

Developing Methodology for Strategic Environment Assessment for Urban Transportation Policy: A Case of Ahmadabad City, India

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Abstract

The last two decades have witness controversial yet rapid development of the environmental policy agenda. It is considered more important to improve environmental performance and environmental awareness in decision-making. Nowadays Strategic Environment Assessment (SEA) is the most accepted term for the environmental assessment of impacts of proposed policy or plan, for ensuring full inclusion of environmental concern. SEA appropriately addresses the environmental, social and financial consideration at the earliest and appropriate stage of decision-making.

This work is an attempt to formulate SEA process which could be helpful in formulating plan/policy for urban transportation system, thereby ensuring that economical, social and environmental considerations are taken at planning stage itself.

It was found out that the proposals should consider the city's morphology into account before arriving at any decision. More stress should be given on decreasing the total passenger-Km by innovative land-use planning; concern should be toward controlling motorization and encouraging non- motorized movement in the city. The increasing trend to travel by vehicle will put extra economical burden on the economical weaker section of society. Hence it is concluded that for long term Sustainability there is a need of integrated land-use and transportation planning.

1. Introduction

Environment Impact Assessment (EIA) has always stayed as a legal obligation for the formality of obtaining 'clearance' for the proposed project. This assessment only deal with 'project', hence its scope of geographical boundary and people affected is always 'limited'. Project-specific Environmental Assessment can never influence decision-making and planning at the policy level. EIA in general, is not an effective means for assessing the cumulative impacts of projects and is not suitable for analyzing alternative project design or sitting proposals. It is already apparent that EIA has often been taken as a additional requirement secondary to the economic and engineering issues.

Several institutions and countries have struggled with these shortcomings and the foremost response that has surfaced is the concept of strategic environmental assessment (SEA). SEA is the most accepted term for the environmental assessment of impacts of proposed policy or plan, for ensuring full inclusion of environmental concern. SEA appropriately addresses the environmental, social and financial consideration at the earliest and appropriate stage of decision-making.

The foremost issue in today's context is to reorient the conventional planning process of transportation projects for ensuring that environmental, social & financial concerns are taken at the planning stage itself. This work is an attempt to formulate SEA process which could be helpful in formulating plan/ policy for urban transportation system, thereby ensuring that economical, social and environmental considerations are taken at planning stage itself.

2. What Is Strategic Environment Assessment?

An early and widely quoted definition of SEA, by Therivel et al., 1992, is: "the formalized, systematic and comprehensive process of evaluating the environmental impacts of a policy, plan or program and its alternatives, including the preparation of a written report on the findings of that evaluation, and using the findings in publicly accountable decision-making" [1].

SEA is a proactive tool, which allows local planning authorities, individuals, researchers and other stakeholders to identify evaluate and integrate the potential changes to environment from a proposed initiative.

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Despite its broader perspective, it still remains a complex definition. For practical purposes, two other definitions are rather complementary and can be used:

SEA of a proposed policy is an appraisal of the environmental impacts of a policy which is used in decision-making [2].

"SEA is an instrument that must be adapted to existing decision-making processes. It is more political than technical, and is related to concepts, rather than to activities with geographic and technological specifications" [1].

3. The Project and the Context of Study

Ahmadabad is taken as a study area. Integrated Public Transit System (IPTS) Study undertaken by LB Associates [11] [12] in 2000 has given some proposals [3] [4] [5] regarding improvement to public transportation in the city, which can be broadly classified as:

- Road improvement alternative
- Bus based IPTS System
- Rail and Bus Based IPTS System

These strategic options are taken for the study purpose. The study is carried out in and around city of Ahmadabad. The study area comprises of 3000SQ.KM. [11-17]

Ahmadabad is the seventh largest metropolis in India. It is the commercial capital of the state. Ahmadabad has been a major industrial, cultural and regional service center. Its fortunate location at a sub continental portal allowed it to develop as a center of trade and medieval government [6, 18].

The city has grown radially from the core walled city area. Due to this compact structure of the city and land-uses, average trip distances are shorter [7]. The Road network is historically evolved & with time it is patched and not planned, thus most of the routes leads to walled city, hence there is high concentration of bus availability in the center but there are not much depend in the central area (mostly short trips) [18]. Demand is on the periphery, but it is low density. Uneven distribution of population and employment has created trip generation and attraction concentrated at few areas, which is a hindrance for mass transit system, as any PT has to deal with multiple routes, none of which give high rider-ship to recover cost. The service in such conditions deteriorates. These are great challenges to any transit service which is planned for long route passengers. In fact from sustainable point of view we should try to preserve the compactness and promote smart growth [8-9].

The provision of basic infrastructure is not up to the standard and not proportional to population and physical developed area. The city is actually moving with slow speed.

Today development in the region has reached to a point that activities outside the walled city area are a significant force in metropolitan development. It is believed that during next 35 years both population and employment in areas outside the municipal corporation will exceed that existing in the municipal corporation. This means that more and more future trips will have no reason to travel to the walled city [10].

Recent projections show that the growth within the next 30 years will see a further 2.5 million people added to the existing number. This will cause ever-increasing congestion. The population growth will mean that the developed areas will either spread far or will increase the densities of existing areas. The demands will become more critical and more widespread. As a result, some corridors will emerge as very high demand for public transport [9].

At present deterioration in public transport has resulted in increased patronage of two wheeler and shared auto mode [13 -14]. Vehicular growth in the region is rising at alarming rate; this will increase the motorized trip in the region, particularly two wheelers. At present, though the use of car as a mode does not form a significant number, the rise would be significant in a short period. This would lead to severe clogging on the roads and also be a severe problem for ambient air quality.

