Key Challenges of Sustainability Index Development for Urban Transport System of Jaipur City

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Key Challenges of Sustainability Index Development for Urban Transport System of Jaipur City

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Abstract: Urban areas help a nation's economic growth. Urban efficiency can support economic development. Allocating and using resources determines efficiency. Transportation efficiency is crucial. A reliable urban transportation system improves metropolitan regions' operation. Increased automobile ownership in cities has caused traffic congestion, pollution, accidents, and a fall in non-motorized mode share. Rapid growth in private cars has led to unequal mode share in most Indian cities. These problems are connected to sustainable development's social, economic, and environmental elements. In light of these problems, a technique exists to evaluate transport sustainability. Given the importance of urban mobility, a micro- and macro-level evaluation framework is needed. The project aims to create a comprehensive framework for evaluating transportation sustainability. The study focused on indicator selection, data collection, and analysis. Researcher evaluating electric mobility, shared and electric mobility, and trip time and cost. The paper recommends two policy solutions for boosting the transport system's sustainability based on an examination of nine distinct scenarios under three different methodologies.

Keywords: Sustainable transport system; Performance indicators; Composite index, Fuzzy Analytic Hierarchy Process, Benchmarking, transport system

1. Introduction

To make our cities more sustainable and resilient in the future, one of the most important steps is to increase our understanding of the processes that take place in urban contexts. In view of the fact that cities are, for the most part, complex systems, it is vital, in order to be able to make successful decisions, to analyze and be able to quantify the constituent elements of a city. One of these subsystems is the urban transport system, which is the fundamental component in transporting products and people within and between cities. Another one of these subsystems is the waste management system. The system that deals with waste management is another another of these subsystems. Consequently, in light of the study that has been made public, the question arises as to whether or not there is a sustainable transportation system, despite the fact that the city itself is not sustainable. Is it even possible for a city to experience expansion in a way that is ecologically responsible while at the same time its transportation infrastructure is not environmentally responsible? On the other hand, according to the United Nations' 2014 Revision of World Urbanization Prospects, there are currently 54 percent of the world's population living in urban areas, and it is anticipated that this figure would climb to 66 percent by the year 2050. Even though the percentage of the population that lives in urban regions varies from region to region, as of right now, 73.4% of Europe's population does, and it is anticipated that this number would climb to 80% by the year 2050. Because of this, an increasing number of people are making use of these systems on a daily basis, which has led to the pressure being placed on the urban transport system to gradually increase and become the primary driver of sustainable cities. As a result of this pressure, the urban transport system has gradually increased and become the primary driver of sustainable cities[1-5].

Transportation is the source of approximately one half of the nitrogen oxides (NOx), approximately one third of the chlorofluorocarbons (CFCs), and approximately 1/5th of CO2 present in local environment. Transportation not only has a significant impact on the economy, but also on society and the environment; hence, it is an important factor in the process of achieving sustainable development.

"transportation that does not damage public health or ecosystems and that fulfills the requirements for access," according to the definition provided by the Organization for Economic Co-operation and Development (OECD), is the definition of "sustainable mobility"[6 7].

Because of the prevalence of individual motorized modes of transportation, the vast majority of large cities are forced to contend with traffic congestion as well as increased levels of air pollution. Because of these problems, a sizeable proportion of the population is compelled to spend a large amount of time traveling in order to reach their goals. However, there is a widespread agreement on a global scale that the potential given by technology improvements to reduce emissions of greenhouse gases are not adequate to be able to reduce these emissions effectively. This is the consensus reached by the world community. As a consequence of this, there is a requirement for adjustments in behavior on both the level of the person and the size of the decision-making process. The revitalization of the central business district in Wien, Austria, which saw the majority of the city's streets converted into pedestrian thoroughfares to create one of the most livable and vibrant urban structures in Europe, prompted researchers from a variety of institutions to offer their interpretations of the effects of the revitalization of the central business district. The fact that public transportation, cycling, or walking are the principal means of transportation for two-thirds of today's commuters underscores the necessity of making well-considered decisions on urban transportation networks in order to achieve sustainability on an urban scale[8-12].

