Development of Toolkit under "Sustainable Urban Transport Project"

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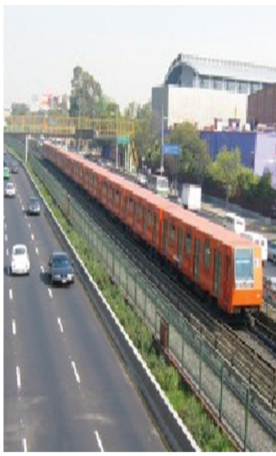

Urban Road Safety Audit

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The Institute of Urban Transport (India) is a premier professional non-profit making organization under the purview of the Ministry of Urban Development, Government of India (MoUD). The National Urban Transport Policy (NUTP), 2006 has empowered IUT to serve as a National Level Facility for continuous advice and guidance on the principles of sustainable urban transport. The objective of the Institute is to promote, encourage and coordinate the state of the art of urban transport including planning, development, operation, education, research and management at the national level.

The Institute has been nominated as the project monitoring unit for Component 1A of the SUTP. IUT is responsible for overseeing the preparation of the training modules, subject toolkits and conduct of training of 1000 city officials in urban transport.

The Ministry of Urban Development (MoUD), Government of India (GoI) has initiated the Sustainable Urban Transport Project (SUTP) with support of Global Environment Facility (GEF) and the World Bank to foster a long-term partnership between GoI and state/local governments in the implementation of a greener environment under the ambit of the NUTP. The aim of the project is to achieve a paradigm shift in India's urban transport systems in favour of sustainable development. The MoUD is the nodal agency for the implementation of the project, to be implemented over a four-year period starting from May, 2010 to 30 November 2014. Project cost is Rs. 14,161.55 Million. The project's development objective (PDO) is to promote environmentally sustainable urban transport in India and to improve the usage of environment-friendly transport modes through demonstration projects in selected cities.

The Transportation Research and Injury Prevention Programme (TRIPP) at the Indian Institute of Technology (Delhi) is an interdisciplinary programme focussing on the reduction of adverse health effects of road transport. TRIPP attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. Faculty members are involved in planning safer urban and inter-city transportation systems, and developing designs for vehicles, safety equipment and infrastructure for the future. Activities include applied research projects, special courses and workshops, and supervision of student projects at post graduate and undergraduate levels. Projects are done in collaboration with associated departments and centres at IIT Delhi, government departments, industry and international agencies.

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Project Team:

Geetam Tiwari	Project Coordinator
K.R.Rao	Project Advisor
Hassan M. Mahadhavi	Project Associate

Support:

Mahesh Gaur	Office Administrator
Parvesh Sharawat	Design Service

Preface

Government of India has initiated the Sustainable Urban Transport Project (SUTP) with support from Global Environment Facility (GEF), World Bank and UNDP. The primary objective of SUTP is to facilitate urban transport infrastructure in a sustainable environment and under the ambit of National Urban Transport Policy (NUTP).

Component 1A of GEF-SUTP project aims at capacity building amongst practitioners in the field of sustainable urban transport. The objective of the initiative is to create an enabling institutional framework for sustainable urban transport in India. This is to be accomplished by enhancing the capacity of policymakers, planners, researchers, executive agencies, service providers, managers and other professionals involved in urban transport to plan, implement, operate and manage sustainable urban transport.

To achieve the objectives of Component 1A, as part of the program 5 sub-components have been identified which include the following:

- Sub-Component 1 – Institutional capacity development, focusing on strengthening of Institute of Urban transport (IUT)
- Sub-Component 2 – Individual capacity development
- Sub-Component 3 – Preparation of manuals and toolkits
- Sub-Component 4 – Promotion, awareness and dissemination of information to expand and enhance the impact of GEF-SUTP
- Sub-Component 5 – Technical assistance to cities to address emerging issues encountered during project implementation.

Sub-Component 3 aims at providing step by step guidance to cities and other concerned authorities to enable them to plan and implement projects related to urban transport and also facilitate public decision makers and transport planners/ engineers in overseeing urban transport projects. It will include briefly the concept behind the subject of the tool kit, applicable planning standards and norms (most up to-date version to be used) and reference to a code of practice where necessary. The toolkits are as follows:

1. Land use transport Integration
2. Urban Travel Demand Modelling
3. Transport Demand Management
4. ITS for Traffic Management System
5. Public Transport Accessibility

6. **Urban Road Safety & Safety Audits**
7. Planning, Design and Evaluation of Urban Traffic systems
8. Finance and Financial Analysis
9. Environmental Analysis/SEA & SIA
10. Social Impact Assessment and R &R plan

The present toolkit would deal with the subject of "**Urban Road Safety**". The aim of this toolkit is to develop context specific Urban Road Safety Audit (URSA), with specific objectives as follows:

- To minimize the potential for accidents during design and post construction phases
- To ensure pedestrian and cyclists safety and accessibility
- To minimize the number and severity of accidents that will occur on the new or reconstructed road

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Guidance to users

Why was the Toolkit developed?