Any development policy/ plan for Ahmadabad should consider the fact that two- third of the city population falls under low and middle-income category. Over 55 percent do not own any motorized vehicles and hence fall captive to public transport [15-16] This group behaves more homogeneous which is confirmed by their expenditure behavior. 60% of the users spend up to Rs.150 / month. 80% of the passengers are regular. This fact should be considered while proposing any future scheme for Public Transport.

4. Strategic Environment Assessment Study Objective

The ultimate goal of Strategic Environment Assessment (SEA) is to develop a Public transport system in Ahmadabad with due regard to Environmental and Social aspects such that IPTS study addresses potential environmental and social impacts of different transportation strategies to ensure future developments are realized in an environmentally acceptable manner. To achieve this goal a set of objectives is framed. The purpose of these objectives [19] is to:

- State the direction and priorities of the SEA;
- Give a structure to the appraisal; and
- Help identify relevant indicators.

The concept of this assessment is to test how the indicators of Sustainable development perform when subjected to proposed interventions.

5. Methodology

Firstly, Sustainable Checks have been developed, which will enable any evaluator to consider 'broad' issues of sustainable development and various problems related to transportation. For this concept of Sustainable development has been used and also various environmental and social issues related to transportation have been considered.[20] [21] [22] [23]. Once the checks have been designed, they are detailed out in form of 'specific' Sustainable Objectives. These Objectives are specific requirements that need to be achieved in order to realize sustainable development. These objectives are checked for any mutual conflict so as to aware of at initial change and if possible can be modified so as to suit larger objectives.

Though objectives will be prioritized and conflicting objectives can be taken care of that stage (the priority is to be given such that environmental and social parameters are not overweighed by service or economical parameters) but this prioritization is not done at this stage and will only be done only after the study of baseline data and assessment of all the parameters so as to aware the evaluators about the real scenario of the existing problems and issues of at the local level. In order to measure the objectives various indicators were than framed in order to measure each of the alternatives in different scenarios. These were than tested against each of the project actions

for each of the alternatives. The primary testing will reveal the broad issues (of sustainability) considered/ not considered. From this assessment the scope of detailed assessment is decided i.e. what actions have to be considered for assessment, what parameters are to be tested, what will be the geographical area for analysis and for what time period the assessment is to be carried out.

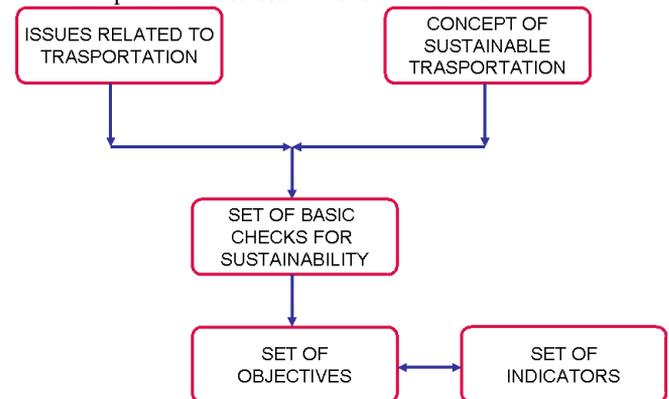


Fig. 1: Methodology for framing Sustainable Objectives

6. Sustainable Checks

Going by the above methodology following are the 'Sustainable checks' with subsequent Sustainable Objectives [20-24], which any decision makers should apply in making decisions on urban transport systems:

Is the environmental performance of the transportation sector improving?

Air pollution is minimized

Noise pollution is minimized

Light pollution from Roadway lighting installations is minimized.

Habitat fragmentation, including Green Belt, is avoided.

Adverse impact on natural topography or site of ecological Importance

Adverse impact on cultural heritage and site of national importance is minimized.

Minimize the vulnerability of the transportation infrastructure to flood risks.

Protect agricultural land from development which would irreversibly prevent its use for agricultural production.

Does the resource Efficiency is achieved by the transportation system?

Promote material resource efficiency in construction and maintenance of transport infrastructure.

Promote land resource efficiency in providing infrastructure for transport

Promote fuel resource efficiency in operating the transport system.

Promote network efficiency in operating the transport system.

Efficient utilization of passenger vehicle.

Are we getting better at managing transport demand and at improving the modal split?

Controlling the transportation growth and minimizing the transportation activity.

Reduce dependence on private vehicle movement for access to jobs and services, by encouraging the provision of viable alternative modes of transport.

Are land use, urban form, and transportation systems changing so as to reduce transportation effort?

Implementation of policy and planning practices that lead to more accessible, dense, clustered, mixed development. (Smart Growth)

Increase the vitality of the town centre and encourage urban renaissance.

Does the transportation system is improving the Equity and Accessibility to the society?

Improve access to public amenities and open areas.

Improved Accessibility by Transport Diversity.

Encourage an increase in cycle & pedestrian, thereby achieving equity to non-drivers.
 Improve transport accessibility for disabled groups.
 Achieving Equity to Socially weaker section
 Achieving Equity to Children's Travel
 Encourage women to travel.
 Does the transportation system is improving the Safety and Security to the society so as to ensure Healthy life to the citizen?
 Improve safety and security.
 Improving the Health
 Are we moving towards more sustainable pricing system which is not only affordable to disadvantaged but also competitive and productive as compared to other modes of transport?
 Transportation Cost should be Affordability to low income household.
 Economical Efficiency of daily operation should be achieved for sustainable persistence.