The United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro in 1992, was the first time that sustainable indicators were discussed. These indicators are now widely utilized as important tools for measuring a wide range of aspects related to sustainable development. At the United Nations Conference on Environment and Development, the concept of sustainable indicators was presented for the first time (UNCED). Because they convey a huge quantity of information in a plain manner that is easier to consume and to relate the information with policy makers, scientists and researchers to make the proper decision to overcome the transportation related issues. This makes it possible for all three groups to more effectively collaborate (Alberti, 1996)[13]. They take a difficult topic and break it down into easily digestible bits of knowledge, which helps consumers to swiftly grasp the several components of environmentally responsible transportation. They simplify the idea by reducing it down into readily edible chunks of information[14 15].

By combining the findings of several indicators into a single index, one may do a pragmatic assessment of the viability of a system in a way that is both efficient and accurate. In order to accomplish this, it measures aspects of sustainability that are multi-dimensional and cannot be expressed completely by individual indicators operating on their own. In spite of the fact that composite indices are used in a variety of contexts, there are two distinct schools of thought on them. The subjective character of the formulation of the composite index is a primary point of contention among those who are opposed to using it as a measuring tool. They believe this contributes to the index's unreliability[16-19]. In addition, there is not a single index that is capable of answering all of the questions; for this reason, it is necessary to have a wide number of signals. On the other hand, there are academics who believe that composite indices are helpful communication tools due to the fact that they limit the quantity of information that is given and make it simple to draw comparisons in a quick and clear manner. These academics believe that composite indices are helpful communication tools due to the fact that they limit the quantity of information that is given. Both of these concepts are analogous to two sides of the same coin, and one may reason from this to the conclusion that indicators aggregation is successful if explicit assumptions and techniques are utilized, and if the index can be disaggregated into its constituent components. Both of these concepts might be seen as opposite sides of the same coin.[20-22].

In these studies, a wide range of distinct indicators were each given equal priority, despite the fact that this may not accurately reflect the world as it is. In addition to that, the indicator quantifications in these studies are obtained from the results of surveys as well as statistical data.

The aim of the present study to develop the sustainable urban transport index to overcome the issues related with the transportation in the following cities like Jaipur, Agra and Delhi. In present study researcher conduct a survey among all stake holders. In present study the survey was made as per economic, environmental and social point of view. Descriptive analysis and SUTI index are calculate using open-source software known as JASP statistical software. In order to accomplish the goal of the research and fulfill the objective of this study, these information gaps will need to be filled. The sustainable transport indicators for the urban transport was present in table 1.

2. Research methods

Sustainable urban transport index (SUTI) was very helpful to overcome the barrier of the urban transport specially in developing countries. SUTI can help to increase the social and financial growth of the stake holders involved with urban transportation like private vehicles owners, drivers, etc[22]. This makes composite indices one of the most essential types of indices. At first, it was necessary to select relevant indicators that would adequately reflect the societal, economic, and ecological spheres. After then, the results obtained through the use of a number of distinct measuring units were standardized. An exhaustive transportation sustainability index was produced after factors/variables were compiled into some important sections like economic, social etc, and then weighting was applied to a selection of those indices.

The final step in the process was to apply the weighting to the indicators. The research flow diagram was shown in figure 1.

Table 1. Sustainable transport index parameters[20-23)]

Aspect	Indicator	Determinant
Environmental sustainability	CO_2 emissions per passenger-kilometer	Vehicle technology and fuel type
	Air pollutants (e.g. NOx, particulate matter) per passenger-kilometer	Vehicle technology and fuel type
	Energy efficiency (e.g. kWh/100 km)	Vehicle technology and fuel type
	Modal split (e.g. share of trips by car, public transport, walking, cycling)	Transport policy and infrastructure
Economic sustainability	Affordability (e.g. percentage of income spent on transport)	Income levels and transport costs
	Cost-effectiveness (e.g. cost per passenger-kilometer)	Transport system efficiency and pricing
	Accessibility (e.g. proximity of transport services)	Transport infrastructure and urban planning
Social sustainability	Accessibility (e.g. proximity of transport services)	Transport infrastructure and urban planning
	Equity (e.g. access to transport services for disadvantaged groups)	Transport policy and planning
	Health and safety (e.g. number of accidents, noise pollution)	Transport policy and infrastructure

3. Case study-Jaipur

Jaipur, the "Pink City" of India, is the state capital of Rajasthan. Desert Rajasthan. Maharaja Sawai Jai Singh II created Jaipur in 1727. In honor of its creator. It is on the eastern edge of the Thar, the only desert in India. At 431 meters/1,417 feet above sea level, Jaipur has a semiarid environment and year-round high temperatures. The city's beauty and position in the Aravalli Hills attract visitors from throughout the globe. These hills protect Jaipur from the harsh environment of the desert. Jaipur encompasses 4292.6 square kilometers and extends 180 kilometers east to west and 110 kilometers north to south. This gorgeous metropolis with a rich royal past and well-designed layout is home to about 3.1 million people. The city was developed using the grid pattern and Vastu Shastra to ensure the prosperity and tranquility of its inhabitants. The Google map location of the Jaipur was shown in figure 2 with live traffic sources available on Google map.

