Urban Sprawl and Transport Sustainability on Highway Corridors Using Stake Holder Analysis

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Abstract The effects of overpopulation in India in the form of an increased pressure on infrastructure and land is well visible in the form of an exponentially increasing population migration in suburb areas and mushrooming of residential townships along highway corridors. The sustainability of this practice calls for an urgent exposition—although its nature is still exploratory, the challenges faced are crucial. This paper proposes a study relating the effect of overpopulation on the acquisition of land in and around the highways and the effect of this practice on the transportation sector. The paper employs a case study of the Mumbai-Pune Expressway to analyse the trickledown effect of overpopulation on the transport sustainability of the corridor. The failure of traffic management system in the corridor has been attributed to multiple reasons ranging from insufficient government funds, to repair and maintenance work, to inefficient traffic management infrastructure, but what has largely remained unspoken of is the explosion of population migration to the suburbs around the corridor, which is also a major potential reason for the unsustainable traffic flow along the corridor, with the corridor now facing a twin burden—that of inter-city trips as well as that of local trips originating from the growing residential blocks along the corridor. This hitherto ignored aspect behind the unsustainable transport flow along the corridor needs a further exploration. The chapter would also discuss strategic measures which could be used to address the challenge faced by commuters and enhance traffic management systems. Stakeholder analysis and financial trends to extrapolate density pressure on roads would be accounted for in the analysis.

Keywords Urban sprawl · Overpopulation · Traffic density

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The Changing Paradigms of Transport Planning

The Transport Paradox - Transport is unique as the only development sector that worsens as incomes rise. While sanitation, health, education and employment tend to improve through economic development, traffic congestion tends to worsen.

~Lloyd Wright, Transport Specialist, Asian

1 Development Bank

Transportation infrastructure is often described as the lifeline of an economy, owing to the major role it plays in economic growth. While this is true, the continuous increase in economic growth, urban population, incomes, and motorization are creating and intensifying new problems for the transportation sector, which were previously either non-existent or were too small to be heeded to. Transportation externalities like congestion, ambient air quality, GHG emissions, urban sprawl, and traffic crashes seem like a 'necessary evil' of an urban life today. There may be improved quality of life with the growing urbanization and economic growth, but along with it, the growth of such transportation externalities severely restricts the quality of life that urban centres offer. If not well managed, transportation externalities can also retard economic growth. New transport policy paradigms focus on building sustainable cities—with improved travel choice (multi-modal transit), efficient land use, and efficient pricing mechanisms that ensure that private motor usage covers full costs of externalities (Asian Development Bank 2009; Litman 1999).

- Is the developing world repeating the mistakes of the developed world?
  Conventional transport planning has largely been supply side. The great motorization era in the now developed world after the World War I, saw policy makers responding to transportation problems of congestion with more and more supply of capacity in the form of roadways and highways. The supply expansion of roadway infrastructure was based on traffic forecasts. It was believed that with the prediction of demand, supply of roadways could be expanded accordingly and that would solve the transportation woes. Peak hour congestion, however, got no better, in fact it grew worse by day, as more capacity meant the encouragement of more automobile ownership. It was in the late 1960s that the debate over supply side transport policies emerged in the Europe and the US. Unfortunately, the developing world today is following the same automobile oriented transit development patterns that the west followed in the past, with a disregard to Travel Demand Management (TDM) strategies, efficient travel choice, and efficient land use.
- A drift away from supply side transport policies
  The position against supply side transport policies was introduced in the 1960s by Downs (1962) and the famous traffic engineer Leeming (1969), through the concept of induced demand, which states that the creation of more roadways does not eliminate congestion, in fact, creates unnecessary trips and in some situations

causes urban sprawl. This is to say that a creation of roadway capacity enables commuters not only to take increased frequency of trips but also trips to farther destinations—something that they would have otherwise avoided. The reasoning behind this is rooted in the basic economic theory of supply and demand. When there is an increase in roadway capacity (supply), it reduces the generalized cost of travelling (price), in terms of reduced commute time (by temporary congestion alleviation) and reduced vehicle operating (fuel) costs. This decrease in price prompts an increased quantity of consumption—reflected in terms of increased travel demand, which is 'induced' in its nature. This induced travel imposes several costs like downstream congestion, accidents, parking costs, pollution, urban fringe development, and other environmental costs.

