



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 Issue: IV Month of publication: April 2019

DOI: <https://doi.org/10.22214/ijraset.2019.4315>

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Review Paper on Sustainability Objectives and Performance Measures

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Abstract: *As per the current trends in the field of transportation developments the sustainable transportation is the planning for the system which is safe, effective and efficient in order to access and with mobility for future taking into consideration various economic, social and environmental requirements. In these work it is tried to find out the some parameters which can be used as to define sustainability of a region based on the some data and methods so that anyone can find the sustainability of any region or link or city without much efforts.*

The main objective of this research work is to evaluate the sustainable transportation for emerging Metropolitan Cities by developing the approach based on performance and measurement. Certain essential goals are finalized to enhance the transportation sustainability. Each goal will contain some parameters which are used to improve the goal and these parameters are known as performance indicators.

Here it is tried to find the set of objectives and the performance measures which are defined in order to fix the goals of Transportation authorities in concern with the transportation sustainability. The different objectives and performance measures will be based on safety, effectiveness, efficiency, improvement, and increase in transportation. The objectives and performance measures are such a type that they can be used to describe current and future scenarios for the selected site. Also they can be used to compare the current and future scenario.

The performance measures can be calculated and will be expressed in terms of values so that it will be effective and understandable. There will be some methodologies to apply the performance measures. It is tried to make set of goals with the performance indicators which represents economy, increase in transportation, safety, efficiency etc. The set of performance indicators are selected as described earlier required be evaluating and quantifying, scaling suitably and aggregating by consolidating the results to obtain the final index as a parameter representing the sustainability evaluation.

Keyword: *Performance indicators, performance measures, sustainable transportation, intelligent transportation system,*

I. INTRODUCTION

In today's scenario of global development transportation plays an important and vital role. In other words we can say that transportation is an essential requirement in today's world. As far as the transportation policies are concerned the various issues related to contribution of transportation in fuel diminution or depletion, pollution, toxic pollution, greenhouse gas emission are discussed vigorously in this era of fast infrastructural development. These all issues are related with the cost and health parameters and also with all equities having impact on transportation. Hence in order to attain the overall sustainability it becomes necessary to achieve the sustainability of transportation system. We can also say that transportation sustainability is the one of the important steps in attaining the overall sustainability.

Number of researchers have worked on the area of evaluation or quantifying the sustainability of transportation very less effort till now are dedicated to implement sustainability assessment to any transportation development authority for emerging metropolitan cities. Hence this issue will be of great significance as the sustainability goals are need to be matched with the planning goals of transportation authority. As far as Indian scenario is taken into consideration the local departments of transportation may not be in a position to address the transportation sustainability by dedicating the available resources. But still it is possible to evaluate and enhance the sustainability in legal manner scientifically, logically and reasonably within the general planning concepts considering it as an initiative to move towards the development which will sustainable over time.

The main target of this research work is to develop a performance measurement based system for Emerging Metropolitan Cities in order to evaluate and achieve the transportation sustainability. This will be carried out by addressing the strategic goals planned by the concerned development or transportation authority. Hence it can be stated that the ultimate aim of this research work will be to transportation sustainability performance measures for Emerging Metropolitan Cities and to develop the transportation sustainability implementation methodology.



Here the scope of the project was focused on the sustainability of the transportation system in urban area of emerging metropolitan city. The broad investigation was carried out for finalizing the performance indicators

The initial part of the work includes the deep literature review covering the aspects related to the sustainability of transportation system, selection of performance indicators and Intelligent Transportation System.

A. *Transportation In Indian Context*

India is developing country with a diverse environment related to social, economic issues. Land area of 3.287 million km² is covered by India. Indian scenario is of mix type of population in social and economical aspect along with variation in environment issues and climatic conditions. Density is the main parameter characterizing a city and it has impact on travel distances parameter and the modal split. In INDIA the density of all city is different at different point that is it very largely changing over the locations. Also safety is one of the main issue in Indian scenario. Based on statistics and studies it can be stated that India and Indian cities has a problem with traffic safety. When compared with other countries it shows that Indian cities are among the unsafe localities in the world, as far as traffic scenario are concerned. (Vanderschuren and Irvine, 2002).

At present the major investment on infrastructure in India focuses on the improvement and maintenance of roads to establish connections between cities as well as the different accessibility of urban areas. Only where villages and cities grow, new roads are constructed which are generally small and short. In Indian scenario there is an also issue regarding the public transportation. There is no proper public transportation in many of the Indian region while if the region has the transportation then there are issues related to congestion, delays, less number of public vehicles, etc. But in recent years the private transportation has been increased.

II. LITERATURE REVIEW

For understanding the existing transport system it is necessary to understand the structure of Indian cities as it is different from other cities around the world due to many connected reasons

A. *Intelligent Transportation System*

This literature review discusses basic concepts of Intelligent Transportation System sustainable transportation, transportation performance measures, and the role of performance measurement in decision making applications in details.

