Proceedings of 8th IOE Graduate Conference
Peer Reviewed
ISSN: 2350-8914 (Online), 2350-8906 (Print)
Year: 2020 Month: June Volume: 8

Strategies for Sustainable Urban Mobility: A Case Dharan Sub-Metropolitan City

Suman Limbu [a], Padma Bahadur Shahi [b]

[a, b] *Department of Architecture and Urban Planning, Pulchowk Campus, IOE, TU, Nepal*
Corresponding Email: [a] sumanlimbu243@gmail.com, [b] pb_shahi@yahoo.com

Abstract
Urban mobility is one of the components of integrated urban transport. Urban transport plays a major role in urban planning and development, providing citizens with access to a variety of land uses, such as education, markets, employment, recreation, health care and other major services that are specific to cities in developing countries. The objective of this research is to study the urban mobility and to propose strategies for sustainable urban mobility in Dharan city. Understanding people's opinion in the survey questionnaire was made to determine existing issues in urban mobility to gain appropriate decisions toward adequate planning transportation system which would be able to meet the commuters need and propose integrated strategies. In order to determine existing issues in urban mobility as perceived by the people and to seek out their opinion on critical issues, a survey questionnaire method of research used. It sought to assess commuter needs to support appropriate decisions towards developing integrated strategies for sustainable urban mobility and planning for adequate transportation system. Planning strategies are proposed to solve identified problems and to achieve an integrated and sustainable urban mobility system in central business district of Dharan city. The indicators used to measure sustainable urban mobility in city are Affordability of public transport for the poorest people, Accessibility for mobility impaired groups, Air polluting emissions, Noise hindrance, Traffic Safety, Access to mobility services, Quality of public area, Functional diversity, Commuting travel time, Economic opportunity, Net public finance, Mobility space usage, Emissions of greenhouse gases (GHG), Congestion and delays, Energy efficiency, Opportunity for active mobility, Resilience for disaster and ecologic /social disruptions, Intermodal connectivity, Intermodal integration, Occupancy rate, Comfort and pleasure, Security. It was analyzed using likert's scale from 1-5 rating.

Keywords
Sustainable Urban Mobility, Strategies, Indicators

1. Introduction

Urban mobility is one of the components of integrated urban transport. Urban transport plays a major role in urban planning and development, providing citizens with access to a variety of land uses, such as education, markets, employment, recreation, health care and other major services that are specific to cities in developing countries. Streets are the most important link and have an identifiable role in the urban structure occupied by vehicles. The streets are the most crowded in the central region because of the narrow roads and large numbers of vehicles making movement slow, unsafe and unhealthy and impairing social cohesion etc[1].

Transportation is a functional land use and an important part of today's life. It has always been an important part of the operation of the city of Dharan. In urban areas, transportation provides links to residential units to take advantage of job opportunities and staff mobility in the most efficient manner[2].

Peter Midgley (2011) emphasizes that urban mobility is concerned with the movement of people and goods, not the movement of vehicles. The goal is to create an efficient, flexible, responsive, safe and affordable urban travel system with minimal traffic, travel and effort while ensuring environmental sustainability. This means giving priority to public transport, trucks, pedestrians and non-motor vehicles. This means providing attractive and efficient public transport services and reducing the need for motorized travel by cars or motorcycles. It also means taking advantage of what already exists in roads and services before investing in new roads and services.

Sustainable urban mobility should meet people's transportation and accessibility needs by providing safe and friendly environmental transportation. In cities in developing countries, this is a complex and arduous task, because the needs of people belonging to different income groups are not only different, but are often incompatible in nature. In cities, increasing the mobility of poor and disadvantaged groups is one of the most important prerequisites for achieving urban development goals.

A sustainable urban mobility plan is a more effective way to address transport-related issues in urban areas with the aim of creating a sustainable urban transport system by: a) ensuring that everyone has access to work and services; b) Improve safety; c) reduce pollution, greenhouse gas emissions and energy consumption; d) increase the efficiency and cost-effectiveness of personnel and cargo transportation; and increase the attractiveness and quality of the urban environment[3].

2. Objectives of Study

The objective of this research is to study the urban mobility and to propose strategies for sustainable urban mobility in Dharan city.

3. Literature study

3.1 Sustainable Mobility

Sustainable mobility is the ability to meet society's need to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological values, today or in the future[4]. The definition of the sustainable mobility concept can be drawn based on the 4 dimension used in the sustainability.

- Global environment : It refers to the global scale, i.e. mobility impacts that occur far beyond the city limits, and is focused on long term environmental aspects(such as climate change).
- Quality of life : It refers to the city or local scale and the short term (direct impacts) on social aspects of urban life(such as health or safety and security).
- Economic success : It refers to the economic aspects at the city scale(such as public finance related to mobility).
- Mobility system : It refers to the performance of the mobility system itself.