Increasing number of road traffic injuries in Indian cities is a major concern. As number of cities grows and existing cities expand the road infrastructure, it is imperative on city authorities to ensure safe infrastructure. In India, road authorities have been responsible for both ensuring safety in their road designs as well as rehabilitation and improvement of existing roads. The authorities are expected to apply safety principles in all of their road projects to prevent accidents and to ensure safety of their vulnerable road users.

RDP (2004) as a road development program defined RSA as a systematic study and formal process of checking the safety aspects of road schemes before they are built. Its objective is to address the safe operation of a roadway and to ensure high level of safety for all its users.

The toolkit attempts to address the problems relating to urban road safety, identifying the indicators of safety in urban areas and provide a comprehensive solution for urban road safety audit. It aims at developing context specific road safety audit. The purpose is not doing policy based audit, but audit for specific area; Site based or city level which would help engineers and planners to develop safety plans for car occupants, motorcyclists, pedestrians, bicyclists and public transport users.

How the Toolkit was developed?

The toolkit was developed by the Transport Research and Injury Prevention Program of Indian Institute of Technology in New Delhi and Civil Engineering department (Transportation Engineering department section) of Indian Institute of Technology in New Delhi in India. All the relevant information including best practices on road safety audit from all over the world was gathered and after identification of indicators for urban areas, a draft of toolkit was prepared and reviewed by international experts. The draft toolkit was discussed with various stakeholders and IUT (Institute of Urban Transport) representatives in two workshops. It is envisaged that the toolkit will be further refined in the light of experience in its use.

Who are intended users of this toolkit?

The prime user for whom the tool kit is being prepared - the city official who is required to supervise and monitor consultant's work; consultants will also benefit. This tool kit will assist the user groups and civil

society groups to monitor the improvement in urban road safety. It includes all municipal corporations and urban development authorities.

When urban road safety audit can be conducted?

Road Safety Audits can be used in any phase of project development from planning to construction. It is intended to minimize the risk of a traffic crash and ensure that measures to eliminate or reduce identified urban roadway problems are fully considered.

Structure of Toolkit

The Toolkit is separated into 6units to assist readers in addressing urban road safety audit. These 6 units are considered dependently. Such structure gives planners more flexibility to customize their target audiences for specific urban areas. Each unit provides users with information enabling them to respond to key urban road safety questions and conduction of safety audits. Each unit begins with an overview of the unit's content and list of objectives to help in assessing the achieved outcomes.

Chapter 1 - Introduction and Background

Section highlights the key problems in urban road safety and the objectives of a toolkit

Chapter 2 - Subject description (Urban Road Safety Audit Toolkit)

Chapter 3 - Indian Context, Policies and Regulations (Different Safety Provisions)

Chapter 4 - Summary of Case Studies – Best practices and Lessons, Options and Way Forward

[Detailed case study (State of the art) is given in Appendix 1]

Chapter 5 - Inventory and Present Status and Planning, Design and Impact Assessment

[Checklists are given in Appendix 2]

Chapter 6 - Implementation and Procurement

APPENDIX 1 - State of the art -Detailed case study

APPENDIX 2- Checklists

APPENDIX 3 - International Expert workshop and International Reviewers comments

APPENDIX 4 - Glossary

Executive Summary

Aim of the Toolkit

'Urban Road Safety Audit' is meantfor accident prevention rather than accident reduction. It is a safety performance examination of an existing road or a future road by an independent audit team.The Audit can be conducted at any stage of a project, starting with the project planning stage to the Final design stage. It can even be conducted on roads that have already been completed and started operating.

Importance of Urban Road Safety Audit

Road safety audit (RSA) is important because it is a means of accident prevention rather than accident reduction. It is a formal safety performance examination of an existing road or a future road or an intersection by an independent audit team. RSA can be conducted at any stage of a project, starting with the project planning stage to the Final design stage. It can even be conducted on roads that have already been completed and started operating. The audit helps in identifying strategies to minimize risk and severity of road crashes; minimize the need for remedial works after construction; and reduce the life costs of the project.

Road Safety Audit (RSA) is dependent on the kind of activities and characteristics of a geographical area and can be classified into three types depending on its applicability; namely application to Highway, Rural areas and Urban areas.In urban areas, safe people's movement is at most important. As a result people who moves by different modes needs safe environment.