A lot of transport economists and experts describe the use of roadway expansion to combat congestion, as a 'self defeating' exercise in what is called today as the 'Downs Thompson Paradox'. The basic idea behind this paradox is that road capacity investments as a remedy for congestion can actually make overall congestion even worse. This occurs because when more road capacity is provided, more people get lured towards private motorization and there is a shift away from public transportation. The fact that lesser people would now use public transport, makes the public transit ineffective due to reduced frequency of public transit usage and increased fares by the operators who start suffering losses, which further pushes people towards private motorization, thus exacerbating congestion. A similar voice is also echoed in Downs' Principle of Triple Convergence (1992), which captures the difficulty of eliminating peak hour congestion from highways. According to this principle, if a congested highway is expanded in its capacity, the confluence of three effects, namely, the changes in routes, times and modes of travel will crowd out the congestion reduction benefits that the expansion would offer, making the highway as congested as before. These three effects can be explained as:

i Changes in routes—With an increase in capacity, commuters who were previously using alternative routes will shift to the now convenient highway.
ii Changes in time—The commuters who travelled off the peak hour to avoid peak hour congestion would now be enticed to shift to the peak hour.
iii Changes in modes—With an expanded capacity, some commuters who were hitherto using public transit may now find it convenient (and cheaper) to shift from public transit to private transit modes.

Ultimately, the lethal mix of these three effects would offset the congestion reduction benefits offered by the capacity expansion, thus implying the counter-productive nature of supply side transport policies. It should however be noted that this proposition does not mean that roadway capacity expansion has no benefits. With a capacity expansion, the road can carry more vehicles per hour than before, even if it is congested, so more people can commute it a point of time than before. It also reduces the congestion on other roads (Downs 2004). Thus, roadway expansion is a necessary but not a sufficient condition. Improved travel choice (multi-modal transit), efficient land use, and efficient pricing mechanisms

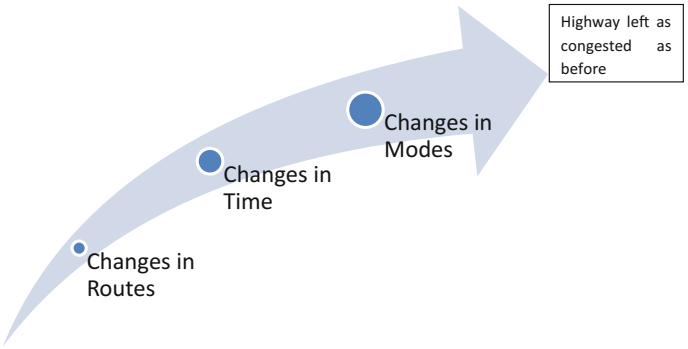

Fig. 1 Downs' principle of triple convergence (1992)

that ensure that private motor usage covers full costs of externalities must be concomitant to a roadway capacity expansion (Fig. 1).