The objectives were finalized after doing initial Consistency test. The final objectives are presented in subsequent section.

7. Final Sustainable Objectives and Indicators

Each objective is measured by suitable indicator for assessment purpose. The list is as follows:

Table 1: List of Indicators to measure specific Object

Objective	Indicator
Emissions from transport affecting Ambient air quality are minimized.	Per capita emissions of air pollutants
	Critical area (Area exposed to exceedances of air quality standards for PM, NOx, CO2, SOx)
	Per passenger Km emissions of air pollutants
	Per Capita Green House Emission
Noise pollution due to transportation is minimized	Change in over all Noise level
	Length of main transportation network with a change in noise levels
	Critical area (Area exposed to exceedances of noise quality standards)
Minimize light pollution from Roadway lighting installations	% roadside lighting designed to modern "low spill" standards.
Avoiding Habitat fragmentation, including the undeveloped and open character of the Green Belt.	Number and area of wildlife/open spaces cut by new transportation infrastructure.
	Proximity of infrastructure to sensitive areas and ecosystem fragmentation
Minimize adverse change natural topography or site of ecological Importance	Area of transportation infrastructure affecting designated or historic landscapes or natural topography or site of ecological
Minimize adverse affects on the integrity of nationally designated sites of cultural	Number of conservation areas experiencing a change in their setting

Minimize the vulnerability of the transportation infrastructure to flood risks.	Area of floodplain occupied by new transportation infrastructure/ % of transport network at risk from flooding (i.e. within the indicative floodplain)
Protect agricultural land from development which would irreversibly prevent its use for agricultural production.	% land taken of agricultural land due to transportation schemes
Promote material resource efficiency in construction and maintenance of transport infrastructure.	% of transport schemes making use of recycled/secondary materials in construction and maintenance of transport infrastructure.
Promote land resource efficiency in providing infrastructure for transport	Per capita Land gone for transportation Infrastructure.
Promote fuel resource efficiency in operating the transport system.	Per capita fossil fuel consumption (liter/ person)
	Energy efficiency for passenger (per pass-km and by mode).
Efficient utilization of passenger vehicle.	Veh- km of travel per pass- km
Promote network efficiency in operating the transport system.	Congestion index (volume/ capacity ratio)
Controlling the transportation growth and minimizing the transportation activity.	Road traffic growth (Per Capita no. of trips per day)
	Per capita Passenger-Km
Reduce dependence on private vehicle movement for access to jobs and services, by encouraging the provision of viable alternative modes of transport.	Ratio public and private Trips
	Per capita Trips by Private Vehicles
	% of trips by sustainable Modes of transport (cycling, walking, public transport, car sharing).
Implementation of policy and planning practices that lead to more accessible, dense, clustered, mixed development.(Smart Growth)	Percentage of Passenger-km by Renewable Source of Energy
	Land use (Area) per capita.
Increase the vitality of the town centre and encourage urban renaissance.	Land use (Area) by class (Social) size and zone.
	Employment density by urban size, class and zone.
	Average number of basic services (schools, shops and government offices) within walking distance of homes.
Development on previously developed land.	Mixed use (percent walking to work, ratio of jobs to employed labor force- zone wise).
	Share of population and employment growth on already urbanized lands.
Derelict land and empty properties.	Development on previously developed land.
	Derelict land and empty properties.

Improve access to public amenities and open areas thereby providing support to employment and economic competitiveness in local communities whilst protecting the environment.	% of job opportunities served by transit.
	Share of population served by transit.
	Accessibility to Basic Services
	Emergency Response:
Improved Accessibility by Transport Diversity to those areas which are not served or underserved by public transport such that safety of road user and environment is ensured.	Accessibility to Transportation services:
	Variety and quality of transport options available in a community.
Encourage an increase in cycle & pedestrian, thereby achieving equity to non-drivers.	Ratio of Motorized Mobility and Non Motorized Mobility
	Ratio of motorized and Non Motorized Trips
Improve transport accessibility for disabled groups.	% increase of bus transport with assumption that PT encourages their movement by providing
Encourage women to travel.	% increase of bus transport with assumption that PT encourages their movement by providing
Achieving Equity to Children's Travel	Portion of children's travel to school and other local destinations by walking, cycling or public
Achieving Equity to Socially weaker section	Share of population (weaker section) served by transit.
Improve safety and security.	Fatality & Accident ratio
	Traffic Accidents per 1000 vehicle
Improving the Health	Fitness (Portion of population that regularly walks and cycles)
	Population exposed to exceedances of air quality standards for PM10, NO2, benzene, ozone, lead and CO
	Portion of population exposed to high levels of traffic noise.
Transportation Cost should be Affordability to low income household.	Portion of budgets spent on transport by lower income households.
	subsidies per person
Economical Efficiency of daily operation should be achieved for sustainable persistence.	Ratio of operation revenue to operation cost
	Total cost per vehicle km

to identify areas where the implementation of the objective is fundamental to a sustainable plan.

The important findings and conclusions from the above table are as follows:

Three objectives viz. 'Minimize light pollution from roadway lighting installations', 'Promote material resource efficiency in construction and maintenance of transport infrastructure' and 'Increase the vitality of the town centre and encourage urban renaissance' are not at all covered by any of the proposed actions of any of the alternatives. These objectives will be dropped down for further analysis (Impact assessment) and will be referred during the framing of Mitigation Measures.