Development of Toolkit

URSA Toolkit attempts to integrate all issues concerned with transportation in order to promote safety, cleaner air, and energy conservation. The prime user for whom the tool kit is being prepared is city officials who are required to supervise and monitor consultant's work. This tool kit will assist the user groups and civil society groups to monitor the improvement in urban road safety. It includes all municipal corporations and urban development authorities.

How to conduct URSA?

Step 1: Scope of the Audit

This Audit shall only consider urban road safety matters and is not a fully technical checklist that the design conforms to Standards. So it does not consider structural safety.

Step 2: Urban Road Safety Audit Area Identification

In step 2, the purpose is determination of locations where "accident clusters" or specific accident types occur. (For Post-construction phase procedure in URSA, Hot-Spot identification using density clustering will be required).

Final Map from Hot spot analysis would provide the critical sections of the road based on clustering of accidents. Next, the key indicators that could affect the safety in urban areas are to be identified and a description of their existing status is to be given in the report.

STEP 2. Hotspot identification in Urban Road Safety Audit Toolkit

For Post Construction Phase Propose a Model to identify Audit Area (HOT

Hot spot — **Density clustering technique**

Prepare a Map of locations to be audited

Categorize a problem area into different types of roads, Modes and Locations

Problems based on Road

1. Arterial roads
2. Collector roads
3. Local roads

Problems based on Modes

1. Pedestrian and bicycle
2. 2 Wheelers
3. Public transit (Bus, orheavy vehicles like truck)
4. Light vehicle (Car, Taxi, Jeep, SUV)

Problems based on Locations

1. Bus stops and metro stations (Public Transit related)
2. Shopping concentrated zones (Commercial areas)
3. Schools and Hospitals
4. Residential areas
5. Intersection (Cyclists Paths, Foot paths)


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Step 3: Checklist preparation and assessment procedure

After Identifying project or existing urban road for URSA (Problem Area or Hotspot), and collecting information on indicators which data needs to be collected, conduct URSA analysis and report the results.

STEP 3.Providing Background information

Statement of expected outcome of audit (Aim and objective of URSA for particular area)

Specify required site data based on different stages

Different Stages	Information required
Feasibility Stage	Road design standards and layout visualization
Preliminary Design Stage	Local Knowledge
Detailed Design Stage	Critically examine the details
Pre-opening Stage and Construction Time	Police officer and maintenance engineer
	Familiar with traffic control devices
	Familiar behavioural side of road safety
Monitoring and Existing stage (Post-Construction)	

The checklist is categorized into three types of roads including Arterial or sub-arterial, Collector and Local Road. Each type of road has to have a separate checklist for different hotspots. URSA Toolkit has identified three different problem areas to be audited; midblock or intersection, bus stops or metro stations and educational facilities like schools or hospitals.

STEP 3.1. Checklist Preparation

Road Type

- Specify important issues relating to road type
- Specify a road type: Arterial, Collector and Local
- Specify Audit area on map

Midblock or Intersection

Bus Stop or Metro Stations

Educational facilities or Hospitals

- Running the checklist for each specific hot spot
- Score the checklist for final evaluation

Evaluation and Recommendation based on Scored checklist for each specific problem area