Just 48% of the roads being considered have four lanes in each direction. A number of problems, including parking and encroachments on the route, are contributing to the fact that the road is not being used to its maximum capacity. Because growth has been unevenly distributed throughout different geographic areas, much of the city's traffic comes from its outskirts into its central business district. Radial highways, in particular those on the periphery, are inadequate since there are not enough extra circumferential roads that link to the radial highway system[31,35,36,37,38)].

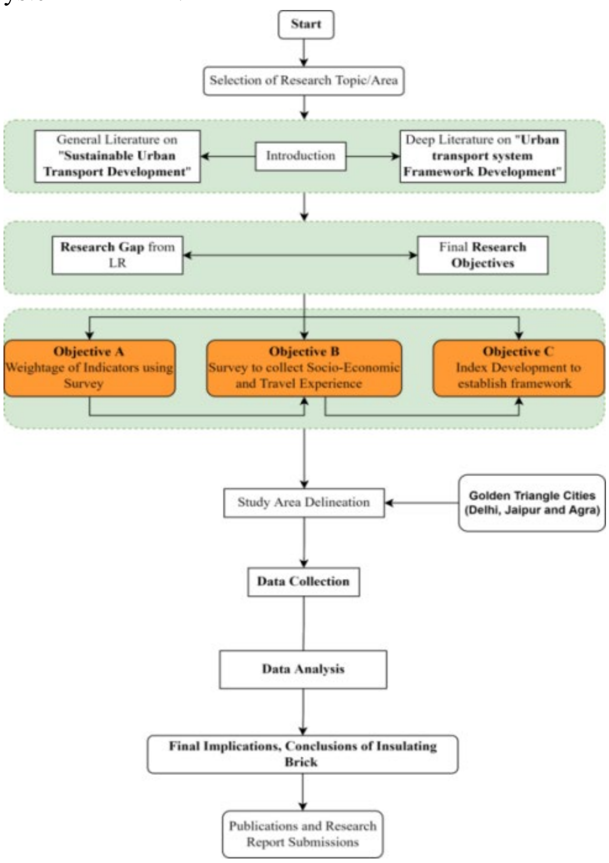

Fig.1: Research Methodology for present study

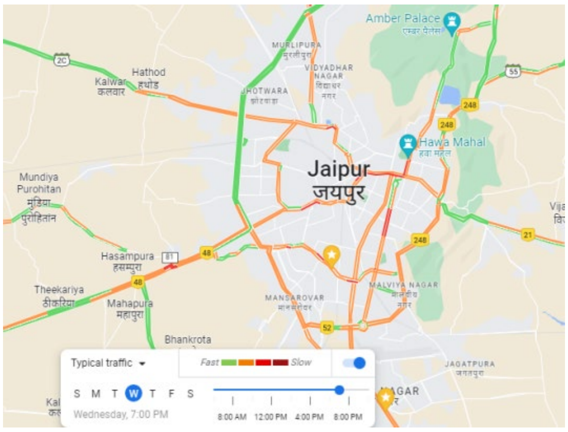

Fig.2: Live Traffic in Jaipur City (Source: Google Map)

4. Indicators selection for index development

It is possible that it will be challenging to select a collection of indicators that, when taken together, can provide a comprehensive picture of the system that is being considered. When choosing indicators, you usually have to settle with less than ideal solutions[15]. Even if it is more practical to use a smaller number of indicators, if you do so you run the danger of missing out on some critical effects. This is the case even though it is more convenient to employ a smaller collection of indicators. On the other hand, a large number of indicators could be able to provide a full picture, but the costs involved with collecting them and analyzing them might be rather significant. As a result, the choice of indicators calls for the use of some kind of criterion. With the assistance of some selection criteria, a list of metrics has been produced that has the potential to be utilized in quantifying Jaipur's commitment to ecologically friendly modes of transportation. The final Sustainable indicators for the present study was present in table 2.

