International Journal of Application or Innovation in Engineering & Management (IJAIEM)
Web Site: www.ijaiem.org Email: editor@ijaiem.org
Volume 6, Issue 7, July 2017 **ISSN 2319 - 4847**

Development of Public transport sustainability model for Ahmedabad

Anal Sheth[1] , Dr. Debasis Sarkar[2]

[1]Assistant Professor, CEPT University, Ahmedabad

[2]Associate Professor and Head, School of Technology, PanditDeendayal Petroleum University, Gandhinagar

Abstract

A high level of research activity is being carried out in the current decadeto look into transport sustainability. Sustainable transport is viewed as an inherent element of sustainable development worldwide and public transportation is one of key contributors of sustainability in most developing countries.Public transport infrastructure is meant to last long and therefore decisions that affect its development, operation and management are crucial to local and national governments, and the public realm. Although there is no unique definition of transport sustainability, various practice and research initiatives emphasize on different aspects of addressing and achieving sustainability in transport thereby establishing multiple definitions and assessment parameters. This paper examines various frameworks and models adopted for addressing the transportation system sustainability and attempts to derive upon a suitable set of indicators and metrics for assessment of publictransport sustainability in context of the city of Ahmedabad in India.

Keywords:public transport, sustainability, Ahmedabad

1. INTRODUCTION

One of the first definitions of "sustainable development" can be traced back to the WCED (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." According to a study by Peter Hardi (1995) and later similar research by Jeon et al. (2005), there is no standard definition for transportation system sustainability and various practice and research initiatives emphasize on different aspects of addressing and achieving sustainability in transport thereby establishing various definitions and assessment parameters.

Globally the concept of sustainability is widely embraced and its principles of health, safety and environment preservation are well accepted. Nationally, various policies have been formulated in India implying input oriented approach to this paradigm. The role of municipal governments and urban local bodies is highly instrumental in this development. Achieving sustainability in practice therefore requires recognition of city level transport issues, development of a scale to measure these problems, identification of suitable interventions to abate these issues and assessment of impact of these interventions on the same scale. Public transport is an inherent and significant part of the transportation system of a city and there is no debate on the benefits of public transport in Indian cities. Need exists however to strengthen and make healthier the public transport system for sustainability benefits.

Literature boasts of approximately 200 types of indicators of sustainability that have either been adopted by or recommended to various agencies. The paper is organized as follows: The researchersfirst examine and present brieflytenpopular and relevant models adopted and/or recommended for addressing the transportation system sustainability. Next, the state of public transport in the city is captured following which, attempt has been made to derive upon a suitable set of indicators and metrics for assessment of public transport sustainability in context of the city of Ahmedabad. The purpose of the paper is not to compare the city with another city or province but to identify and recommend measures that can lead to a healthier public transport system in various respects.

2. FRAMEWORKS OF SUSTAINABILITY

Research by Jeon et al (2005) identifies three major types of frameworks for addressing sustainability of a system. All models exemplified in this paper can be classified to follow one of these frameworks. These frameworks are classified to be linkage based, impact based or influence based as described subsequently.

A Linkages-based framework captures relationships between the causal factors, impacts and corrective actions related to achieving sustainability. Three linkage based models have been studied as part of this research. These include the PSR Model (Pressure – State – Response), the DPSIR Model (Drivers – Pressures – State – Impact – Responses) and

the Environment – Economy linkages model.

An Impacts-based framework focuses on the nature and extent of various kinds of impacts that collectively determine the sustainability of a system without necessarily capturing causal factors and corrective actions. The most common impacts-based framework is the three dimensional framework of indicators based on economic, environmental, and social impacts. Many models use this tripartite framework to evaluate sustainability of different types of civil infrastructure. These include the Litman (2003) model, the Pearce and Vanegas (2002) model and the Rijsberman and van de Ven (2000) model which are also found relevant for study and application to transportation infrastructure system.