With growing population of vehicles the transport networks become more congested and conventional approach of new highway or infrastructure construction is not sustainable solution for long-term. Hence there is a growing need to adopt approaches that manage demand and make full use of existing infrastructure. Advances in computer and electronics technologies in ITS (Intelligent Transportation System) offer such possibilities to meet these challenges. This is executed by predicting and providing the solution to manage transport properly on large scale.

Total six main objectives have been identified in various published literature (Mitretek System, 2001) as explained below.

- 1) *Safety*: Mobility, efficiency, productivity, energy, environment and customer satisfaction. Safety is related with transportation system capable to provide a safe environment for travel with continuous improvement in the performance of the system.
- 2) *Mobility*: By reducing delay and travel time mobility can be improved and this is the main objectives of ITS. Delay can be measured in many ways based on transportation system to be analyzed.
- 3) *Efficiency*: ITS parameters and provision are capable of optimizing the efficiency of existing facilities. It also facilitates use of right of way to enhance mobility reducing the need to construct or expand infrastructural facilities.
- 4) *Productivity*: Due to introduction of ITS operating costs reduces and productivity get improved. ITS option also has lower acquisition and life cycle costs compared to traditional transportation infrastructural improvements.
- 5) *Energy and Environment*: The air quality and energy impacts of ITS services are very important for assessing the attainment of sustainability
- 6) *Customer Satisfaction*: Usually ITS project and programs are proposed specifically to serve the public based on user expectations

B. *Sustainable Transportation System*

The term “sustainable development” was first used as world conservation strategy in 1980. Different authors have provided variety of definitions for sustainable development and transportation. Mostly definition proposed by the Brundtland Commission as “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” is adopted by many for reference. In more common way transportation system is usually defined

considering the impacts of the system on the economy, environment, and social. Transportation sustainability also measures performance according to system effectiveness and efficiency considering the impact of the system on the natural environment.

In many literatures review the importance of sustainability and requirement for addressing sustainable transportation was elaborate. To implement evaluations of sustainability of transportation it is needed to define the scope and aims of the problems identified. The usual assessment of sustainable transportation generally consists of three stages respectively conceptualization operationalization, and utilization. Conceptualization deals with defining the sustainability in a particular context and operationalization deals with selection of parameters to measure sustainability whereas utilization deals with actually utilizing the results to guide the further policy development addressing sustainable transportation. The first approach is transportation policy and the second approach is sustainable transportation which has certain environmental and social constraints which to be addressed. The second approach is more valuable in terms of practical applications of sustainability measurement as per consideration of scientific community. Performance measures for sustainable Transportation and performance measurement can be considered as management tool to evaluate progress toward goals attainment using measurable results or targets.

In any project it is necessary to identify appropriate performance measures as these measures are to be used to develop a framework for assessment of sustainability. in this work it is tried to select the performance measures aligned with goals, objectives of the local transportation authorities to development the assessment framework and the sustainability evaluation is based on performance based framework. It is decided on the basis of level of analysis, purpose etc. For any system the performance measures must be defined based on the four R-test, which includes consents of relevance, robust, reputability and responsiveness. Large number of performance related measures can be listed relevant to sustainability of transportation system. Following table 1.1 shown the probable objectives and the various performance related to the identified objectives. These objectives and possible performance measures are selected on the basis of relevancy with sustainability perspectives.

Table 1.1 Objectives and Probable Performance Measures (Source- Tara Ramani et.al., 2009)

Objective	Possible Performance Measures
Increase accessibility	acceptable travel time, ability of non-drivers to reach employment centers and services, land-use mix, transit supply
Increase economic benefit	Jobs added and value added to goods produced, wages added to job payrolls, tax revenues
Increase equity	Point-to-point travel cost and travel time, percentage of income devoted to transportation, transportation decision-making.
Increase livability	Average vehicle speed, mode split, per capita land area paved for roads and parking
Increase mobility	Travel time index, total delay, delay per person, person throughput. Volume /capacity ratio, vehicle miles of travel.
Increase safety	Accident rate, accident fatality rate, freeway incident rates, tons of hazardous materials spilled due to accidents, percent of vehicles exceeding speed limit, percent of motorists using seat belts.
Reduce air pollution	Concentration of hydrocarbons (HC), oxides of nitrogen (NO) and carbon monoxide (CO) emissions, vehicular emissions and emission rates.
Reduce congestion	Travel and delay rate , average speed mobility index, hour of congestion, level of service (LOS)

Basically Multi Criteria Decision Making process considers qualitative attributes into a framework and is capable of making choice between various available alternatives in a scientific manner. It is very much essential to account for a vast range of differing but relevant criteria of objectives. The common aspects taken into consideration in all the studies can be summarized are as given below.

- 1) Criteria and related attributes reflecting sustainability concerns;
- 2) Quantification of levels of the selected attributes and scaling to obtain a “utility or value function”.
- 3) Quantification of overall utility of different alternative.

Hence it can be stated that the concepts related to sustainability along with connected attributes were taken into consideration in many evaluations.

The specific goals identified for any transportation system based on scoping activity are as follow



- a) To reduce congestion,
- b) To enhance safety,
- c) To expand economic opportunity,
- d) To improve air quality, and
- e) To increase the value of transportation assets.