Table 2. Sustainable transport index parameters for present study

Indicators	Values
Environmental Indicators	
Use of Conventional Energy Source	L/year/household
Pollution by Vehicles	Kg/household
Pollution by other Source like gen-set, road construction Eq.	Kg/household
Use of land for Road and other application for transportation	M2 per household
Social Indicators	
Accidents on Roads	As per Household
Illness due to Pollution on Roads	As per Household
Accessibility	0-1
Economical Indicators	
Vehicle Purchase	As per Household
Expanses due to Road Accidents	As per Household
Maintenance due to Road quality	As per Household

Because the objective of achieving sustainable urban transport varies depending on context, location, time, and specialized knowledge, the set of indicators that was selected needed to be flexible enough to indicate Jaipur's path toward sustainable transport and include all aspects of sustainable development. In order to accomplish this, the set of indicators that was selected was comprised of: (environmental, social and economic). It is generally agreed upon that the aforementioned are some of the most critical characteristics of sustainability in the sector as a whole, and more particularly of sustainable transportation.

It is crucial that the fact that some of the environmental indicators that were chosen are not the end consequences of the transportation system, but rather the intermediary impacts of the system, be brought to people's attention. For instance, emissions of greenhouse gases as well as other pollutants in the air are the major cause of climate change on a worldwide scale as well as on a country-by-country level. [Citation needed] Damage caused by climate change can be ascribed to a variety of factors, including shifts in the pattern of precipitation, wildfires, flooding, droughts, rising sea levels, and storms, to name just a few. The consequences of climate change are also contributing to the acceleration of the rise in sea level. These damages are a contributing factor in both the fatalities that have taken place as well as the expenditures that have been paid as a result of these fatalities. It's possible that the expenses of pollution, in addition to the social repercussions of pollution, are the final indication. As a result of the difficulty involved in accurately quantifying these expenditures for the purpose of this investigation, the emissions of air pollutants were used as indicators instead.

5. Indicator data collections

Following the selection of indicators, several indicators will each require values provided to them in order for the indicators to be quantified. The information that was utilized to build this study's data was supplied by the household participants in this survey who either run for transportation or had possessed vehicles for the purpose of transportation at some point in their lives. With the help of this data, we were able to calculate the quantities of several transport indicators. As was mentioned earlier, this study, in contrast to other studies on the viability of transportation, makes an effort to develop models for the quantification of indicators rather than making direct use of the databases indicators. This is because the authors of this study believe that such an approach is more likely to produce accurate results.

Some crucial input data that were necessary for the development of the indicators index were obtained from the study that came before it and are included in tables 3 and 4. Emissions factors which were considered for private vehicles and public transport vehicles were shown in table 3.

Table 3. Emissions factros of Vehicles for Travel by Vehicle (TBV) [32-33]

Polution Parameters	Emission by Private Vehicles	Emissions by Public Vehicle
NOx	0.008 kg/TBV	0.01 kg/TBV
CO	0.0044 kg/TBV	0.00506 kg/TBV
PM Particles	0.000008 kg/TBV	0.00569 kg/TBV

This table help to calculate the emissions factors required during the travel completed by the participants and how much emissions were produce by the participants. The travel distance used for the present study was present in table 4.

Table 4. Travel distance set point for normal passgenr[34]

Travel Destinations	Min to max distance for walking	Min to max distance for accessibility by public transport
Commercial Places	800–1600 m	20–50 min
Hospitals	600–1200 m	20–40 min
Educations centres	600–1200 m	20–40 min
Public Places	500–1500 m	20–40 min
Bus/Railway Stand	300–1000 for bus, 600–1200 for train	-

6. Principal component analysis/factor analysis

Principal Component Analysis/Factor Analysis (PCA/FA) is a common method that is utilized in the process of analyzing a number of indicators with reference to a number of distinct factors. This analysis method was developed by Karl Pearson and first introduced in the 1960s. This kind of analysis may be broken down into two distinct components: the principal component analysis and the factor analysis. The utilization of the variation and covariation of the data matrix is the sole means by which the technique accomplishes its primary purpose of building weights for the indices. Because of this, it does not rely on the judgments of specialists, and if this approach were used, the challenge of subjectivity that is associated with weighing would be removed if it were used. Nevertheless, as we are going to see in the next discussion, PCA/FA is able to rank efficient and non-efficient DMUs according to the degree to which they are sustainable. This is a significant advantage. This distinguishes principal component analysis (PCA) as an approach that is superior to any other statistical model, while DEA and BoD just classified DMUs as efficient or inefficient. PCA is better to every other statistical model that could possibly be used. In addition, in order to develop a relevant index for decision makers, it is necessary to compare a large number of DMUs, which is something that neither the Board of Directors nor the Drug Enforcement Administration presently performs. This is an essential step that has to be taken.