An Influence-oriented framework is developed keeping in mind the role and level of influence of the responsible agency or organization conducting the study. Thus the various actions and/or activities of the organizations that influence progress toward sustainability define the scope and objective of the framework. A comparison done by Gudmundsson (2000) among models developed by three different organizations/agencies, namely Transport Canada (TC), United States Departments of Transportation (USDOTs) and the European Union (EU), illustrates clearly the differences in the indicators on the basis of which these agencies/organizations attempt to evaluate the transportation system sustainability.

3. STUDY OF SUSTAINABILITY MODELS

This section captures the development and ideology of various sustainability models, namely the PSR, DPSIR, Environment-Economy, Pearce and Vanegas, Rijsberman and Van de Ven, Litman, Jeon and model adopted by US departments of transport, European Union and Canada.

The PSR (Pressure – State – Response) Model developed by the Organization for Economic Co-operation and Development (OECD 1994) is said to be an extension of the Rapport and Friend's (1979) stress–response model. At the same time, it was considered by the International Institute for Sustainable Development (Peter Hardi, 1995) wherein it was identified as a means to measure sustainable performance on social, economic and biophysical dimensions at a level of government and large municipalities. It was recognized by the time that, many sustainability measurement projects were in place however it was difficult to develop upon these due to the uniqueness of the data and performance indicators used for the decision. Thus the PSR model was an attempt to identify globally relevant indicators and provide useful measurement methods for arriving at a decision. The model establishes societal action as sources of pressure on the state of the environment which calls for the response required mainly by human efforts (political and societal decisions, measures and policies) to counterbalance the adverse effects of the action. Although the PSR model was soon modified to include the drivers and the impact thus giving rise to the more popularly used DPSIR Model (Drivers – Pressures – State – Impact – Responses), the paper by Peter Hardi gives useful insight on the selection of indicators for sustainability.

The DPSIR widely adopted by the European Environmental Agency traces causal linkage beginning with the 'driving forces' (economic sectors, human activities) through 'pressures' (emissions, waste) to 'states' (physical, chemical and biological) and 'impacts' on ecosystems, human health and functions, eventually leading to political 'responses' (prioritization, target setting, indicators). The DPSIR model has also been critically examined for its applications by several researchers including Riley and Bowen, 2003 and Edward Carret all, 2007. At least two major shortfalls have been identified with the models: first the reasons underlying the pressures are not identified which makes it difficult to bring out the controlling factors for way of response and second the motivations behind responses are not identified.

The Environment – Economy linkages are addressed by almost all countries now and in fact, the first environment – economy linkage model was formulated even before the PSR model by Hickling Corporation and Econometrics Research Limited in 1993. The concept has been revised in computerized form by ORTEE as a "criterion-influences-actions-measures" system wherein a selected criterion, such as carbon dioxide emissions, for example, can be deconstructed into a number of influences e.g., persons per vehicle, vehicle kilometers traveled, etc.

The Pearce and Vanegas (2002) model was developed for measuring technological sustainability for building infrastructure. It derives its concepts from thermodynamic fundamentals assuming the earth to be a constrained but open system where there is no net loss of energy however there is entropy defined by the "degradation of energy". Realizing that the consumption of energy leads to entropy and the adverse impact is offset mainly by the efforts of the natural ecosystem, the sustainability objectives are defined in thermodynamic sense as "minimizing consumption of matter and energy" and "minimizing negative impacts to natural ecosystems". The concepts are extended by Pearce and Vanegas for the operation and management of built systems and to identify and compare system performance. The

model also considers the stakeholder satisfaction, resource base impact and ecosystem impact. This may be considered more relevant for the decision making process as other optimization models and methods can be used to optimize on travel time or energy consumption or reduction in pollution or similar parameters, this model can incorporate various dimensions of every alternative which when plotted on an octant of sustainability can help take a decision from the stakeholders perspective.

The Rijsberman and van de Ven (2000) model addresses sustainability in qualitative as well as quantitative terms thus explaining four basic approaches to sustainability that are influenced by people, norms, values, and the environment. The quantitative approach is based on norms, and the qualitative approach is based on values. These approaches are: (i) Capacity approach: norms and environment (ii) Ratio centric approach: norms and people (iii) Socio centric approach: values and people (iv) Eco centric approach: values and environment.