- The New Paradigms
  Post the Brundtland Commission's Our Common Future (1987), the concept of sustainability has also seen itself venturing into transportation. Many definitions for sustainable transport exist and all of them embrace the three pillars of sustainability—social, economic, and environmental. The report "Sustainable Urban Transport in Asia" (2005) by the Partnership for Sustainable Urban Transport in Asia (PSUTA) describes sustainable urban transport as one that eases access and mobility for all groups of the society in a manner that is within the carrying capacity of the environment and is affordable to both the transport providers as well as the transport users. The concept of sustainability requires individual needs to be subordinate to community's long term strategic objectives (Litman 1999). Hence, sustainable transport essentially promotes both inter-generational as well as intra-generational equity across the three pillars of sustainability-social, economic and environmental. Any transport policy decision that transgresses such an equity would not be regarded as sustainable. Thus, whether it is high private motorization levels within the city, that penalizes pedestrians and non motorists, or automobile dependent urban fringe developments that penalize everyone using highways—anything that leaves equity (at an economic, social or environmental level) in jeopardy and does not account fully for the associated external costs generated, is not sustainable.
  One cannot have a highway built and simply assume it would be sustainable by just accounting for the financial costs if the associated congestion, accident, pollution and sprawl costs are ignored. If roadway capacity is implemented without Transport Demand Management (TDM) strategies like commute trip reduction programs, parking management, public transit improvements, rideshare programs, road pricing, congestion pricing, land use management policies, road space rationing etc., the planning cannot be said sustainable, since such a planning would overvalue the economic benefits of capacity increase and undervalue the negative effects.

Sustainable planning also requires that transport models designed for prediction of future traffic take into account the 'diverted traffic' (traffic on the now roadway due to shifts in travel time and route to use the now convenient new roadway) and 'induced traffic' (additional trips generated on the new roadway due to alteration in travel behavior in the form of increased trip frequency and trips to farther destinations, which would have otherwise not been taken), and thus incorporate 'full feedback' in their prediction models (Litman 2001). Omission of diverted and induced traffic (collectively called 'generated traffic') leads to inaccurate predictions and an undervaluation of the costs. Even more accurate are integrated models that take into account interrelationships between transport and land use patterns (Litman 2001). Ignoring all these would tend to skew planning in favour of highways, urban sprawl and automobile dependency.

Land use planning is becoming increasingly recognized as closely linked with sustainable transport planning. The link between land use and transport planning should be such that it reduces the need to travel and increases accessibility by the provision of a multi-modal public transport. Low density urban settlements, which are becoming a quintessential feature of urban life in the form of urban sprawl, are viewed as dangerous to sustainable urban transport. Not only do they make public transit modes ineffective, but also increase travel demand and automobile dependence. The concept of 'smart growth' which is gaining popularity, is based on promoting high density mixed use zoning with a multi-modal transport. The Asian Development Bank (2005) describes the two tools to promote such a smart growth in the form of an essential mix of 'carrots' and 'sticks'. While 'carrots' imply multi-modal public transit, 'sticks' imply the demand management tools.

The new paradigm also prioritizes accessibility over mobility. While mobility oriented approach aims at maximum movement of people, an accessibility oriented approach aims at improving the ability of people to reach the desired services and destinations. Mobility assumes that movement is an end in itself instead of being a means to an end. Accessibility, on the other hand is the ultimate aim of transportation. It promotes not only the interests of the motorists but also the non-motorists and gives consideration to optimal land use with multi-modal transport—both of which, the mobility centred approach ignores.

The following table, borrowed from Litman (1999) crisply brings out the distinction between the old paradigms and the new paradigms of transport planning.

Land Use Patterns & Transport Policies—The Essential Link to Understanding Highway Enabled Urban Sprawl and its Impact

> Sustainability planning is to development what preventive medicine is to health: it anticipates and manages problems rather than waiting for crises to develop. Just as preventive medicine requires individuals to be informed and motivated to maintain healthy habits, sustainable development requires that individuals be involved in community decisions and be rewarded for socially beneficial behaviours
>
> ~Todd Litman (1999), Executive Director, Victoria Transport Policy Insitute

The interaction between land use pattern and transportation is fundamental to sustainable urban transport planning. It is interesting to note how roadway expansions