3.2 Indicators of Sustainable Urban Mobility

From literature and other research experiences, this research takes up the following as the indicators used to measure sustainable urban mobility in city are Affordability of public transport for the poorest people, Accessibility for mobility impaired groups, Air polluting emissions, Noise hindrance, Traffic Safety, Access to mobility services, Quality of public area, Functional diversity, Commuting travel time, Economic opportunity, Net public finance, Mobility space usage, Emissions of greenhouse gases (GHG), Congestion and delays, Energy efficiency, Opportunity for active mobility, Resilience for disaster and ecologic /social disruptions, Intermodal connectivity, Intermodal integration, Occupancy rate, Comfort and pleasure, Security.

The indicator mentioned emissions of greenhouse gases directly refers to the impact on climate change. Net public finance is an indicator referring to the economic demands of the mobility system. Economic opportunity and commuting travel time are considered as indicators for the economic output (or impact) of urban mobility. Commuting travel time refers to a cost that may endanger economic development in the city (because of the delocalization of people and companies due to a bad score). Economic opportunity refers to economic development in the city as directly related to the transport sector. Apart from their economic impact, these two indicators have a social impact too: economic opportunity is related to job creation and commuting travel time is also an indicator of quality of life.

The impact of mobility on quality of life is regarded as a growing concern for citizens and city authorities. Quality of public area, access to mobility services, traffic safety, noise hindrance and air polluting emissions are selected as mere quality of life indicators. Traffic (un)safety and air polluting emissions are classified in this group because they are a direct threat to human life. Moreover (traffic) noise is regarded increasingly as an aspect of human health, and even less harmful lower noise emissions might cause annoyance. But not all quality of life indicators refer to negative impacts: a well-organized mobility system might enhance the quality of public area and clearly guarantee a high level of access to mobility services, both important issues contributing to the social life in the city.

Accessibility for mobility-impaired groups, affordability of public transport for the poorest group, comfort and pleasure and security are mobility system performance indicators but also reflect the quality of life in the city.

Opportunity for active mobility is an internal mobility system property, but the improvement of this indicator can clearly contribute to diminishing city transport greenhouse gasses emissions per unit travelled. Occupancy rate, intermodal connectivity and intermodal integration are the three indicators only referred to as mobility system performance features.

Energy efficiency is commonly regarded as an important indicator of the use of global resources by city transport. But because the parameter also refers to efficiency, the indicator can be classified as an internal mobility system feature too[5].

4. Methodology

The research follows Post-Positivist Paradigm, Case-Study research strategy and Inductive approach. It includes both primary and secondary data collection. Primary data has been gathered through structured questionnaires, visual surveys, and field studies and observations in the central areas. The secondary data from Municipality, Town Planning and Transport Departments were collected. The various documents such as research reports, annual reports, research papers and books and case studies have been examined.Interviews were held with Deputy Mayor of Dharan city, Director of Public Bus Organization, Director of Taxi Organization and Citizens. There are sample surveys which will be conducted for public and analyzed by using SPSS Software.

Dharan city has been studied by appraising the current situation of socio economic and physical aspects, demographic profile and the growth of vehicular traffic of Dharan city including the land uses which has effect on urban mobility situation, which helps to unravel urban mobility problems in central business district of Dharan city. Analysis and assessment of current urban traffic and transportation has been carried out through classification of roads maps, accounting traffic volumes especially in peak hours. Understanding people's opinion in the survey questionnaire was made to determine existing issues in urban mobility to gain appropriate decisions toward adequate planning transportation system which would be able to meet the commuters need and propose integrated strategies. Planning strategies are proposed to solve identified problems and to achieve an integrated and sustainable urban mobility system in central business district of Dharan city.

In order to evaluate the data availability, frequency and reliability of Dharan City and highlight the appropriate indicators, a method consisting of the following three steps has been adopted. First, considering the OECD's relative approach (1999), an evaluation tool was developed. The tools developed include the Likert scale, which includes ratings from 1 (lowest score indicates poor performance) to 5 (highest score indicates best performance).

The selected indicators are divided into 8 groups according to the main sustainable mobility goals. The final method steps include identifying potential data sources and evaluating data tolerance. It should be noted here that most indicators can be estimated from many different sources, or more often can be estimated through field measurements by independent researchers. However, the latter is beyond the scope of the current study because the assessment given below is based on currently available data obtained from official sources. In addition, regarding the data deemed unusable, the data frequency and data reliability were not checked. Table 1 lists the assessment tools developed.