Chapter 1

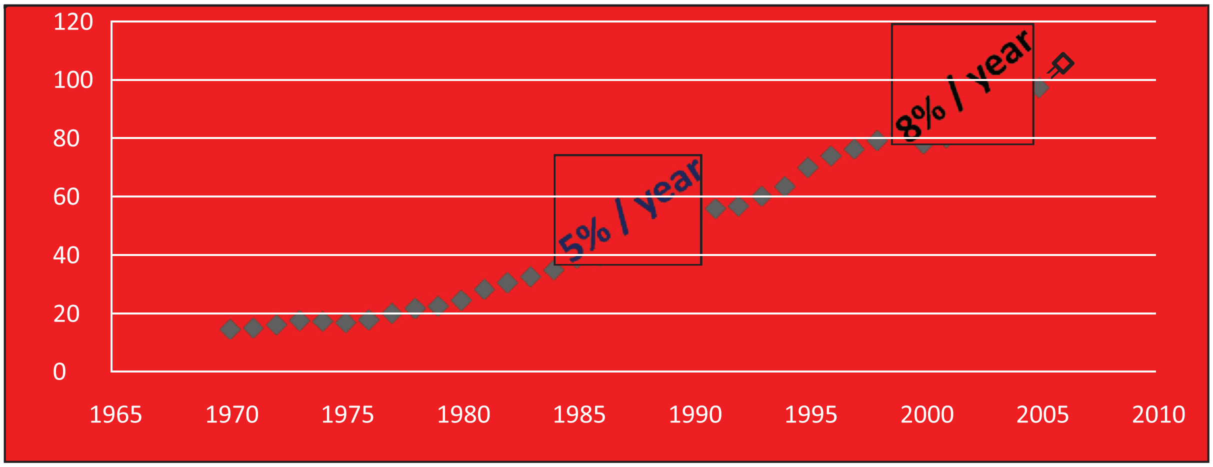
Introduction and Background

1.1 Safety problems in urban areas

One of major concerns in India relates to Fatalities and injuries caused by traffic. Total number of people involved in traffic crashes as well as rates per million population have been increasing in the last three decades. According to official statistics, 1,14,444 people were killed in road traffic crashes in India in 2007(NCRB, 2007) which increased to 1,34,599 in 2010 (NCRB, 2010). 3,94,982 accidental deaths were reported in the country during the 2012. Traffic fatalities increased by about 5% per year from 1980 to 2000, and since then have increased by about 8% per year for the four years for which statistics are available. The fatality rate has increased from 36 fatalities per million persons in 1980 to 95 fatalities per million persons in 2006 (Mohan et al. 2009). However, a study done in Bangalore shows that while the number of traffic crash deaths recorded by the police may be reasonably reliable, the total number of injuries is grossly underestimated (Gururaj 2006). According to that study, deaths were underestimated by 5% and the number injured who needed treatment in hospitals was underestimated by more than a factor of two. In that study, the ratio of injured people reporting to hospitals versus those killed was 8% .An estimated 1,650,000 people were victimised in traffic crashes were hospitalised in 2006.

Clearly, the road injury problems that generates at urban level cannot be entirely solved without measurements specific for urban areas. Most of the urban injury accidents and of fatalities involve vulnerable road users because of being unprotected from motorized traffic and existence of organized road spaces only for facilitating the movements of motorized vehicles and not vulnerable road users who are mostly pedestrians, cyclists and two wheelers.

Figure 1.1: Number of people (in thousands) killed in road traffic crashes



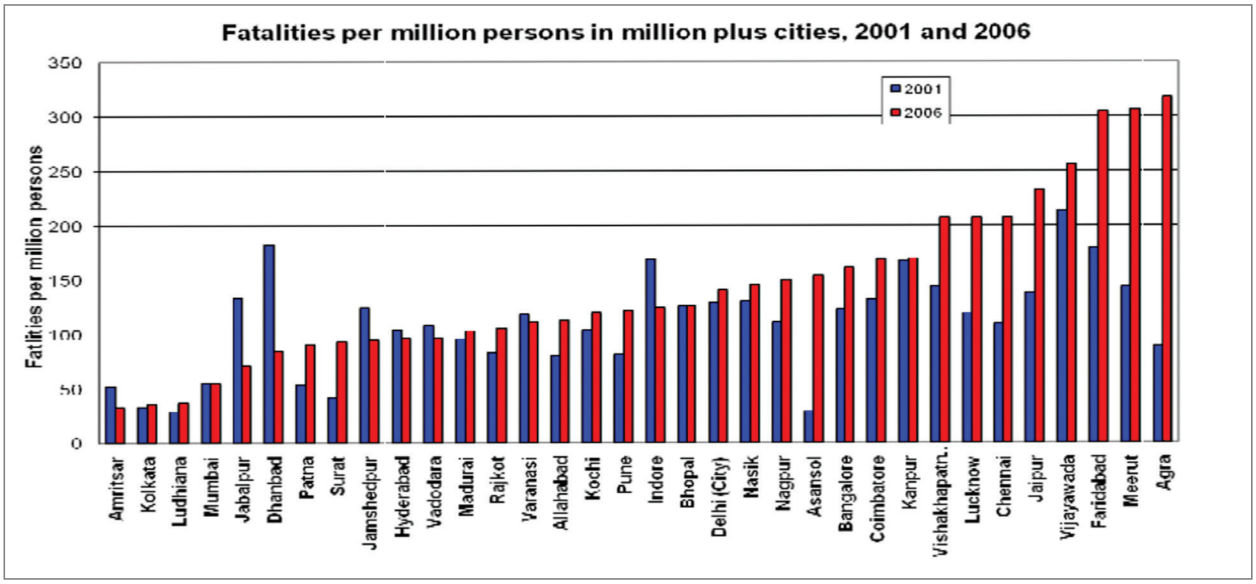
Source: (NCRB, 2010)

Figure 1.1 shows that while the total number of road accidents increase to almost four times from the year 1970 to 2004, the number of persons killed in them becomes approximately six times.

1.2 Projecting road traffic fatalities in Indian cities

India's base road fatalities Kuznets curve (21.6 fatalities per 100,000 persons in 2000) peaks in 2012 at 23.8 fatalities per 100,000 persons. Fatalities per 100,000 persons gradually fall after 2012 to 17.3 fatalities per 100,000 persons in 2050. There were 225,000 road fatalities in India in 2000.

