resources from various stakeholders is necessary to overcome the barrier of lack of resources in the developing countries. Shrestha et al. argue that use of bio-fuels in the transport sector would require higher subsidies for the fuel and regulation requiring oil companies to sell them. It was further opined that research and development programs need to be instituted to investigate the viability of biofuels and to gain more insights on their effective use in the developing country cities of Asia.

In a similar effort at a country level, Jiang and Songli from China claim that diesel car, CNG vehicles and Mass Rapid Transport (MRT) are the potential options to control emissions from transport sector in Chinese cities. They opined that for wider application of diesel cars in Chinese cities it is important to have new standards for vehicles using diesel; carry out R&D on diesel car engines, and oil refining technology; improved public education and outreach. For better implementation of CNG vehicles it was found necessary to have improved public education and outreach programmes; subsidise the additional expenditure for vehicle conversion or acquisition; financial incentives for AFVs operation; and innovative financial mechanism to attract social investment flowing to gas station construction. In an effort to implement MRT, it was found that important measures, among others, are innovative financing mechanisms, such as public-private partnerships, to diversify investments and operating bodies, enhanced R&D to promote occupancy rate of indigenous facilities related to MRT to decrease the high initial cost, and offering special management rights to specialised operators in a certain period.

Environmental Decision Support Systems (EDSSs), viz. GIS and GPS, are among the most promising approaches to handling the complexity of environmental problems. The paper by Anjaneyulu et al. highlights the application of integrated decision support system for calculation of environmental friendly traffic flows in urban networks under different management strategies viz. modifying the existing road network; road widening activities; bus bay relocation; construction of RUB/ROBs; rescheduling the work activities; and parking management. For each link of the network an environmental capacity (pollution load) is calculated taking into consideration the hydrodynamic theory based traffic flow dependent on the length of the road network and the average traffic volume and speed. This paper demonstrates the potential of applying advanced tools to environmental monitoring and planning.

Fuel efficiency improvement is one of the important and well adopted methods worldwide to control pollution loads from transport sector. The fuel efficiency of vehicles depends not only on common parameters like congestion and road condition but also on components like platooning. Platooning is a synchronised movement of two or more vehicles as a unit travelling at the same speed with relatively small inter-vehicle spacing. It was recognised early on that close follow up would likely decrease the average vehicle drag which in turn increases the fuel efficiency. In a study to examine the effect of platooning on vehicle drag, Mitra and Mazumdar estimated drag on a maximum four-vehicle platoon model carried out in a subsonic low turbulence closed circuit wind tunnel test section at Jadavpur University, India. Mitra and Mazumdar report a significant drag minimisation with platooning, which in turn decreases fuel consumption.

It was observed that the higher the number of vehicles in the platoon the lower would be the drag coefficient. The leading car in the platoon was found experiencing the highest drag. The middle car experiences the lowest drag in a three-car platoon, and the third car from the front experiences the least drag in a four-car platoon. It was concluded, based on the drag experiments that platooning causes less fuel consumption thus reducing vehicular pollution.

While platooning impacts the efficiency of fuel consumption, vehicle wake factor impacts dispersion of the pollution emitted from vehicles. Heterogeneity adds to the complexity of pollutant dispersion in air. Gokhale and Khare have attempted to determine appropriate vehicle wake factors for the heterogeneous ambient conditions in Indian cities.

Vehicle 'wakes' are used as a wind-speed-correction factor in several air quality models considering the effects of traffic movements on the pollutant dispersion. By applying the inverse general finite line source model, GFLSM for a busy traffic intersection of Delhi with the prevailing unstable conditions, Gokhale and Khare have found that Vehicle Wake Factors (VWF) for unstable conditions vary between 1.63 and 0.3 (for wind direction, $\theta = 90°$) and 2.5–0.8 (for wind direction, $\theta = 180°$). Under the neutral and stable conditions, VWF were in the range of 0.84–0.4 to 1.91–0.85 for wind direction $\theta = 270°$ and 1.7–0.7 to 3.1–0.3 for wind direction $\theta = 360°$. The finding by Gokhale and Khare helps in constructing better air quality models in order to assess the impact of emissions from urban transportation on the ambient air quality.

One of the major challenges in air quality modelling is the data availability. Emission factors that are available in literature are mostly for the laboratory conditions. However, the actual emissions from the vehicles depend on various operating conditions. This difference leads to substantial variations in emission estimation. Thus, information on emission factors for the in use vehicles is an important element while assessing the environmental impacts of urban transportation. In these lines, Montazeri-Gh and Naghizadeh in their paper describes the development of the car driving cycle for the capital city of Tehran. Driving cycle is an elemental requirement for the evaluation of the exhaust emissions using the chassis dynamometer test. The data collected from several cars in the real traffic conditions using a data logging system were analysed using a developed computer program, and the Tehran car driving cycle is presented. Comparing the Tehran car driving cycle with other cycles, Montazeri and Naghizadeh claim that it has greater maximum acceleration and deceleration but smaller average acceleration and deceleration.