Another popular transport sustainability model has been established by the works of Litman. His recent report "Well measured" (2016), provides guidance on use of indicators for sustainable transport. It elaborates on the process of selection of indicators based on various levels of impacts and presents various cases of quantitative and qualitative data for the purpose. The choice of indicators to be selected for a particular community involves tradeoffs as indicated by the report. It is possible to integrate sustainability indicators with other types of statistical data such as financial accounting. The report provides a dictionary of indicators as proposed by various bodies and researchers. The report finally concludes with set of goals, objectives and performance indicators for four types of impacts: (a) Economic (b) Social (c) Environmental and (d) Good governance and planning.

Many countries and organizations have developed and/or adopted their own models and approaches to evaluate transport sustainability. Based on literature by Gudmundsson (2000, 2003, 2010) as well as Jeon (2005), it can be identified that (a) the framework adopted by the US Department of Transportation (1997) outlines four strategic goals for transport sustainability which are majorly environment-oriented (b) the European Union (2000) framework addresses seven policy questions of a very wide range and (c) Transport Canada (2000) framework also recognizes some seven challenges but with a slight shift of focus as compared to EU. The tiered framework of performance indicators for sustainability for TC and VTPI has been updated further by recent efforts of Yuri V. Yevdokimov (2003) as well as Litmann Todd (2003). Since Europe's approach covers a wider range of surrounding policy issues that would affect or influence progress toward transport sustainability, this has been termed as an "input-oriented" approach, while TC and the USDOT approaches give more emphasis on management challenges and internal responsibilities aiming for system performance and are therefore considered "output-oriented" approaches.

The models put forth for sustainable transportation in Canada have seen dynamic developments and therefore some more details on these developments have been illustrated here. Transport Canada (2001) has developed a tiered framework of performance indicators of three levels (state level indicators, behavioral indicators and operational indicators) that reflects the relative level of influence and control that the agency has with respect to making progress toward sustainability. Similar to the concepts laid by PSR model etc., the state level indicators describe the state and performance of the system and the behavioral indicators identify the effect of all actors and stakeholders involved including transportation infrastructure and service providers, system operators, political, and other decision-makers, and the general public. This is similar to the "pressure" and "response" part that accounts for the human interaction except that it has a more comprehensive set of actors/stakeholders identified. In addition, since this is an initiative by the agency (TC), the framework also has a set of operational indicators over which TC has direct control and therefore it can also attempt to take necessary action to improve transportation sustainability. The framework considers the previous two indicator sets over which the agency has direct or indirect influence to evaluate the sustainability but cannot directly attempt to modify.Recent efforts by Yuri V. Yevdokimov (2003) address the present approaches of measuring sustainability of transportation in Canada and have recommended an upgraded mathematical model for the Canadian ground transport system that stands out over the existing methods in two major ways:

a. It is more quantitative than the indicator based approaches in which lot of variation is possible in assessment. The model is mathematical and computerized method has been developed based on it for reducing processing time.
b. The model gives more emphasis to the economic parameters as well, as compared to indicators such as GHG emissions etc. so that the decision to make a move towards sustainability must indicate short term as well as long term economic benefits. The author claims that it is important to illustrate short term economic benefits to bring about the changes in social attitudes towards sustainable transport. Long term benefits are major mainly at the organizational/agency level and span over generations but are significant to control climate change issues.

The literature by Jeon et all (2005) summarizes the many models and suggests a "Unified framework" for developing indicator systems for infrastructure system sustainability, in which all three types of framework approaches may be combined, as illustrated in the Fig 2. Sixteen influence oriented frameworks were studied by Jeon et al (2005) before summarizing this unified framework. About 176 major indicators and metric have been considered by one or the other agencies. Two major remarks that the authors identify are that firstly, all of these initiatives fail to address the education related to sustainable transport. This is an inherent element for bringing awareness among various stakeholders so that they can take necessary actions to bring about this desired change. Although it may not be measurable, it has a value that should also be captured. Secondly, they note that under all paradigms considered, it might be useful to have a balance of input-oriented and output-oriented parameters. Sometimes performance or output or impact based models do not give importance to inputs or causal parameters, maybe because it is outside the responsibility scope of the agency; however, identifications of causes of critical impacts could be used for policy formulation and provide direction towards effective action.