Table 1: Presentation of the developed assessment tool

Examined criteria	Grades				
	1 (minimum)	2	3 (moderate)	4	5 (maximum)
Data availability	Not available	Available at a cost	Available with special permission	Freely available	Freely available online
Data frequency	Measurements ≥ 10 years	3 years < measurements < 10 years	1 year < measurements ≤ 3 years	Annual measurements	Daily measurements
Data reliability	Weak assumptions/ Significant inconsistency in data collection process	Debatable assumptions/ Considerable inconsistency in data collection process	Reasonable assumptions/ Moderate inconsistency in data collection process	Realistic assumptions/ Slight inconsistency in data collection process	No assumptions/ Consistency in data collection process

5. Study Area

The study area is selected to be main streets namely Chatara Line, Aharya Line, Himali Marg, Shanti Path and Putali Line of Dharan city as micro-level study for understanding traffic congestion at the streets and junctions and all the by-passing lanes. Dharan has lack of efficient public transportation. Rickshaws seem pre dominant in the city with higher transporting rate. There are two predominant modes of public transportation in the city, bus and taxi of which, Two buses a day leave from Bhanu Chowk for Kathmandu. Heading south, there are buses to Biratnagar every $1\frac{1}{2}$ hours. Local buses run north regularly from 5am to 4pm to Bhedetar every 15 minutes, Dhankuta every three hours and Hile every four hours. There are also buses heading east to the Indian border at Kakarbhitta in every four to five hours.

6. Findings and Discussions

The potential data sources for each one of the 80 indicators as well as the results of the assessment process are presented in Table 2 below.

Table 2: Data availability, frequency and reliability assessment related to Dharan City

Objective	Indicator	Availability	Frequency	Reliability
Integration of land use/ transport planning	Change in land use by transport infrastructure	3	1	4
	Land take by transport infrastructure mode	3	4	5
	Land use mix	3	1	4
	Population Density	5	1	5
	Rate of use of urban land	3	1	4
Accessibility	Access to basic services	3	1	4
	PT network coverage	3	4	4
	PT size in relation to population	5	4	4
	Quality of transport for disadvantaged people	3	2	4
	Share of PT vehicles and stops which are wheelchair accessible	3	4	4
Increased mobility	Average passenger travel time	3	5	2
	Average speed of private vehicles	3	5	3
	Capacity of Park and Ride facilities	3	4	5
	Condition of transport networks	3	3	3
	Daily or annual passenger-km by means of PT	3	4	2
	Daily or annual passenger-km by private vehicles	3	5	2
	Length of paved roads	3	4	4
	Occupancy rates of private vehicles	3	1	4
	Passenger transport trends by mode (Modal split)	5	2	2
	Private car ownership	3	4	3
	Road network density	3	4	5
	Road network length	3	4	5
	Traffic congestion	3	5	3
Promotion of non-motorized means	Bicycle network density	3	4	5
	Bicycle network length	3	4	5
	Cycle parking availability	3	4	4
	Pedestrian network density	3	4	5
	Pedestrian network length	3	4	5
	Share of streets with traffic calming measures	3	4	3
Encouragement of PT	Average PT speed	3	4	4
	Number of means of PT	5	4	5
	PT comfort	3	3	3
	PT frequency during peak-hour	3	4	5
	PT occupancy	3	4	4
	PT reliability	3	4	4
	PT security	3	4	3
Environmental concerns	Average age of PT fleet	3	4	5
	Average age of vehicle fleet	3	5	5
	Cases of chronic respiratory diseases due to vehicle pollution	1	-	-
	CH_4 emissions (per capita)	5	5	4
	CO emissions (per capita)	5	5	4
	CO_2 emissions (per capita)	2	5	3
	Environmental damage relating to transport	1	-	-
	External costs of transport activities by mode	1	-	-

Table 3: Data availability, frequency and reliability assessment related to Dharan City