Table 2: Final Summary Table

	Do Minimum Alternative (Road Based IPTS)	Bus Based IPTS Alternative	Rail Based IPTS Alternative
<i>O1</i>	+	?	?
<i>O2</i>	+	?	?
<i>O3</i>	0	0	0
<i>O4</i>	?	?	?
<i>O5</i>	?	?	?
<i>O6</i>	?	?	?
<i>O7</i>	?	?	0
<i>O8</i>	?	?	?
<i>O9</i>	0	0	0
<i>O10</i>	?	?	?
<i>O11</i>	+	?	?
<i>O12</i>	++	++	++
<i>O13</i>	0	?	?
<i>O14</i>	-	?	?
<i>O15</i>	+	?	?
<i>O16</i>	-	-	--
<i>O17</i>	0	0	0
<i>O18</i>	+	?	?
<i>O19</i>	+	++	+
<i>O20</i>	?	0	-
<i>O21</i>	+	?	?
<i>O22</i>	?	?	?
<i>O23</i>	++	?	?
<i>O24</i>	0	?	?
<i>O25</i>	+	+	+
<i>O26</i>	?	+	+
<i>O27</i>	?	+	?
<i>O28</i>	+	?	?

Note: ++ is major positive + is minor positive
-- is major negative - is minor negative
? is uncertain 0 is no relation

All the three alternatives show major positive change for 'promoting Network Efficiency in operating the transport system'. This objective will also be not tested in further appraisal as it is already showing major positive results.

'Implementation of policy and planning practices for achieving dense, mixed development (Smart Growth)' is not at all touched by

any of the alternatives but is anticipated to show major negative results for the same. This will not be evaluated but will be referred during the framing of Mitigation Measures.

Broadly the project actions are anticipated to improve issues related to emission reduction, noise reduction, fuel resource efficiency, accessibility, equity to disabled and children travel, reducing private vehicle usage, economic efficiency and improving safety/ security and health. This is a broad anticipation and need to be analyzed in more detail in further appraisal.

Controlling the growth of transportation and achieving equity to non-drivers are anticipated to be adversely affected. This is a broad anticipation and need to be analyzed in more detail in further appraisal.

Most of the other objective will depend upon site location and other aspects that cannot be predicted at this stage hence will be carried forward in the further appraisal process.

Those objectives that have negative impacts will be major area of concern during framing out of Mitigation measure.

9. Scoping

For simplicity and comprehensive assessment purpose, with due regard to limited time and data restriction, the scope of this exercise is limited as described subsequently.

Project Actions to be considered: the main theme for our study is to evaluate long term proposals which forms bases for one of the most crucial policy issues that is coming up in almost every mega cities in our country i.e. from present basic bus based service whether we should go to rapid bus based transit system or rail based transit system. Hence we will restrict ourselves to only two project actions for appraisal purpose viz.

Bus based IPTS system

Rail and Bus Based IPTS system

Objective to be considered: as described above all those objective that are not touched upon by any of the project actions or are having major positive or negative impacts will also be not evaluated but will be referred later in proposing environmental management plan. Due to time and data restrictions not all the listed objectives could be evaluated and following is the list of final objectives, which will be subjected to appraisal:

Emissions from transport affecting ambient air quality are minimized.

Noise pollution due to transportation is minimized

Avoiding Habitat fragmentation, including the undeveloped and open character of the Green Belt.

Minimize adverse change natural topography or site of ecological Importance

Minimize adverse affects on the integrity of nationally designated sites of cultural heritage

Minimize the vulnerability of the transportation infrastructure to flood risks.

Protect agricultural land from development which would irreversibly prevent its use for agricultural production.

Promote land resource efficiency in providing infrastructure for transport

Promote fuel resource efficiency in operating the transport system.

Efficient utilization of passenger vehicle.

Controlling the transportation growth and minimizing the transportation activity.

Reduce dependence on private vehicle movement for access to jobs and services, by encouraging the provision of viable alternative modes of transport.

Improve access to public amenities and open areas thereby providing support to employment and economic competitiveness in local communities whilst protecting the environment.

Improved Accessibility by Transport Diversity to those areas which are not served or underserved by public transport such that safety of road user and environment is ensured.

Encourage an increase in cycle & pedestrian, thereby achieving equity to non-drivers.

Improve transport accessibility for disabled groups.

Encourage women to travel.

Achieving Equity to Children's Travel

Achieving Equity to Socially weaker section

Improve safety and security.

Improving the Health

Geographical boundary to be considered: the AMC administrative boundary along with peripheral AUDA east and peripheral AUDA west (as described in [15]) is taken for appraisal purpose because it is anticipated that these areas will experience more pronounced changes in spatial distribution of population and employment thus will get maximum affected by any transportation related decision.

Time duration to be considered: the project is conceived with plan horizon of 35 years. This is to make proposal feasible as the proposed actions are long range and won't be feasible for short term period because of reasons like there is no demand for such proposals in existing situation and it will take time to develop demand for them. Thus our appraisal will also follow this time duration. The base line starts from year 2000 and horizon year is 2035.

10. Scoring of Impacts

The purpose of this assessment is to check whether the proposed plan will lead towards sustainable growth or not. Now there are two benchmarks to judge the growth. Firstly, the most important aspect for proposed alternatives is that they should excel from Do-minimum Scenario in planed horizon of the proposal. Secondly, the future scenario of the proposed alternatives should also be in better condition than Base year condition. Keeping this in mind following scoring framework is prepared:

Table 3: Scoring criteria

Category	Scoring (-2 to 2)	Criteria
BEST	2 to 1	Better than Do- Minimum Scenario and Base year Condition.
BETTER	1 to 0	Better than Do-Min. Scenario But worse than Base year Condition.
WORSE	-1 to 0	Worse than Do-Min. Scenario But better than Base Year Condition.
WORST	-2 to -1	Worse than Do-Minimum Scenario and Base Year Condition

From the above criteria we can decide the range, and then the magnitude of the indicators can be added as the fractional part to arrive at the final score so that different alternatives can be compared.