Figure 1.2: Fatalities per million persons in million plus cities, 2001 and 2006



Source: (NCRB, 2007)

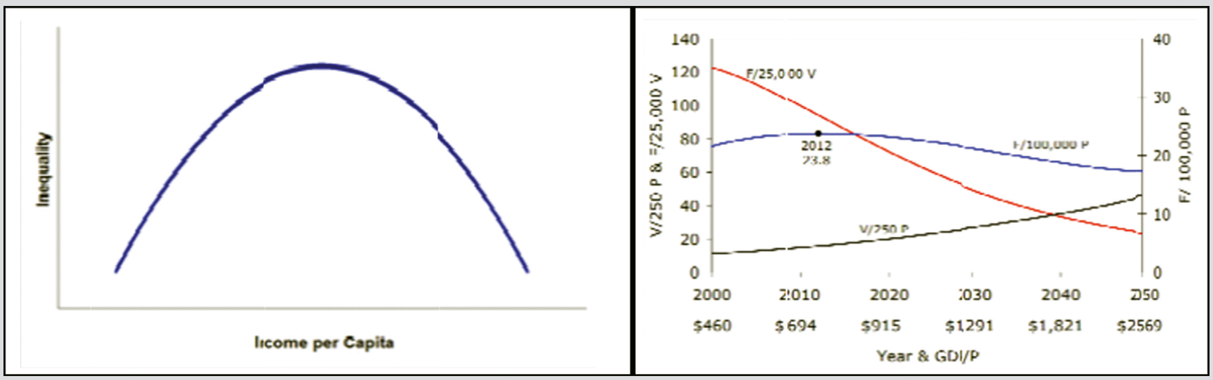
Figure 1.2 shows traffic fatality rates in cities with populations of at least one million for the years 2001 and 2006. Many cities depict a fatality increase of 2-5 times in five years duration. Fatality rates have increased regardless of the size of the city or the region. The issues regarding traffic crashes in urban areas may be understood by the fact that at present less than one in 40 families owns a car in India. The car ownership level in India is so low that even at reasonable economic growth rates (say 5-7% per year) most families are not likely to own a car in the year 2020. Consequently, a majority of the population in India is not likely to use cars for surface travel for the near future.

1.3 Objectives

- To minimize the potential for accidents during design and post construction phases
- To ensure pedestrian and cyclists safety and accessibility
- To minimize the number and severity of accidents that will occur on the new or reconstructed road

Box 1.1: Kuznets curve

A Kuznets curve is the graphical representation of Simon Kuznets' hypothesis where there is a natural cycle of economic inequality driven by market forces which at first increases inequality, and then decreases it after a certain average income is attained. Applying the Kuznets curve to road fatalities is an outgrowth of the environmental Kuznets curve. It is applicable to a large data set and develops projections of future traffic fatalities with it. Fatalities per capita are defined as the product of vehicles per capita and fatalities per vehicle. Fatalities are undesirable, so the fatalities per vehicle function is interpreted as a negative. Demand function (a demand to reduce fatalities per vehicle). It is reasonable to assume that as income per capita grows, the demand for fewer fatalities per vehicle rises, meaning that safety (in the form of fewer fatalities per vehicle) is what economists call a normal good.