Basis	Conventional planning	Sustainable planning
1. Transportation	Defines and measures transportation primarily in terms of vehicle travel	Defines and measures transportation in terms of access
2. Objectives	Maximize road and parking capacity to meet predicted traffic demand	Uses economic analysis to determine optimal policies and investments
3. Public involvement	Modest to moderate public involvement. Public is invited to comment at specific points in the planning process	Moderate to high public involvement. Public is involved at many points in the planning process
4. Facility costs	Considers costs to a specific agency or level of government	Considers all facility costs, including costs to other levels of government
5. User costs	Considers user time, vehicle operating costs, and fares or tolls	Considers user time, vehicle operating and ownership costs, fares and tolls
6. External costs	May consider local air pollution costs	Considers local and global air pollution, down-stream congestion, uncompensated accident damages, impacts on other road users, and other identified impacts
7. Equity	Considers a limited range of equity issues. Addresses equity primarily by subsidizing transit	Considers a wide range of equity issues. Favors transportation policies that improve access for non-drivers and disadvantaged populations
8. Travel demand	Defines travel demand based on existing user costs	Defines travel demand as a function, based on various levels of user costs
9. Generated traffic/induced travel	Ignores altogether, or may incorporate limited feedback into modelling	Takes generated traffic into account in modelling and economic evaluation of alternative policies and investments
10. Integration with strategic planning	Considers community land use plans as an input to transportation modelling	Individual transportation decisions are selected to support community's strategic vision. Transportation decisions are recognized as having land use impacts
11. Investment policy	Based on existing funding mechanisms that target money by mode	Least-cost planning allows resources to be used for the most cost-effective solution
12. Pricing	Road and parking facilities are free, or priced for cost recovery	Road and parking facilities are priced for cost recovery and based on marginal costs to encourage economic efficiency
13. Transportation demand management	Uses TDM only where increasing roadway or parking capacity is considered infeasible (i.e., large cities and central business districts)	Implements TDM wherever possible. Capacity expansion only occurs where TDM is not cost effective. Considers a wide range of TDM strategies

Source Litman (1999)

can alter travel behaviour and preferences of commuters, and contribute to sprawl in the long run. Litman (2001) has provided a comprehensive typology of such alteration in the behaviour of commutes with respect to roadway expansion. While diverted trips from off peak hour and alternative routes is known to have short term impact, the induced trips which alter the land use and modal choice have long term impact. With the cost of trips reducing with highway expansion, longer trips may be generated and

Table 1 Litman (2001)'s typology of generated traffic

Type of generated traffic	Category	Time frame	Travel impacts	Cost impacts
Shorter route improved road allows drivers to use more direct route	Diverted trip	Short term	Small reduction	Reduction
Longer route improved road attracts traffic from more direct routes	Diverted trip	Short term	Small increase	Slight increase
Time change reduced peak period congestion reduces the need to defer trips to off-peak periods	Diverted trip	Short term	None	Slight increase
Mode shift; existing travel choices improved traffic flow makes driving relatively more attractive than other modes	Induced vehicle trip	Short term	Increased driving	Moderate to large increase
Mode shift; changes in travel choice less demand leads to reduced rail and bus service, less suitable conditions for walking and cycling, and more automobile ownership	Induced vehicle trip	Long term	Increased driving, reduced alternatives	Large increase, reduced equity
Destination change; existing land use reduced travel costs allow drivers to choose farther destinations. No change in land use patterns	Longer trip	Short term	Increase	Moderate to large increase
Destination change; land use changes improved access allows land use changes, especially urban fringe development	Longer trip	Long term	More driving and auto dependency	Moderate to large increase, equity costs
New trip; no land use changes improved travel time allows driving to substitute for non-travel activities	Induced trip	Short term	Increase	Large increase
Automobile dependency synergetic effects of increased automobile oriented land use and transportation system	Induced trip	Long term	Increased driving, fewer alternatives	Large increase, reduced equity

Source Litman (2001)

people are induced to choose farther destinations, increasing the total Vehicle Miles Travelled (VMT). In the long term, such behaviours alter the land use patterns and automobile dependency as improved access enables people to choose housing and workplaces farther away. Thus, highway expansion stimulates more dispersed, low density, automobile dependent urban fringes (Table 1).