The principal component analysis (PCA) and factor analysis (FA) both analyze the correlation between a number of different indicators in order to generate a composite index that is as accurate as is practically possible in reflecting the information that is communicated by the individual indicators. PCA and FA are both examples of statistical techniques. Individually examining each of the factors and components will, in turn, disclose the set of indications that are most strongly related with that particular factor or component.

Verifying that the association is not the product of duplicate information in the dataset is one of the steps that must be taken before attempting to apply principal component analysis or factor analysis. Before attempting to employ PCA or FA, this step absolutely has to be completed. The Kaiser–Meyer–Olkin measure (KMO), which is sometimes referred to as a measure of sample adequacy, is utilized in order to assess whether or not the principal component analysis and factor analysis (PCA/FA) approach should be utilized. In order to carry out a combined PCA and F analysis that is to your satisfaction, you will need to have values that are on the higher end (between 0.6 and 1.0).

7. Result and discussion

In this part of the article, we are going to talk about the results of the technique that was used in the production of the index. In addition to this, we are going to talk about the link that exists between the land use sustainability index and the transport sustainability index. Principal component analysis and factor analysis were utilized by the researchers in this study to establish the relative relevance of environmental, social, and economic variables in their own special ways. These analyses were carried out in order to determine the relative importance of the variables in question. According to the data that are presented in Table 5, the Kaiser–Meyer–Olkin (KMO) measure has a significant importance for each of the elements that are taken into consideration. Principal component analysis (PCA) and confirmatory factor (FA) are both viable options for the indicator weighting part of the study as a direct result of the aforementioned reality. Both of these analyses are referred to as factor analyses. Since there was only one component in this aspect that had an eigenvalue that was greater than 1, the weights of the variables in the financial standpoint were only computed for the first element because of this. Because there was only one component in the financial aspect that had an eigenvalue greater than 1, this choice was made because it was the only one available. In the context of the environmental and social factors, there had been two factors with an eigen that was more than one, and the values of indicators were computed for each of these elements. These weights were based on the importance of the factor. Both of these aspects were taken into account in the decision-making process. One of these facets was related to the environment, while the other one was concerned with the people involved. After the weights were assigned, the indicators from each dimension were then aggregated into three distinct sub-indices. These were done after the weights were assigned. After the weights had been given, this step was carried out. The next step was to combine all of these subindices into one index, which was known as ICST, and the stage before that was to give weights to each of the subindices. The transport sustainability of each SLA is compared to that of the other SLAs by using values that range from zero to one and that are contained inside the indices. These values may be found in the table. If it were feasible to boost the overall average of each SLA's distinct degree of sustainability, there would be a significant increase in the value of ICST in each SLA. This increase would be significant.

Table 5. Developed sustainable transport index parameters

Indicators	Values	KMO Measure	Index
Environmental Indicators			
Use of Conventional Energy Source	L/year/household	0.712	0.354
Pollution by Vehicles	Kg/household		0.405
Pollution by other Source like gen-set, road construction Eq.	Kg/household		0.284
Use of land for Road and other application for transportation	M2 per household		Balance
Social Indicators			
Accidents on Roads	As per Household	0.634	0.310
Illness due to Pollution on Roads	As per Household		0.398
Accessibility	0-1		Balance
Economical Indicators			
Vehicle Purchase	As per Household	0.584	0.351
Expanses due to Road Accidents	As per Household		0.322
Maintenance due to Road quality	As per Household		Balance

As a result of this, the practice of doing so would be beneficial to the urban planning in Jaipur. This study looked at previous research and took those findings into consideration in an effort to differentiate between transport sustainability indicators and transport sustainability factors. This research contains the final set of indicators, which were selected from a wide range of previous studies using a specified set of selection criteria. These indicators may be found in this research. Despite the fact that they were limited in number, they addressed a range of aspects of sustainability. As a consequence, it is permissible to use them to monitor the sustainability of transport in the study region since they addressed a variety of aspects of sustainability.