Based on above mentioned scoring style various impacts are discussed below:

11. Impact Assessment

Is The Environmental Performance Of The Transportation Sector Improving?

Emissions from transport affecting ambient air quality are minimized.

Table 4: Final Scoring for Emissions from transport affecting ambient air quality are minimized

Final Scoring			
Scenario 1		Scenario 2	
Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
0.2089	0.3131	0.21507	0.31914

From the above table it is clear that Emissions affecting ambient air quality will be minimized as compared to Do- Minimum Scenario in 2035 [25] [26]. But will be higher than Base year conditions. Hence this objective is fulfilled by the proposed objective.

11.1 Noise Pollution Due To Transportation Is Minimized

The final scoring suggest that this indicator comes under the 'BEST' category of scoring, which means that the alternatives not only

performs better than Do- Minimum Scenario but will also have better condition than base year. Hence this Objective is fulfilled by the proposed alternatives.

Table 5: Final Score for change in Noise levels w.r.t. Base year

	Scenario 1		Scenario 2	
	Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
change in noise level	1.1934	1.1987	1.2015	1.2057

11.2 Minimize adverse affects on the integrity of nationally designated sites of cultural heritage.

Historically & culturally important sites comes under 500m buffer of proposed corridors.10 of them comes on route for shuttle service between Lal Darwaza and Kalupur. So there is no likelihood of any harm to them. Remaining seven sites need to be carefully watched while finalizing the 'projects'. The choice of corridor should be made such that for alignment of exclusive Bus lane and rail, no site of historical and cultural importance should be disturbed. EIA should check that no harm is done to these sites. Hence this objective needs to take care of while finalizing corridor alignment.

11.3 Avoid habitat fragmentation, including undeveloped and open character of the green belt.

Proposed corridors will not fragment any open green space in the limits our study area. This objective needs some consideration as to give 'compensative measure' (since prevention (for agricultural land) is not possible and mitigation measure is not required).

11.4 Protect agricultural land from development which would irreversibly prevent its use for agricultural production

80 km of the total corridor length will be directly affecting the growth along the agricultural land. However, in our study area limit very little agricultural area comes. But because this issue is considered to be of great importance it is concluded that this objective needs immediate attention for policy makers so that mitigation/ compensation measures could be taken to control land use in the area affected by new schemes.

11.5 Minimize adverse change in designated or historic landscapes or natural topography or site of ecological importance

Since the bus lane will be using the existing ROW of roads and metro will go overhead, so there is no question of majorly changing the topography of our concerned area. Hence it is concluded that this objective is fulfilled by the Alternatives.

11.6 Minimize the vulnerability of the transportation infrastructure to flood risks

18 km of the total 225km proposed corridor length for bus or rail based system will be severely affected by water logging problem. 127 water logged areas out of 215 identified for water logging problem will come within 500m buffer of proposed corridor. These areas need to be considered for mitigation measures during future EIA.

From the above discussion it is concluded that air quality and noise quality of the region will improve due to proposed scheme. Rail Based system will perform better than Bus based system. Few objectives require preventive and mitigation measures in order to get fulfilled. Overall environmental conditions will improve.

Does the transportation system is improving the safety and security to the society so as to ensure healthy life to the citizen?

11.7 Improve Safety and Security

It is expected that overall road safety will increase. Both Bus Based and Rail based alternatives are considered safe mode of travel than any other public mode. There is no mention of any proposal that improves security for Public transport (e.g. CCTV, street lighting). This should be looked into in order of fulfillment of objective

11.8 Improving the Health

People getting directly affected will reduce and as already stated the emission load and noise level will also reduce. Hence we can conclude that there will be some improvement in health of the people. One of the problems due to improved transportation is that it reduces the physical exertion of walking and hence gives rise to many health related problem (like obesity and heart related problems).

From the above discussion it is concluded that their will be a mixed effect on health. People getting directly affected will reduce but fitness level might go down, but this is a minor effect to be considered. Similarly the safety on roads will increase but security is still to be considered. Overall we can say that to some extent the new interventions will improve the safety and health conditions of the citizens.

Does the transportation system is improving the equity and accessibility to the society?

Improve access to public amenities and open areas thereby providing support to employment and economic competitiveness in local communities whilst protecting the environment.

More people will be connected to better transportation facilities and also more jobs will be covered by the transit facility. Most of the educational institutions will be covered by the transit but health facilities need to be further integrated with these corridors. 80% of the fire stations will be connected by high speed corridors. Almost all of the major terminals are connected by high speed corridors.

Table 6: Final scoring for improved accessibility

Scenario 1		Scenario 2	
Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
0.0051	0.0047	0.0074	0.007

From the above table it is clear that both alternatives will achieve this objective. Bus based system will improve the accessibility better as compared to Rail based system.

Improved accessibility, by transport diversity, to those areas which are not served or underserved by public transport, such that safety of road users and environment is ensured.

From the above table it is clear that Bus based system will have optimum number of alternative modes so as to serve the population with safety of environment.

Achieving equity to non drivers, disabled, women, children and economically weaker section.