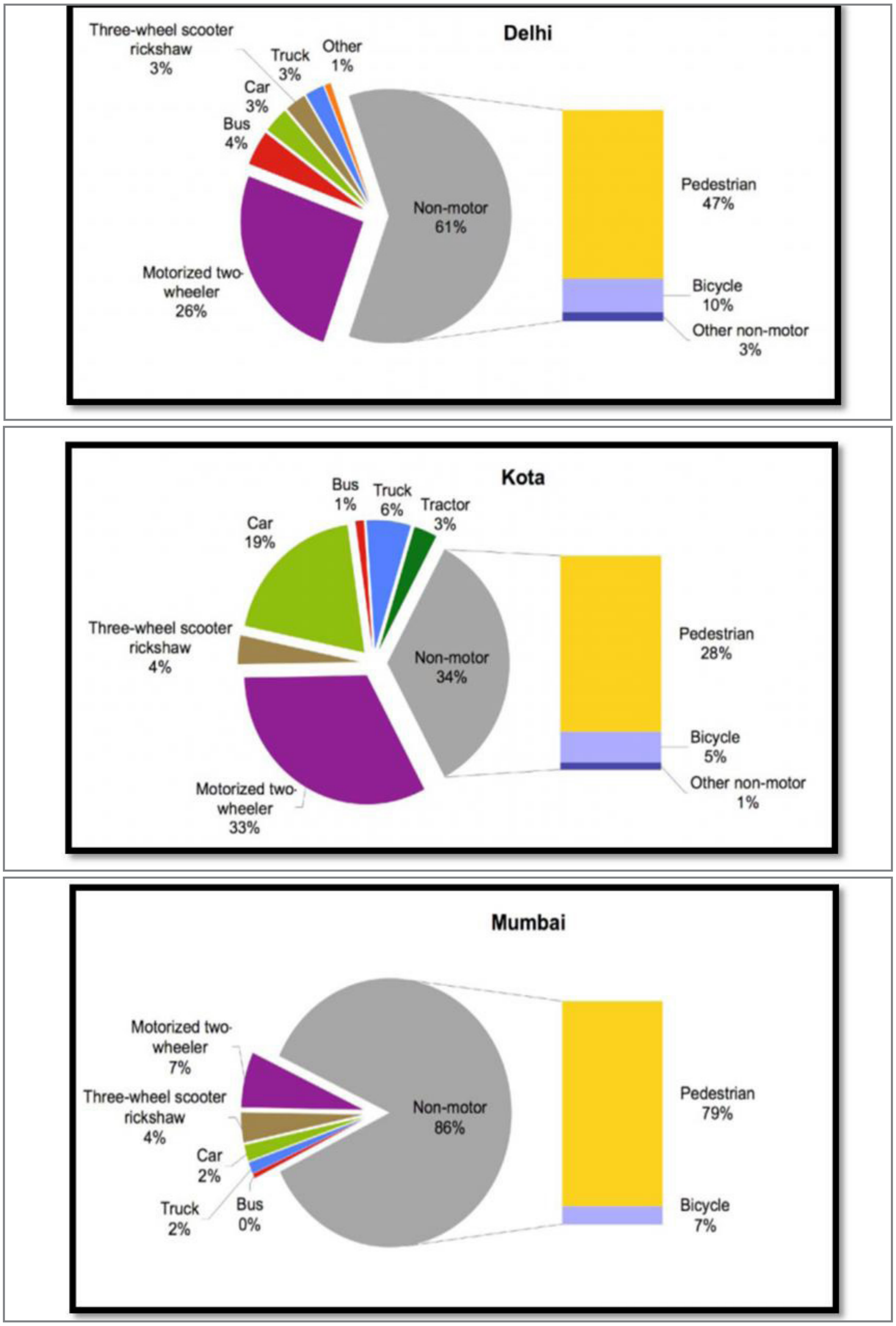


Source: McManus et al., 2007

1.4 Example: Victims in Road Crashes - Illustration from 3 cities

Illustration from 3 Indian cities (Delhi, Mumbai and Kota) represents that pedestrians plus bicycle are the largest number of victims followed by motorized two wheeler riders. It is mostly people outside the vehicles who are major victims and priority is with that pedestrians and bicycles. In small cities like Kota, two wheelers modal share are higher than Delhi and Mumbai with 33, 26 and 7% respectively. Also, the sizes of buses in small cities like Kota are smaller than in Delhi and Mumbai. Furthermore, 47 % of all NMV Road crashes in Delhi are pedestrians; it is 79% in Mumbai and 28 % in Kota. Figure 1.3 represents that NMV victims are more than 60% in large cities like Delhi, 86% in Mumbai and 34% in small cities like Kota.

Figure 1.3: Delhi (2001-2005), Kota (2007) and Mumbai (1996-1997) Victims in road crashes



Source: Mohan et al. (2009)

Chapter 2

Subject Description

2.1 Subject Description

Road safety audit (RSA) is required because it is a means of accident prevention rather than accident reduction (DFID, 2003).It is a formal safety performance examination of an existing road or a future road or an intersection by an independent audit team (Rodrigues and Bezerra, 2005). RSA can be conducted at any stage of a project, starting with the project planning stage to the Final design stage. It can even be conducted on roads that have already been completed and started operating. That is, it can be conducted at different stages of the road infrastructure life cycle (ADB, 2003, Austroads, 2002, Rodrigues and Bezerra, 2005, DFID, 2003, Surrey, 1996, NZTA, 2010). The audit aim is to minimize risk and severity of road crashes; minimize the need for remedial works after construction; and reduce the life costs of the project (Austroads, 2002).

Box 2.1: Definitions

Urban safety

It refers to road accidents, casualties in a town or city, having different and integrated disciplines. (**GIZ 2011)**

Road Safety Audit:

JSRPRCD (2012) defined Road Safety Audit as a formal procedure for assessing accident potential & safety performance in the provision of new road as well as improvement, rehabilitation and maintenance of existing roads

Austroads (2002) describes it as a formal examination of a future road or traffic project or an existing road, in which an independent, qualified team reports on the project's crash potential and safety performance.