4. SUSTAINABILITY INITIATIVES IN INDIA

The Government of India reflects its vision for providing a Sustainable Urban Transport System through the 2006 National Urban Transport Policy (NUTP). The input-oriented efforts are aimed to contain and reduce the environmental impacts that are a consequence of traffic growth in the cities. The Ministry of Urban Development has initiated a Sustainable Urban Transport Project with support of Global Environment facility and the World Bank to promote environmentally sustainable urban transport in India and to improve the usage of environment-friendly transport modes through demonstration projects in selected cities. Many other long term plans are in place by GOI and state governments that include policies related to vehicle emissions, promotion of public transport (bus and rail) and promotion of electric vehicles.

Reddy et. all (2000) reflect the sustainable transport goal in the Indian context on basis of energy parameters as "an efficient, capital-saving,non-import-intensive, affordable, service-oriented and environmentally sound transport system". Further they identify key components as "(1) minimization of dependence on petroleum fuels, (2) maximization of thelevel of safe, comfortable and time-saving transport services, (3) maximization of the environmentalsoundness of the transport system, and in particular, reduction of local and global environmentalpollution, (4) minimization of the capital requirements for the transport modal mix that should alsoinclude non-motorized transport (NMT), and (5) minimization of the energy used by the transportsystem without a reduction of the services provided." The working paper on "Urban transport in India: Challenges and Recommendations" by the Indian Institute of human settlements gives a concise picture of the transport problems faced in cities like Ahmedabad. It identifies that though mobility has increased, accessibility still remains an issue in terms of convenience, cost and time. The crisis situation described by the report is characterized by "high levels of congestion, environmental pollution, traffic fatalities and inequity" and indicates special concern to the mobility needs of the poor. Many other initiatives have been taken by various national and international institutions for addressing sustainability of urban transport in India.

5. PUBLIC TRANSPORT SUSTAINABILITY

Assessing public transport sustainability requires more focus on indicators relevant to the public transport system against the entire pool of transport sustainability indicators. Although the most common adapted framework is a tripartite framework with economic, environmental and social indicators; an additional dimension of system effectiveness has been reflected in research while addressing public transport sustainability in various cities and countries. Miller et al (2016) have identified a total of 7 environmental indicators, covering aspects such as energy, pollutants, noise, and land uptake ; 10 social indicators (covering accessibility, affordability, and safety), 8 economic indicators (covering system and user costs, subsidies, and travel time), and 4 system effectiveness indicators (covering vehicle occupancy, reliability, trip rates, and mode split). The work was undertaken mainly in the United States and Canada. Following this, similar but wider attempt by Gruyter et al (2016) addresses sustainability measures of urban public transport system in cities of the world wherein they have focused on Asia and Middle East region. The research also captures sustainability status of two Indian cities, namely Chennai and Delhi on a global scale. They summarize a list of 15 indicators (3 environmental, 4 social, 4 economic and 4 for system effectiveness). Much literature is available for transport sustainability but not much research has been done for public transport sustainability by itself.

6. PUBLIC TRANSPORT IN AHMEDABAD

The case of public transport in Ahmedabad is set with the background of the Ahmedabad Municipal Transport system (AMTS) that provides bus service to the city since more than 60 years now. In its initial years, the AMTS was one of its kind services in the country and attracted plenty of ridership. It also catered to the public demand through capacity