While technological and management measures do provide a sign of relief from air pollution, people's willingness to pay for measures aiming at air pollution reduction plays an important role in air quality management. This is particularly true among developing country cities which face serious resource constraint in development activities. In an effort to demonstrate the variations, Afroz et al. have employed Contingent Valuation Method (CVM) to assess the Willingness To Pay (WTP) of the respondents to improve the air quality in Klang Valley, Malaysia. The aggregate willingness to pay varied between RM0.91 billion and RM1.16 billion[2] for the reduction of PM10 by 10 and 20%, respectively. Respondents showed no significant variations in their WTP with different types of questionnaire format. And they have showed different levels of WTP for different levels of pollution and corresponding different levels of mitigation. Increasing awareness for environmental pollution in the region could be one reason for this behavioural pattern.

While most of the attention in the recent past has been on air pollution, dust and GHG, auxiliary pollution like noise pollution resulting from vehicles has been ignored. However, with increased health impacts, noise pollution is also catching attention in recent years. This is particularly true in the context of developing countries in Asia where the congestion levels are alarming. In an effort to document the intensity of noise pollution and its source Sharma et al. have carried out comprehensive sampling by covering all classified zones in Warangal city, India. They observed that noise levels have increased with increasing traffic volume and always in excess of the allowable limits at all locations. Based on the correlation exercise, Sharma et al. claim that three-wheelers are the main culprits of noise pollution. It was interesting to understand from this study that both traffic and highway parameters are influencing traffic noise. Higher traffic densities, excessive congestion coupled with attitudes of drivers and poor infrastructure for non-motorised transport could be a major reason for this severe noise pollution.

Finally, in a technical note, He et al. present the air pollution challenges and various response strategies adopted by Chinese cities. With drastic urbanisation and motorisation, China has been experiencing increasing demand for mobility and private car ownership. That leads to 400 million people suffering from air pollution, traffic congestion, and other adverse social consequences. With an estimated annual vehicular growth rate of 13%, vehicular transportation in China is expected to worsen the situation further. The Central and Municipal Governments in China have been attempting to control these environmental implications of urban transportation and such efforts can be broadly classified into three categories viz. improving vehicle technologies; improving fuel quality or introducing cleaner alternative fuels; and reducing total vehicle mileage. This is very much in line with the overall framework provided by Schipper et al. (2000), which structures the urban transportation into 'issues-responses' matrix. This is termed as ASIF framework where 'A' stands for activity, 'S' for structure/mode, 'I' for intensity and 'F' for fuel. Any efforts towards controlling environmental implications of transportation essentially fall under one of these four domains (Schipper et al., 2000; Dhakal and Schipper, 2005).

Focusing on the possible strategies, He et al. opine that central government could make up priorities to establish a technical requirement system (e.g. emission standards) with a long-term (over 20 years) vision for both vehicles and fuels; establish fiscal/policy incentive mechanism to encourage the use of cleaner vehicles; launch public education campaigns (including vehicle labelling system) to encourage consumers to use cleaner vehicles and reduce the vehicle drive; and establish advanced technology introduction program. For local governments, the main policy priorities could be to encourages the use of public transport and reduction in personal vehicle use; establish an I/M programme; retrofit and scrappage programmes for old vehicles; and demonstrate and use advanced vehicle technologies. With increased public awareness of urban air pollution, the government and auto industry are becoming increasingly aware of the urgent need to control motor vehicle emissions, which presents an optimistic scenario for future air quality in Chinese cities.

Another element critical for the management of urban transportation and the related environmental implications is the regulatory/legal interventions. It has been proved time and again, that legal intervention, mostly due to the active participation of public and non-governmental organisations (environmental activists), brings much needed break through in environmental management. Particularly when the pollution levels cross the

threshold limits. In one such episode, the Supreme Court of India has directed the Government of Delhi to adopt cleaner fuel (CNG) for the public transport vehicles and convert the complete bus fleet to CNG (Yedla, 2005; TERI, 2002). These directives came when Delhi was experiencing severe air pollution and was rated among the ten most polluted cities in the world. Court directives, along with the other initiatives, have had great impact on Delhi air quality over time. Though this special issue misses out on this important element, details on such initiatives can be found in IGIDR (2002, 2004), TERI (2002), UN (2001, 2003) and Yedla (2005).

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Notes

[1]Along these lines of observation, Dhakal and Yedla have been working on the development of strategies to improve the share of public and non-motorised transportation in selected Asian cities.

[2]1 RM (Malaysian ringgit is 0.26 US dollar (approx.).