ADB (2003) defined RSA as systematic procedure for accessing the road safety of roads and road schemes.

Risk

Probability of adverse health outcome, or a factor that raises this probability

Source: Mohan, 2006, Road traffic injury prevention – Training manual

2.2 Why Urban Road Safety Audit

Urban areas have density of activities including people and vehicle movement. The transport infrastructure is used by motorized vehicles as well as non-motorized vehicles users such as bicyclists and pedestrians.

Urban layout and design of transport infrastructure in general and especially road infrastructure influences level of exposure and risk to different road users. Urban road safety audit can identify various risk factors in urban areas where remedial measures can be applied.

Internationally development of road safety audits has resulted in a number of guidelines. These guidelines are supported by audit checklists and audit procedures which are being implemented and tested in different countries. UK, New Zealand, Australia and Denmark are some of the forerunners in developing these toolkits and implementing them. The toolkits that have been developed till date have mostly focused either on rural area or highway projects. The applicability of these toolkits on urban areas is hence minimal (See Appendix 1).

In urban areas, safe movement of people is the most important. As a result people who moves by different modes needs safe environment.

2.3 Key Factors Affecting Urban Road Safety

2.3.1 Factors influencing exposure of risk

As the movement of people and goods on the urban roads is necessary for social, economic and political reasons, it leads to risk of urban road traffic injuries. Eliminating of all risks is impossible, but the purpose could be to reduce the exposure to risk of severe injuries and minimize its consequences. (See Box 2.2)


Box 2.2: Factors influencing exposure of risk

- Economic factors such as level of economic development and social deprivation
  - A. Growth in number of motor vehicles
  - B. Growth in Motorized two wheelers and three wheelers in low and medium income groups
  - C. Effect on Non-motorized traffic (predominant in urban areas of low and middle income groups)

Requirements:

- Appropriate urban road safety measures should accompany this growth
- Provision of infrastructure for pedestrians and cyclists and proper planning of growth of number of motor vehicles which leads to increase in walking and cycling in urban areas
- Countries with high volume of passengers in their urban areas have and impact on safety and consequently their vulnerable road users
- Demographic factors such as age and sex
  - A. Fluctuation in relative size of different population groups have effect on traffic

Requirements:

- Provision of safe and short pedestrian routes and safe and convenient public transport for old population
- Provision of safety measurements for young drivers who are predominant group in road traffic crashes in low and high income countries
- Land use planning practices influencing length of trip and mode of travel
  - A. Effect on economic activity, property prices, air and noise pollution, social deprivation and crime
  - B. Of the four main modes of travel, road travel presents the highest risk in most countries – using almost any measure of exposure – compared with rail, air and marine travel. Within this mode of road travel, major variations exist between pedestrians, cyclists, riders of motorized two-wheelers, car occupants, and bus and truck passengers

Requirements:

- Proper land use planning, residential, commercial and industrial activity
- Mixture of high speed motorized traffic with vulnerable road users
- Insufficient attention to integration of road function with decision about speed limits, road layout.

Source: Mohan, 2006, Road traffic injury prevention – Training manual

2.3.2 Factors influencing crash involvement

There have been many studies investigating various aspects of crashes in urban roads. Speed is the most frequently cited factor contributing to crashes in the literature. (See Box 2.3)

Box 2.3: Factors influencing crash involvement

1. Inappropriate and excessive speed

Speed choice is influenced by:

- Driver-related factors (age, sex, alcohol level, number of people in the vehicle);
- Factors relating to the road and the vehicle (road layout, surface quality, vehicle power, maximum speed);
- Traffic-related and environment-related factors (traffic density and composition, prevailing speed, weather conditions).

2. Presence of alcohol, medicinal or recreational drugs
3. Fatigue or sleepiness caused by long distance driving, sleep deprivation and disruption of circadian rhythms
4. Being a young male
5. Having youths driving in the same car
6. Being a vulnerable road user in urban and residential areas
7. Travelling in darkness
8. Vehicle factors – such as braking, handling and maintenance
9. Defects in road design, layout and maintenance, which can also lead to unsafe behavior by road users
10. Inadequate visibility because of environmental factors (making it hard to detect vehicles and other road users)
11. Poor eyesight of road users

Source: Mohan, 2006, Road traffic injury prevention – Training manual

2.4 Important Factors that can be Concluded for Urban Road Safety Audit

1. Relation between speed and vulnerable road users
2. Speed limits, excessive speed, road layout and design
3. Road design, layout and maintenance
4. Visibility issues and environmental factors