Table 7: Percentage of Alternative modes with final scoring

	Scenario 1		Scenario 2	
	Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
% of Alternative modes	5.1	4.92	4.81	4.62
Final Score	0.0051	0.0049	0.0048	0.0046

Equity to non drivers will not be achieved. Rail Based System is going to worsen the situation. Equity to disabled and women will increase with the increase in share of Public Transport. Rail Based system is going to be best for disabled. The share of children's travel by modes friendly to them will decrease. With decreasing trend for walking, some of the EWS and LIG people may opt for mass transit services. This will exert extra Economical load on these people. But the coverage of this section by the proposed corridor will be good.

From the above discussion it is clear that accessibility will increase but equity to all section is still doubtful.

Are we optimizing the use of existing transport infrastructure capacity so as to achieve resource efficiency?

Promote land resource efficiency in providing infrastructure for transport.

Though this objective doesn't come out to be a significant one yet it can be concluded that Bus based IPTS system optimizes the existing infrastructure capacity and promote land resource efficiency as compared to Rail based IPTS system.

11.9 Promote fuel resource efficiency in operating the transport system

The technological intervention will decrease the rate of consumption of fuel with respect to projected Do Minimum Scenario. There is not much difference between Bus Based and Rail & and Bus Based alternative. In spite of increase in the motorization by both of the alternatives, the fuel consumption efficiency is shown per unit of travel. For scenario 1 the difference in the two alternatives is not much but in scenario 2 Rail based system will perform much better.

Table 8: Final Scoring for Fuel Resource Efficiency

	Scenario 1		Scenario 2	
	Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
Fuel Resource Efficiency	0.01345	0.0146	0.0215	0.02335

The Fuel resource efficiency would be definitely achieved. It will be better achieved by Rail based system. Both alternatives will excel in 2035 from Do-Nothing Scenario but will remain lower than base year conditions.

11.10 Efficient Utilization of Passenger Vehicles

Bus based alternative will result in more efficient utilization of passenger vehicles in the city, owing to less use of vehicle for same no. of passengers. There will be very minor improvement in case of Rail based system

From the above discussion it is concluded that we are definitely going to optimize the existing resources and increase the efficiency so as to achieve sustainability, through proposed interventions. Overall Resource Efficiency will be achieved but we won't be able to maintain base year conditions.

Are we getting better at managing transport demand and at improving the modal split?

11.11 Controlling the transportation growth and minimizing the transportation activity

Both alternatives will decrease the amount of trips traveled (mobility) of a person. There is not much difference in alternatives but difference in scenarios is appreciable. This is due to the fact that people traveling extra due to the historically evolved routes and road network. Proposed services will provide direct connection to most desired OD points.

11.12 Reduce dependence on private vehicle movement for access to jobs and services, by encouraging the provision of viable alternative modes of transport.

There will be appreciable reduction in private vehicle trips. Trip rate for Private vehicle will also get reduced. The reduction is more in case of Rail based system. Both alternatives will improve the use of Sustainable mode of transport as compared to Do- Minimum Scenario in 2035. There is not much difference between alternatives but there is appreciable difference between scenarios. Percentage of travel by renewable source will increase by both of the alternatives. Rail and Bus Based IPTS System seems to perform better.

Table 9: Final Scoring for Reduce dependence on Private vehicle

	Scenario 1		Scenario 2	
	Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
Final scoring for Reduce dependence on Private	0.2724	0.2744	0.2827	0.2848

vehicle				
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The above scoring clearly states that with proposed intervention usage of Private vehicles will reduce as compared to Do- minimum scenario in 2035 but it will still remain lower than Base year condition.

From the above discussion it is concluded that we are definitely going to control the transportation activity and will improve the modal split in favor of Sustainable modes of transport, through proposed interventions. Overall their will be improvement in Transportation demand but we won't be able to maintain base year conditions.

12 Impact Summary

For simplicity and comprehensive approach to appraisal the objectives are classified into following groups:

- Environmental parameters
- Social parameters
- Service parameters

Each of the group is considered equally important and has uneven number of parameters, so as to be exhaustive in nature and cover most of the issues related to sustainable transportation. The summary of impacts is described in the following Table: 12.

13 The Best Alternative

Only quantitative parameters are taken for evaluation of best alternative among the various proposals given. The result might not show the true picture because of the limitation of not considering all the parameters. But for given parameters the choice for best alternative is made as discussed below:

Table 10: Final score for all alternatives for three categories

	Scenario 1		Scenario 2	
	Bus Based Alt.	Rail and Bus Based Alt.	Bus Based Alt.	Rail and Bus Based Alt.
Environment	0.471933	0.508788	0.479346	0.516058
Service	0.05955	0.057861	0.063864	0.061653
Social	0.027433	0.030633	0.042067	0.044433
	0.1863055	0.1990941	0.1950923	0.2073814

From the above table it is clear that Rail Based system performs better than Bus based system for environmental and social parameters. Bus Based system will perform better than Rail based system for Service parameters. For environmental parameters both alternatives will show excellent performance as compared to Do-Minimum Scenario in 2035. The difference between both Scenarios is not much for both alternatives. Hence there will be not much improvement in developing all the corridors, developing only those corridors that have highest boarding will give almost same environmental, social and service benefits. Overall we can say that Rail Based System is more preferential over Bus Based system for given set of parameters.

Regarding sustainability it is concluded that the proposed alternatives will improve from Do-Minimum scenario but will still remain below the Base year conditions. Hence these alternatives won't achieve long term Sustainability. For long term sustainability there is a need of integrating Transportation with Land-Use. The smart growth would itself bring about fulfillment of 15 other Sustainable Objectives.