A set of strategies, parameters, measures, indicators can be developed to attain these goals as per requirement in specific time span. It was tried to understand through the deep literature review that how sustainability and other related aspects such as economic development, social issues and environmental issues are contributing towards the attainment of goal in a system. The goals and objectives were classified based on the three important sustainability dimensions namely environmental, economic, and social. It was tried that each of the objectives is capable of addressing multiple aspect of sustainability. It was also tried to define performance indicators related to objective finalized.

Table 1.2 Sustainability-Related Objectives associated with Transportation Planning(Source- Tx-DOT and Tara Ramani, 2009)

Strategic Goal	Sustainability – Related Objective
Congestion Reduction	Improve in mobility along corridors
	Improve reliability of travel
Enhancement of Safety	Minimize crash rates and crash risk
	Improve traffic incident detection along with response
Expansion of Economic Opportunity	Optimize land use potential
	Maximize road-based freight movement
Enhancement of Value of Transportation Assets	Maintain existing quality of the system
	Minimize cost and impact of capacity expansion
	Generate the non-conventional funding sources
	Minimize use of single-occupant Vehicle (SOV) travel
Air Quality Improvement	Reduce adverse impacts on human health
	Reduce greenhouse gas emissions
	Conform to emissions standards

C. Goal-1- Congestion Reduction

As the name indicated it is intended to reduce the congestion and related issues along the study links. The attainment of this goal will result in time saving, reduction in consumption and related emission along with enhancing the safety.

- 1) *Travel Time Index- (TTI)*: Travel Time index is defined as the indicator which measures the extent of delay which is caused because of the congestion only.
- 2) *Program Time Index or Buffer Index - (PTI)*: Program Time Index indicates the reliability of travel time which provides the estimation of travel time variation for a specific period of time.

D. Goal-2- Safety Enhancement-

To attain this goal the main concern is related to the crash rates and the fatality rates as it usually results in the severe injuries to the users. For attaining this goal two important objectives were proposed.

- 1) *Annual Severe Crashes per Kilometer*: Crash rates are usually adopted to represent the extent of crashes. It represent the number of crashes per million vehicle travelled. But the crash rate concept does not take into consideration the increase in the extent due to increase in VMT.
- 2) *Percentage Lane-Kilometers under TMC Surveillance*: This indicates the estimates of presence of Intelligent Transportation System provisions for traffic monitoring and response facilities to cover along the section operated by a Traffic Monitoring Center.

E. Goal-3-Expansion of Economic Opportunity

In any transportation system the planning usually address different trade opportunity, faster deliveries, freight movement transportation system to serve trade locally, opportunities in jobs, businesses and other economic activities which enables in terms of sustainability along with long-term economic viability.



- 1) *Land Use Balance*: It is the means to examine the mix of land use within 1 kilometer zone along the selected stretch. The land area is classified into three different categories: respectively Residential, Commercial or Industrial, and Institutional or Public. Cervero and Kockelman in their work the proposed estimation of land-use to evaluate diversity of land use in specific region, and therefore this performance measure is adopted based same concept.
- 2) *Truck Throughput Efficiency*: The Truck volumes along the selected section in combination with the travels speeds are reflected by this indicator. Freight movement is an important economic benefit of transportation system and this objective in this work is include to enhance freight throughput without affecting the system performance.

F. Goal-4-Enhancing the Value of Transportation Infrastructure

The impact of declining revenue collection from tax which tends to reduce on the existing corridor is tried to relate through this goal.

- 1) *Capacity Addition within the Existing Lanes*: The other objective taken into consideration is the capacity expansion. It must be noted that additional capacity is too much desirable as far as the reduction in concern.
- 2) *Proportion of Non SOV Travel*: For this indicator the occupancy of the vehicle for base case is taken into consideration.

G. Goal-5:- Air Quality Improvement

Air quality is considered as the main concern in terms of environmental aspects in urban areas. Many environmental agencies worldwide have set their standards for the air quality quantification.

III. CONCLUSION

Therefore it can be conclude that the MAUT technique can be used for performance measures and for their objectives. There are many performance measures but for sustainability in Indian context the following parameters will more useful and they also cover the maximum problems which are required to address while performing sustainability. Also they have indicators which can be calculated and sustainability can be found in number to represent and compare.

The list is as follows with goals

Strategic Goal	Sustainability – Related Objective
Congestion Reduction	Improve in mobility along corridors
	Improve reliability of travel
Enhancement of Safety	Minimize crash rates and crash risk
	Improve traffic incident detection along with response
Expansion of Economic Opportunity	Optimize land use potential
	Maximize road-based freight movement
Enhancement of Value of Transportation Assets	Maintain existing quality of the system
	Minimize cost and impact of capacity expansion
	Generate the non-conventional funding sources
	Minimize use of single-occupant Vehicle (SOV) travel
Air Quality Improvement	Reduce adverse impacts on human health
	Reduce greenhouse gas emissions
	Conform to emissions standards



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