addition by increasing number of buses consequently. Special sections of society such as students and villagers were well connected. Service oriented reforms by AMTS such as night and morning service for textile workers, special routes from Government Colonies to secretariat and the civil hospital, special concession rates for children and students, free pass scheme for the blind and concessional pass for professional and medical post-graduate students were beneficial for the society. Once upon a time the service got popularity among citizens and tourists as modern coaches were facilitating special tourist and religious destinations. Picnic and public function facilities were provided at discounted rates. The merry go round service around Kankaria Lake created a unique image for the city's bus service. The AMTS is a service oriented organization managed by the Transport committee and city municipal corporation. Presently more than 170 routes are being served by the AMTS covering 733 km of road network and 88 % of the developed AMC area. It carries 0.9 million passengers per day with about 7950 trips on daily basis. It caters to roughly 11 % of the trips in the city. About a decade ago, the need for rapid transit system was recognized and in 2009 the city saw the inception of the bus rapid transit system, also a subsidiary of the city municipal corporation which is also a national award winning example in mass transit. The BRT attempts to provide faster, eco-friendly, reliable and advanced public transport along major corridors in the city. The buses have a dedicated right of way and intersection priority leading to savings in travel time. Concession is given to students, visually impaired and physically challenged citizens.Very recently, the need for faster and more capable mass transit was recognized in the city which has led to the materialization of the metro rail project in the city. The project is under planning and construction phase currently and is envisaged to provide fast and high volume connectivity in the east west and north south corridors identified for its alignment. In spite of the developing nature of the public transit in the city, some concerns remain. First is the shortfall in the desirable share of public transport with regards to its population. The recommendable values of the desirable share of PT have been set forth by multiple authorities and published in reports on Urban Transport by GOI (1984), MoUD (1998), National commission on Urbanization (1987) and the RITES report (1998) based on population. With a population of above 6 million, the recommended public transport share is more than 65 %. With only about 27 % existing PT share, the city's bus transport needs capacity addition accordingly. Secondly, with urbanization the city limits and population pockets have shifted tremendously in the last few years. This leads to newer route demands and ridership imbalance. Network redesign and optimization is identified by researchers as a need of the hour. Thirdly, although the connectivity is being provided more or less, the potential to improve the accessibility remains high with the same amount of resources. This again, can be achieved by route up gradation to suit the new land use and feeder network design. Fourth is the environmental concern. The buses run of fossil fuels contributing to a large share of air and noise pollution. This is an area which needs definite improvement in terms of pollution as well as energy security. Best international and national practices of using alternative fuels may be adopted in the light of this concern. Fifth is the quality and reliability of service. The level of service in recent years is not rated highly when compared to other leading cities, for matters of comfort, reliability, maintenance and lack of sufficient information. It fails to attract many potential riders, many of whom eventually switch to the private mode. Sixth is the economy concern. The service oriented approach has served a number of citizens well over a number of years but with improvements and updating, come investments and to match that both the ridership as well as the revenue model needs to be looked at. The concern arises when in order to make life cycle costs low, high capital expenditures may be required. Public private partnership and alternative modes of international funding are exercised partially but may need to be exploited further. Seventh is the concern of safety. Road accidents have seen an all-time high rate in the past few years in the city with bus involvements being part of it. Training of drivers and advanced safety mechanisms in buses can be few measures taken in the matter.

7. PUBLIC TRANSPORT SUSTAINABILITY MODEL FOR AHMEDABAD

Based on the literature review and examining the concerns of the city's public transport, the researchers recommend an impact based framework but on a five dimension scale as opposed to a tripartite model usually followed. The three pillars of economic, social and environmental sustainability seem to be principally true and are recognized to be inherently applicable to any sustainability model. The other major takeaways from the literature review were (a) realization of system effectiveness as an important parameter to the public transport sustainability measurement (b) Need to balance input and output oriented approaches and (c) Capturing stakeholder perception for participatory approach to the public transport system.

The five dimensions thus recommended are: (a) Economic, (b) Social, (c) Environmental, (d) System Effectiveness, and (e) Stakeholder perception. The researchers have come up with a set of thirty indicators trying to balance input oriented indicators (such as no. of seats per population, information technology provision etc.) with output oriented indicators (such as air pollutant output measurement, revenue output measurement etc.). Attempt has been made to simplify and quantify most of the indicators in a tangible way. However, perception based measurements are inevitable qualitative in nature and a scale of -5 to +5 is suggested with +5 being most positive impact).