In India, development plan and transport plans are taken up as independent exercises. Transportation plans depend more on data than strategy and tend to accept the development plan as sacrosanct. Generally they do not make any recommendation on improving the development plan and are undertaken as studies meant to reinforce

and promote pre-conceived ideas like road widening, grade separators, LRT and metro.

14. Environment Management Plan

Even the best Alternative will have some impacts on the environment and need to be mitigated. In our case also some of the impacts are taken up for environment Management Plan. Only those parameters that have negative impact with high significance level are taken up for consideration. Besides this those parameters are also taken which were not considered in the proposal. Due to the severity of two parameters, viz., noise and air pollution augmentative measures are proposed. The final EMP is presented in Table 13.

15. Strategic Environmental Assessment (SEA)

The proposed interventions in the region by introducing Rapid Bus system or Mass transit rail system is expected to improve the environmental, social and Service performance of the transportation sector as compared to Do-Minimum Scenario in coming year 2035. But this is only a short term improvement; in the long run we might face similar problems. The proposals should incorporate the city's compact structure and land-use planning into account before arriving at any decision. The difference between both Scenarios is not much for both alternatives. Hence there will be not much improvement in developing all the corridors, developing only those corridors that have highest boarding will give almost same environmental, social and service benefits.

It is evident that city's structure and compact land- use planning are going to pose a challenge to the proposed transit concept. Attempt should be made to follow the city's morphology rather than introducing an alien system and then adjusting already established and historically evolved city's form and compact land –uses, to suit

their purpose in order to make the system work by restructuring the land-uses along the corridor.

More emphasis should be given on decreasing the total passenger-Km by innovative land-use planning; concern should be toward controlling motorization and encouraging and facilitating non-motorized movement in the city. It should also be borne in mind that majority in the region are economically weaker who actually are spending very less or not spending at all on transportation, increasing the trend to travel by vehicle, though convenient but will put extra economical burden on them. Hence it is concluded that for long term Sustainability there is a need of integrated land-use and transportation planning. On the basis of subjective evaluation (based on exercise carried out in previous sections), desirability for various Urban transportation options for million plus cities is shown below for different parameters:

Table 11: Desirability for Different Transportation options for Million plus Cities

	Basic Bus Based System	BRTS	MRTS	Bus and Rail Based System
Environmental	Low	Medium	High	High
Social	Low	High	Medium	High
Service	Low	High	Medium	High

From the above table it is clear that Mix Use of Rapid Bus and Rail Based System in Million Plus Cities yield better results. But this will also be subjected to structural form and land- use pattern of the city.

Table 12: Summary table for impacts

Category	Impact	Impact Characteristic			Significance	Remarks
		Nature of Impact	Duration	Reversibility		
Environment	Air Pollution	Positive	Long Term	Reversible	Medium	Augmentative Measure is Required
	Noise Pollution	Positive	Short Term	Reversible	High	
	Light Pollution	Negative	Long Term	Reversible	-	Mitigation Measure is Required to reduce light pollution from street-lights.
	Habitat Fragmentation	Negative	Long Term	Irreversible	Low	Compensative Measure is Required for Forest Patch Being in close Proximity to Corridor
	Impact on Natural Topography and site of Ecological Importance	Negative	Long Term	Irreversible	Low	Water Bodies outside the study area limit require EMP in Future EIA
	Impact on Site of Cultural Heritage	Negative	Long Term	Irreversible	High	Preventive Measure at this stage is required.
	Vulnerability of infrastructure to Flooding	Negative	Short Term	Reversible	High	Mitigation Measure is Required at this stage.
	Change of Agricultural Land to non-agricultural use	Negative	Long Term	Irreversible	High	In-Direct land taken will be more severe impact than direct land taken. Hence Preventive Measure is Required.
	Non- sustainable use of materials in construction and maintenance of Transportation Infrastructure.	-	Long Term	Reversible	-	Requires consideration at this stage.
	Non- sustainable use of land as a resource in construction Transportation Infrastructure.	Negative	Long Term	Irreversible	Low	-
Non- sustainable use of fuel as a resource.	Positive	Long Term	Irreversible	Medium	-	

	Health Impacts	Positive	Long Term	Irreversible	Medium	-
Service	Efficient utilization of Vehicle	Positive	Long Term	Reversible	Low	Policy Intervention Is Required
	Network Efficiency	Positive	Long Term	Reversible	High	-
	Growth in transportation	Positive	Long Term	Irreversible	Medium	-
	Reduction in Private vehicles					
		Positive	Long Term	Reversible	High	-
	Smart Growth	Negative	Long Term	Irreversible	-	Policy Intervention Is Required
	Increasing Vitality of town	-	Long Term	Irreversible	-	Policy Intervention Is Required
	Improved Accessibility By Transport Diversity	Positive	Long Term	Reversible	Low	-
	Improved Accessibility to Basic Amenities	Positive	Long Term	Irreversible	Low	Compensative Measure to Accessibility to Health Service, emergency response services is required.
Social	Equity to Non Drivers	Negative	Long Term	Irreversible	Medium	Policy Intervention
	Equity to Disabled And Women	Positive	Long Term	Reversible	High	-
	Equity to Children's	Negative	Long Term	Irreversible	Low	-
	Equity to Socially Weaker Section		Long Term	Irreversible	Medium	Policy Intervention