Conclusion

1. Urbanization is better for urban regions' economies, but it increases vehicle numbers owing to increasing transport demand. Congested roadways with more automobiles increase fuel consumption and emissions. This also causes pollution and respiratory illnesses. Conventional planning practices like flyovers and road widening have led to induced traffic, increasing

decentralization, and higher space demand. This causes urban sprawl.

2. Poor mobility will hinder urban economic growth if these issues aren't solved. In 2006, Indian government created the National Urban Transport Policy (NUTP) and amended it in 2014. NUTP is to provide safe, economical, rapid, pleasant, dependable, and sustainable access to jobs, education, entertainment, and other municipal necessities.

3. Transport is India's second-largest energy consumption. It has increased energy usage, air pollution, noise pollution, and health concerns. The policy promotes green energy, energy efficiency, and environmental preservation. The policy advocates avoiding, shifting, and improving (A-S-I). The three strategies focus on-:

(i) Reducing travel demand by reducing the number and length of trips,

(ii) Shifting from personal vehicles to MRT and NMT modes to reduce energy demand and pollution in cities, and

(iii) Improving fuels and vehicle technology.

Identify economic, environmental, and social sustainability metrics and frameworks. First, the study focuses on indicators' scope and grouping approach. For this, a three-step indicator architecture is provided. First stage is &quote; Why to signal & quote; It emphasizes indicators to simplify complicated processes. Second, indicate what. This level examines indicators, their data, and their function in analysis. &quote; How to Indicator & quote; is the framework's final stage. This step focuses on structuring indicators according to their importance, role, and evaluation level. These procedures give a systematic technique to construct indicators. The framework guides picking indicators per project scope.

References

1) Csete, M., and L. Horváth. "Sustainability and green development in urban policies and strategies." Applied Ecology and Environmental Research 10, no. 2 (2012): 185-194.
2) Toth-Szabo, Zsuzsanna, and András Várhelyi. "Indicator framework for measuring sustainability of transport in the city." Procedia-Social and Behavioral Sciences 48 (2012): 2035-2047. doi: 10.1016/j.sbspro.2012.06.1177
3) UN (2014) World Urbanization Prospects: The 2014 Revision. United Nations Department of Economic and Social Affairs, Population Division, New York.
4) Gössling, Stefan. "Urban transport transitions: Copenhagen, city of cyclists." Journal of Transport Geography 33 (2013): 196-206.
5) Gumz, Felix, and Ádám Török. "Investigation of cordon pricing in Budakeszi." Periodica Polytechnica Transportation Engineering 43, no. 2 (2015): 92-97.
6) OECD, 2008. Handbook on Constructing Composite Indicators, Methodology and User Guide. Organisation for Economic Co-operation and Development.
7) EA, 1999. Sustainable Transport: Responding to the Challenges, Sustainable Energy Transport Taskforce Report. The Institution of Engineers, Australia.
8) de Freitas Miranda, Hellem, and Antônio Nélson Rodrigues da Silva. "Benchmarking sustainable urban mobility: The case of Curitiba, Brazil." Transport policy 21 (2012): 141-151.
9) Domanovszky, Henrik. "Gas propulsion or e-mobility is the solution on the way of clean and carbon free road transportation?." Periodica Polytechnica Transportation Engineering 42, no. 1 (2014): 63-72.
10) Knoflacher, H. "Success and failures in urban transport planning in Europe—understanding the transport system." Sadhana. 32 (4). (2007) pp. 293-307. DOI: 10.1007/s12046-007-0026-6
11) Litman, T. (2009) Sustainable Transportation Indicator Data Quality and Availability. Victoria, B.C.: Victoria Transport Policy Institute.
12) Litman, T. (2013) Well measured. Victoria, B.C.: Victoria Transport Policy Institute.
13) Alberti, M., 1996. Measuring urban sustainability. Environ. Impact Assess. Rev. 16, 381–424.
14) Dobranskyte-Niskota, A., Perujo, A., Pregl, M., 2007. Indicators to assess sustainability of transport activities. European Comission, Joint Research Centre. JRC European Commission
15) Castillo, H., Pitfield, D.E., 2010. ELASTIC – a methodological framework for identifying and selecting sustainable transport indicators. Transport. Res. D: Transport Environ. 15, 179–188.
16) Dur, F., Yigitcanlar, T., Bunker, J., 2010. Towars sustainable urban futures: evaluating urban sustainability performance of the Gold Coast, Australia. In: 14th IPHS Conference, Istanbul, Turkey
17) Saisana, M., 2011. Weighting methods, Seminar on composite Indicators: From Theory to Practice, Ispra.
18) Saisana, M., Tarantola, S., 2002. State of the Art Report on Current Methodologies and Practices for Composite Indicator Development. Institute for the Protection and Security of the Citizen.
19) Zhou, Peng, Beng Wah Ang, and Kim Leng Poh. "A mathematical programming approach to constructing composite indicators." Ecological economics 62, no. 2 (2007): 291-297.
20) Cherchye, Laurens, Willem Moesen, Nicky Rogge, and Tom Van Puyenbroeck. "An introduction to 'benefit of the doubt'composite indicators." Social indicators research 82 (2007): 111-145.
21) Jollands, N., Lermit, J., Patterson, M., 2003. The Usefulness of Aggregate Indicators in Policy Making and Evaluation: A Discussion with Application to Eco-efficiency Indicators in New Zealand. Economics and Environment Network. Australian National University.
22) Freudenberg, M., 2003. Composite Indicators of Country Performance: A Critical Assessment. OECD