	Final energy consumption by the transport sector referring to the urban level	3	4	1
	Fuel consumption of private vehicles	3	4	1
	Fuel efficiency of PT fleet	3	4	5
	Greenhouse gas emissions deriving from the transport sector	5	5	4
	Habitat and ecosystem disruption	1	-	-
	NO_x emissions (per capita)	5	5	4
	O_3 concentration (per capita)	5	5	4
	PM_{10} and $PM_{2.5}$ emissions (per capita)	5	5	4
	Population exposed to air pollution deriving from the transport sector	1	-	-
	Population exposed to transport noise ≥ 65 dB	3	2	2
	Share of vehicle fleet meeting certain air emission standards	2	4	5
	SO_x emissions (per capita)	5	5	4
	Structure of road vehicle fleet	3	5	5
	Transport-related waste and related recovery rates	1	-	-
	Type of fuel used in PT fleet	3	4	5
	Use of renewable energy sources & biofuels	3	5	5
Economic welfare	Affordability (share of income devoted to transport)	1	-	-
	Contribution of transport sector (by mode) to employment growth	3	4	2
	Direct subsidies to PT	3	4	4
	Direct user cost referring to travel by private vehicles	1	-	-
	Direct user cost referring to travel by PT	5	4	4
	Fuel prices and taxes	5	5	4
	GDP per capita	5	4	5
	Internalization of costs	1	-	-
	Investment in transport infrastructure (per capita and mode as share of GDP)	3	4	2
	PT affordability (share ofhouseholds' income devoted to trips by means of PT)	1	-	-
	Share of GDP contributed by the transport sector	3	4	4
	Social cost of transport	1	-	-
	Taxation of vehicles	5	4	5
	Total expenditure on pollution prevention and clean-up	1	-	-
	Total per capita transport expenditures	1	-	-
	Trends in PT prices	5	4	4
Road safety	Index of incidence of injuries and fatalities from road transport	3	4	3
	Road safety and vulnerable users	3	4	3
	Road traffic fatalities	3	4	3
	Traffic accidents involving injuries	3	4	3

As shown in the table above, it is strongly recommended that 16% of the proposed indicators be excluded from the indicator system because it is currently very difficult to estimate them due to the lack of necessary data. Regarding data collection involving many indicators mainly included in economic welfare targets, raw data is available at the national or regional level, but not at the city level. In addition, most of the above indicators (49 out of 80) special permissions are required to access the original data, and according to the corresponding data source, data collection is different from a fairly easy process (for example, in the case of the traffic police department), and the challenge is complex issues (for example, the Ministry of Economy) . In addition, in the case of 16 indicators (for example, NOx and SOx emissions), the necessary data can be obtained free of charge on the internet, on the contrary, there is a fee to access certain data sets with reference to the estimates of the two indicators.

Regarding the frequency of data, a 50% indicator is measured every year, while a considerable share of 20% is measured every day. In addition, because the cost of collection and analysis is very expensive, the scope of implementation is wide and there are slight changes in many occasions, so the long-term period of 10 years or more measured the population and land use-related 6 indicators between two consecutive measurement cycles. In terms of data reliability, about 58% of the necessary data is considered to correspond to fairly accurate accuracy of level 5 and level 4, respectively, while in the case of 12 indicators, the data accuracy is characterized as medium (grade 3) . It is strongly recommended that in the absence of any statistical or other verification, do not consider fuzzy data and bad data whose accuracy is almost equivalent to 9% and 3%, respectively.

7. Conclusion

The serious problems faced by many urban areas related to the operation of the transportation system, such as traffic congestion, air pollution, environmental degradation, etc., require a paradigm shift in the planning process. The sustainable transportation planning method is widely accepted, both the emergence of the above phenomenon and its solution. The realization of sustainable mobility should include the vision of each urban area, but it should also contain a challenging issue, in which indicators can play a key role. A comprehensive indicator system should describe the performance of the transportation system in terms of social equity, economic welfare, and environmental integrity. It must also consider the specific characteristics of the urban area under consideration. Selecting indicators is a crucial method step in the evaluation process because it depends on many different criteria, such as policy relevance, continuity, compatibility, sensitivity, and data availability, frequency, and reliability. In the context of the current study, the data availability, data frequency and data reliability were examined, and it was related to the city of Dharan. The analysis of the results highlights the difficulties encountered in the data collection process, advocates the establishment of urban observatories, and points out the most suitable indicators based on the inspection criteria in order to incorporate them into effective, realistic and comprehensive assessment tools of mobility conditions in Dharan City.

References

[1] Ehsan Amini Nasab. *Strategies for sustainable urban mobility in central business district of Sabzevar City Iran*. PhD thesis, Doctor of Philosophy in Urban and Regional Planning), University of Mysore, 2018.

[2] CoenVolp Peter Kellermann, Claudio Masi. A vision for integrated urban mobility: Setting up your transport authority. Technical report, Organising Authorities Committee, 2011.

[3] Sustainable urban mobility plans – planning for people, Dec 2011.

[4] World Business Council. Methodology and indicator calculation method for sustainable urban mobility. Technical report, World Business Council for Sustainable Development Sustainable Mobility Project 2.0 (SMP2.0) Indicators Work Stream, 2004.

[5] Pr. Dirk Lauwers and Georges Allaert. Methodology and indicator calculation method for sustainable urban mobility. Technical report, World Business Council for Sustainable Development (WBCSD), 2015.