Table 13: EMP

Impacts	Mitigation Measure	Institutional Mechanism	Monitoring/ Review
Impact on Site of Cultural Heritage	SEA stage: Cultural heritage sites along the alignment are identified. The existing alignment is to be selected to minimize the land disturbance to avoid archaeological sites. EIA stage: ASI will monitor site clearance, excavations, and other soil disturbance areas and report any finds to authorities for further investigation before construction work continues in the immediate area of the site. No borrow sites or construction access roads will be permitted in the protected areas. In the unlikely event of a new archeological discovery, the project proponent will consult with other government agencies to determine if changes in alignment are needed.	Prime duty: Design Team, Archaeological Survey of India	Monitored by: PWD
Vulnerability of infrastructure to Flooding	SEA stage: the natural drainage of the area is to be studied carefully to identify water logged areas. The existing alignment should not block these water logged areas and should take into consideration existing and future requirements so that the infrastructure remains un-obstructed during rainy seasons also. EIA stage: the project proponent should arrange for drainage of any site water logged due to proposed construction.	Prime duty: Design Team,	Monitored by: PWD
Change of Agricultural Land to non-agricultural use	SEA Stage (Policy Measure): induced development along the Proposed Corridor should be foreseen and Development plan should provide land-use zoning and development control regulations consistent with the upcoming development. EIA Stage: Strict enforcement of Development regulations to certain growth in ecological fragile areas.	AMC/ AUDA	AMC/ AUDA Project Coordinating Consultants
Smart Growth	Mixed-Land use planning with regulations: Develop a policy that Increases, or at least maintains the population density and favors the concentration of employment and retail activity such that trip lengths are reduced. Regulation and taxation on suburban development Strengthen the Institutions & increase their effectiveness: Roles and responsibilities of each relevant institution are clearly redefined. Strengthen institutional linkages through effective communication Develop and maintain a credible database (inventorization of vehicles and their attrition, vehicle utilization, speed, emission factors, continuous monitoring of air quality in critical areas, adulteration, and safety aspects.) Capacity building of local bodies	Planning and regulation by AMC/AUDA Strengthening of institutions: Urban Development Department	UDD, AUDA/ AMC will combine to form a committee to monitor and communicate among various departments. RTO will monitor

			Various Traffic Parameters to keep track Change in traffic Movement..
Non-sustainable use of materials in construction and maintenance of Transportation Infrastructure.	The project proponents should make it a policy that reusable and recycled material is used in the construction and maintenance of infrastructure (e.g. Buses, bus shades, street furniture, etc.) The design of new infrastructure should be such that after the expiry of their life time the building material could be used for some other purpose and should not get wasted.	It should come as a clause in contract document of AMTS and supplier.	AMTS
Light Pollution	The use of streetlight that is designed with "LOW SPILL" Standards. Also these street-lights should be operated by renewable source of energy like solar energy.	It should come as a clause in contract document of AMC and supplier.	AMC
Air Pollution	enforcing higher maintenance standards on existing vehicles, in order to keep emissions closer to the design standards of the vehicles; introducing vehicles designed to meet stricter emission standards; scrap highly polluting and high usage vehicles, introducing unleaded fuels (with or without catalytic converters) for the rapid reduction of atmospheric lead; Retrofitting motor vehicles to use other kinds of fuel modifications or fuels.	RTO	CPCB/ GPCB/ RTO
Noise Pollution	Engineering Measure: Identify the types of heavy vehicles that could be Encapsulated Introduce legislation to require engine encapsulation of the identified vehicle type Introduce strict noise emission standards Consider the feasibility of retrofitting roadways with noise mitigation measure. Control Measure: Planting of vegetation screens should be considered	Motor Vehicle Department RTO PWD EMU	CPCB/ GPCB/ RTO
Increasing Vitality of town	The Project Proponents should consider that their transportation scheme should promote use of derelict land and empty properties within the town and also promote development on already developed land so as to increase the vitality of town and efficient utilization of existing resource.	Design Team	AMC/AUD A
Equity to Non Drivers	Traffic management to raise the cost of private vehicle use: (bans and restrictions on private vehicle movements, creation of high occupancy vehicle lanes, and timely clearance of road encroachments.) Engineering measures (provision of cycle tracks and parking space, pedestrian walkways, redesigning intersections, periodic road maintenance, grade separation, and setting up of freight and bus terminals.) Control measures (traffic signals synchronization, display diversion maps) Parking restraints demand management (such as increased parking fees, road tolls, fuel taxes, and carpooling programs, Congestion charges, Car free day, High Occupancy Vehicle lanes).	AMC/ AUDA/ Traffic police	
Equity to Socially Weaker Section	To reduce their cost of travel, Subsidy should be given on the basis of Identity card issued by AMTS..	AMTS	AMTS

16 Conclusions

The SEA carried out in the preceding sections has given way to many speculations on the method/ process followed; the kind of information available and kind of information required for such analysis; kind of detailing required for such appraisals, keeping time factor as an important constraint; and the level of abstraction that should be allowed for such assessment as the range of considerations are so varied that quantifying every parameter on the same scale is not possible.

Despite these speculations the SEA has come out with potential benefits over other environmental assessments performed till date, in light of the fact that a much wider consideration of impacts and alternatives have been made as compared to traditional EIA; and

also it should be kept in mind that the level of decision making at which it is performed is much higher and important than the level at which EIAs are performed. This is the level at which actual problems are created (though the intension remains to solve the problem) and if tackled carefully can reduce the burden on EIA or even make it redundant.

There is a need to further improve the available methods in SEA so that they could be made more exhaustive in nature while considering different impacts. This should also be followed by improving the techniques of scaling different impacts of entirely different nature. Hence this forms the scope of further research into this field.

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