Table 1: Recommended indicators for PT sustainability assessment for Ahmedabad

Sr. No.	Dimension	Indicator	Desirability	Significance
1	Environmental	Mass of total pollutants emitted (CO, HC, NO_x, CO_2, PM etc.)	Lower the better	Air pollution impact
2	Environmental	dB levels from bus/rail operation alone	Lower the better	Noise pollution impact
3	Environmental	Land under bus/rail corridors and bus/rail parking & stations	Lower the better	Land Resource consumption impact
4	Social	Percentage city area within 500 m of nearest bus/rail stop	Higher the better	Spatial PT accessibility
5	Social	Percentage of population served within 500 m of nearest bus/rail stop	Higher the better	Provided PT accessibility
6	Social	Rating of ride quality, comfort and security	Higher the better	Perceived accessibility
7	Social	Percentage of annual travel cost per income	Lower the better	Affordability
8	Social	No. of fatal and incapacitating accidents with involvement of public transport	Lower the better	Safety and death due to accident
9	Economic	Investment in public transport	Lower the better	Capital expenses due to PT infrastructure
10	Economic	Annual operating and maintenance cost	Lower the better	Recurring expenses of PT infrastructure
11	Economic	Revenue due to ridership (fare), advertisement and other (such as urban transport fund)	Higher the better	Monetary gains for service provision
12	Economic	Percentage of annual travel time per year	Lower is better	Travel time savings
13	Economic	Passenger km travelled per GDP	Higher is better	Total Utilization of PT facility
14	System effectiveness	No. of seats per population	Higher the better	Capacity provision and fleet size
15	System effectiveness	Average Vehicle occupancy (percentage of seating capacity)	Higher the better	Capacity utilization
16	System effectiveness	Percentage of PT trips over all trips	Higher the better	Modal split
17	System effectiveness	Average frequency of public transport	Higher the better	Waiting time savings
18	System effectiveness	Number of instances of late/cancelled service	Lower the better	Reliability of public transport
19	System effectiveness	Provision of information technology	Higher the better	Information technology impact
20	Stakeholder perception	Student perception rating	Higher the better	Student point of view
21	Stakeholder perception	Construction workers perception rating	Higher the better	Construction workers point of view
22	Stakeholder perception	Industrial employees perception rating	Higher the better	Industrial employees point of view
23	Stakeholder perception	Government employees perception rating	Higher the better	Government employees point of view
24	Stakeholder perception	Non-government employees perception rating	Higher the better	Non-government employees point of view
25	Stakeholder perception	Drivers and staff of PT vehicles perception rating	Higher the better	Drivers and staff of PT vehicles point of view

26	Stakeholder perception	Other employees of the PT organization perception rating	Higher the better	Other employees of the PT organization point of view
27	Stakeholder perception	Non PT users perception rating	Higher the better	Non PT users point of view
28	Stakeholder perception	Visually impaired perception rating	Higher the better	Visually impaired point of view
29	Stakeholder perception	Physically challenged perception rating	Higher the better	Physically challenged point of view
30	Stakeholder perception	Tourist perception rating	Higher the better	Tourist point of view

For measuring the impact of an intervention, the researchers suggest associating equal weightage to all five dimensions, which is 20 %. Further, the existing scenario impact may be treated as the base case and the relative impact of intervention may be derived. Normalization of scores for each indicator on a scale of -10 to +10 is recommended to take care of difference in units across indicators and difference in magnitude across interventions. For example, an intervention such as switch to electric buses from diesel buses (existing scenario) may affect indicators such as air pollutants (positively) and capital investment in public transport (negatively) and the tradeoff may decide the overall sustainability of the intervention. Very important in such cases therefore is the stakeholder's perception which can be the controlling parameter for changing the nature of decision lead to some out of box thinking on the revenue model.