Publishing, Paris.

23) Alford, Gavin, and Jeremy Whiteman. "Macro-urban form, transport energy use and greenhouse gas emissions: an investigation for Melbourne." Transport Occasional papers 1 (2009).
24) Janic, Milan. "Sustainable transport in the European Union: A review of the past research and future ideas." Transport Reviews 26, no. 1 (2006): 81-104.
25) Jeon, C., Chang, Y.,Amekudzi,A., 2010. Incorporating uncertainty into transport decision making: a sustianability-oriented approach. In: TRB 2010 Annual Meeting, Washington.
26) Zito, Pietro, and Giuseppe Salvo. "Toward an urban transport sustainability index: an European comparison." European Transport Research Review 3 (2011): 179-195.
27) Wachs, Martin, and T. Gordon Kumagai. "Physical accessibility as a social indicator." Socio-Economic Planning Sciences 7, no. 5 (1973): 437-456.
28) Waitz, Ian, Jessica Townsend, Joel Cutcher-Gershenfeld, Edward Greitzer, and Jack Kerrebrock. "Aviation and the environment: A national vision statement, framework for goals and recommended actions." (2004).
29) Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., 2005. Tools for Composite Indicators Building. Institute for the Protection and Security of Citizen.
30) R N Sharma, Kajod Mal Sharma" Road traffic flow intensity in jaipur city: Challenges and solutions, International Journal of Advanced Research in Commerce, Management & Social Science (IJARCMSS), Volume 03, No. 04, October - December, 2020, pp 295-299
31) NPI, 2002. Emission Estimation Technique Manual for Combustion Engine. Natinal Pollutant Inventory.
32) NPI, 2008. Emission Estimation Technique Manual for Combustion Engine. Natinal Pollutant Inventory.
33) Pitot, M., Yigitcanlar, T., Sipe, N., Evans, R., "Land Use & Public Transport Accessibility Index (LUPTAI) tool: The Development and Pilot Application of LUPTAI for the Gold Coast. Planning and Transport Research Centre (PATREC).", (2006)
34) N. Bhasin, R.N. Kar, and N. Arora, "Green disclosure practices in india: a study of select companies," Evergreen, 2(2) 5–13 (2015). doi:10. 5109/1544075.
35) P. Bhatnagar, S. Kaura, and S. Rajan, "Predictive models and analysis of peak and flatten curve values of covid-19 cases in india," Evergreen, 7(4) 458–467 (2020). doi:10.5109/4150465.
36) Vijay K. Yadav, Vinod Kumar Yadav, and J. P. Yadav, "Cognizance on pandemic corona virus infectious disease (covid-19) by using statistical technique: a study and analysis," Evergreen, 7(3) 329–335 (2020). doi:10.5109/4068611.
37) M.T. Kibria, M. Islam, B.B. Saha, T. Nakagawa, and S. Mizuno, "Assessment of environmental impact for air-conditioning systems in japan using hfc based refrigerants," Evergreen, 6(3) 246–253 (2019). doi.org:10.5109/2349301
38) B. Shahriari, A. Hassanpoor, A. Navehebrahim, and S. Jafar, "Designing a green human resource management model at university environments: case of universities in tehran," Evergreen, 7(3) 336–350 (2020). doi.org:10.5109/4068612