Such automobile dependent urban fringe development transfers the environmental costs to the society at large in the long term, with the society now having to combat more pollution, congestion, and accidents with the increased automobile use. Such low density developments also make public transit and non motorized modes inef-

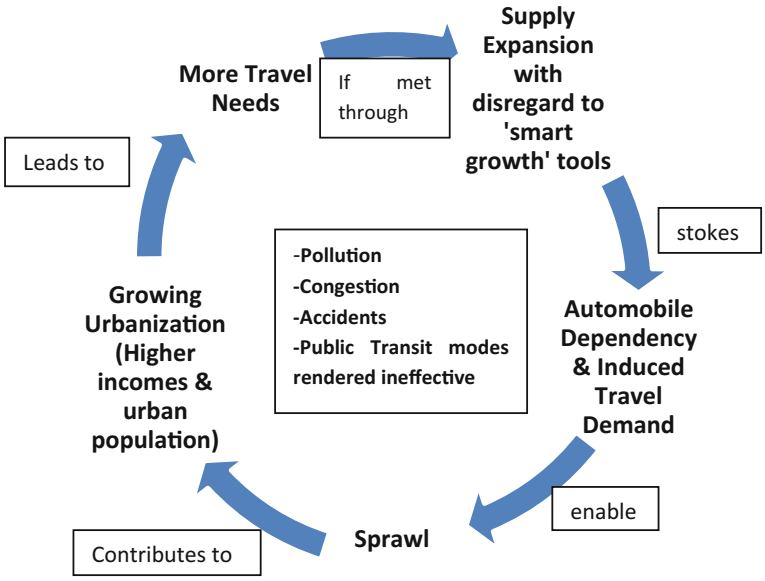

Fig. 2 Vicious circle of unsustainable cities. *Source* Author's own work

fective, and thus creates inequity of access to those who are private vehicle deprived, at the cost of those who are rich and can afford private motorization.

2 Conclusion

How are these transport patterns socially, economically, and environmentally sustainable?

With economic growth and continuous influx in urban population, sprawl keeps growing with more and more people able to buy housing that develops on the urban fringes. This, thus, takes the form of a vicious cycle where more incomes and urban population leads to increased travel needs, which if met by supply expansion and a disregard to the tools of 'smart growth' stokes automobile dependency and induced travel demand, which enables low density sprawling patterns, which further contributes to growing urbanization. As this cycle progresses, the community has to bear the growing negative spill-overs of pollution, congestion, accidents, and ineffectiveness of public transit modes. This brings us to the question of how sustainable are such transport policies after all? (Fig. 2).

It is to be noted that the above vicious cycle does not suggest that highway expansion is a causal force for sprawl. Urban sprawl is a complex phenomenon and is a consequence of a plethora of other factors that might be unrelated to transportation. Since urban sprawl is a difficult concept to quantify, empirical evidence to sug-

gest that highway expansion causes sprawl is mixed, and the relationship between land use and transportation continues to elude empirical researchers. However, most researches while explaining the expansion of metropolitan areas in the United States over the twentieth century recognize highway expansion at least as an enabling force to the increased (and still increasing) suburbanization in the United States.The degree to which additional highway expansion contributes to sprawl by reducing transportation costs and improved accessibilities is, however still debated among empirical researchers (Handy 2005). A great extent of this relationship also varies from region to region with different data sets. Handy (2005) analyses the empirical evidences available and concludes: "Highway building thus appears to contribute to sprawl not by increasing the rate of growth but by influencing where in the region development occurs and by influencing the character of the development that occurs" (Handy 2005). It would also be insightful to quote a 1995 report published by the Transportation Research Board, as cited by Handy (2005): "Major highway capacity additions are likely to have larger effects on travel and to increase emission in the affected transportation corridors in the long run unless some mitigating strategy is implemented in conjunction with the capacity addition".

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