8. CONCLUSION

The authors have attempted to compile various transport sustainability models available in literature in Sections 3, 4 and 5. They present the case of the public transport system in Ahmedabad, a major city in west part of India and attempt to capture seven major concerns of the public transport in the city in the present days. In Section 6, they recognize some interventions that can bring potential benefits to the citizens. Further key learning from the literature are applied to the state of public transport in the city and a sustainability model is developed. An impact based framework is recommended in the model, on a five dimension scale that captures social, economic, environmental, system effectiveness and stakeholder perception parameters. A set of thirty simplified indicators are identified by the researchers and listed in Section 7. The authors conclude that public transport sustainability in the city needs to be measured temporally and giving justice to all five pillars may bring about positive decisions for certain type of interventions.

References

[1] Butterfield D., Hanna E., Kubursi A. and Victor P. (1994), "Environment-economy linkages and sustainable development in Ontario", RAC Project No. 509C, Environmental Research
[2] Carr E., Wingard P., Yorty S., Thompson M., Jensen N. and Roberson J (2007), "Applying DPSIR to sustainable Development", International Journal of Sustainable Development & World Ecology 14 pp. 543–555
[3] Central Institute of Road Transport (1996) "Ahmedabad Municipal Transport Service : a report on structure and strategies" (1996), Central Institute of Road Transport, Pune
[4] Gudmundsson H., (2000) "Indicators and performance measures for Transportation, Environment and Sustainability in North America", Report from a German Marshall Fund Fellowship 2000
[5] Hardi P. and Pinter L. (1995), "Models and methods of measuring sustainable development performance", Discussion Paper for Government of Manitoba, International Institute for Sustainable Development, pp 1-36
[6] Jeon C. &Amekudzi, A. (2005) "Addressing Sustainability in Transportation Systems: Definitions, Indicators, and Metrics", Journal of Infrastructure systems, ASCE, Vol. 11, No. 1, pp 31-50
[7] May A. and Ison S. (2008), "Decision-support for sustainable urban transport strategies" Transport Policy, Vol. 15, pp. 325–327
[8] May A., Page M, Hull A. (2008), "Developing a set of decision-support tools for sustainable urban transport in the UK", Transport Policy ,Vol. 15, pp. 328–340
[9] Reddy A., Anand Y. and D'Sa A. (2000), "Energy for a sustainable road/rail transport system in India", Energy for Sustainable Development, Volume IV, No. 1 l, pp 29-44
[10] Sergio R., Gschwender A., Ortega M. (2014), "The impact of a financial constraint on the spatial structure of public transport services", Transportation, Vol. 41, pp. 21–36

[11] Sørensen C. and Gudmundsson H (2010), "The impact of governance modes on sustainable transport – the case of bus transport in Greater Manchester", UK World Review of Intermodal Transportation Research, Vol. 3, Nos. 1/2, pp 8-25
[12] Wellar B. (2006), "Sustainable Transport Practices in Canada: Exhortation Overwhelms Demonstration", White Paper by Transport 2000 Canada, pp.1-25
[13] Yamamoto T. and Talvitie A (2011)., "Transport infrastructure and services: an Asia and developing world", Transportation, Vol. 38, pp. 715–717
[14] Yevdokimov Y. (2004), "Sustainable Transportation in Canada", Transportation group research papers, University of New Brunswick
[15] Yevdokimov Y. (2003), "Modelling Transportation as a Network Industry", Transportation group research papers, University of New Brunswick
[16] Yevdokimov Y. and Mao H. (2003), "Modeling Sustainable Transportation Systems", Transportation group research papers, University of New Brunswick
[17] Chris De Gruyter, Graham Currie , and Geoff Rose (2016), " Sustainability Measures of Urban Public Transport in Cities: A World Review and Focus on the Asia/Middle East Region", Sustainability 2017, 9, 43

AUTHOR

Anal Shethis an Assistant Professor at CEPT University, Ahmedabad, India and is the program coordinator for infrastructure engineering design program at the University. She is a research scholar at PanditDeendayal Petroleum University, Gandhinagar, India. She completed her MSCE from University of Illinois, Urbana Champaign and is presently pursuing her doctorate in the area of sustainable transport.

Dr. Debasis Sarkar is an Associate Professor and Head at the School of Technology at PanditDeendayal Petroleum University, Gandhinagar, India. He has accomplished his doctorate in Project Management and is currently pursuing research in a variety of domains related to civil engineering and project management.