2.5 Behavioral Patterns of VRU on the Road

The number of road traffic victims and severity of injuries are the most direct measure of road safety. It is also useful to monitor road user behavior or characteristics of the road that have been proven to relate to the road safety level, e.g. driving speeds, the prevalence of drunk driving, seat belt wearing rates, or the presence of forgiving road sides. These types of measures are called safety performance indicators. They provide an indication of the road safety level of a country, and can be used to assess the effects of particular road safety measures. It is important to define safety performance indicators that can be measured reliably and have a causal relationship to the number of crashes or to the injury consequences of a crash (Winkelbauer et al., 2010)

Pedestrians (See Box 2.4), who walk to the work, choose shortest path and do not prefer to spend extra time on the trip. They follow rules when they think it is necessary. Taking the shortest route can mean that they do not use underpasses or pedestrian crossings. They may not obey traffic lights, if waiting for the green light seems to take too long. Cyclists' needs are similar to those of pedestrians (shortest routes, smooth surfacing, etc.), but they are taken into account in traffic as a last resort. Differences in cyclists' behavior are also related to the purpose of their trip. When they use a bicycle to go to work or to school, they are on familiar routes and tend to pay less attention to other traffic. Just like pedestrians, they choose the shortest possible route to reach their destination, which sometimes leads them to use one-way streets in the wrong direction, or to cycle on the pavement, thus creating conflicts with pedestrians (OECD 1998)

Box 2.4: Definitions

Vulnerable road user (VRU)

VRU is road user belonging to a category most at risk in traffic and generating little risk to other road users. By extension: road user unprotected by an outside shield, i.e. pedestrians and two-wheelers. (OECD 1998)

Pedestrian (VRU)

A person who travels by foot or pushes a pram, a wheelchair, a bicycle or a moped. Some countries also consider a person who travels by skis, skates or similar means to be a pedestrian (OECD 1998).

Children (VRU)

Children can be subdivided by age which tends to correlate with distance travelled and their range of activity. Younger children walk outside of their neighborhood only when accompanied by adults. Mostly they begin to walk alone when starting school. Sometimes their parents still cross the main streets with them. Older children, who go to school, travel by foot or by bicycle. The environment they move around is much bigger and more diverse than that used by the younger group (OECD 1998).

Note: Moped riders and motorcyclists are vulnerable because other than helmet, the user does not have any protection. However, because of high speed they can inflict damage to other road users specially the bicyclists and pedestrians.

Chapter 3

Indian Context, Policies and Regulations

3.1 Indian Policy and Regulation

The focus on road safety audit for urban areas has been minimal in India. Below are given different policies on road safety in India:

- National Level Policies in India for Road Safety

  Source: Draft National Road Safety Policy, Department of road transport and highways, Ministry of Shipping, Road Transport and Highways

- National Road Safety Council Report on Road Safety Education

  Source: Road Safety Is No Accident, National Road Safety Council, September 2011, Report of the Working Group on Road Safety Education (RSE)

- Twelfth Five Year Plan 2012–2017

  Source: Twelfth Five Year Plan (2012–2017), Faster, More Inclusive and Sustainable Growth, Planning Commission (Government of India) 2013

- Road Safety Policy by Government of Tamil Nadu, GOI

Source: Road Safety Policy, Home, Prohibition & Excise (transport-v) Department 2007.

3.1.1 National level policies in India for road safety

Government of India is concerned about the growth in the number of road accidents, injuries and fatalities in recent years. Government of India, through National Road Safety Policy, states its commitment to bring about a significant reduction in mortality and morbidity resulting from road accidents. Based on which road safety policy has been established as follow:

Policy Statements

a) Raise Awareness about Road Safety Issues

Efforts to promote awareness about the various aspects of road safety, the social and economic implications of road accidents

b) Establish a Road Safety Information Database

The Government will provide assistance to local bodies, Union Territories and States to improve the quality of crash investigation and of data collection, transmission and analysis.

c) Ensure Safer Road Infrastructure

Review standards pertaining to safety in the design of rural and urban roads and bring them in consonance with international best practices keeping in view Indian traffic conditions.

d) Safer Vehicles

Ensure that safety features are built in at the stage of design, manufacture, usage, operation and maintenance of both motorized and non-motorized vehicles in line with international standards and practices in order to minimize adverse safety and environmental effects of vehicle operation on road users

e) Safety of Vulnerable Road Users

The design and construction of all road facilities including rural and urban will take into account the needs of non-motorized transport and the vulnerable and physically challenged in an appropriate manner

f) Road Traffic Safety Education and Training

Road safety knowledge and awareness will be created amongst the population through education, training and publicity campaigns.

g) Enforcement of Safety Laws

Taking appropriate measures to assist various state and other governments to strengthen and improve the quality of enforcement in order to ensure effective and uniform implementation of safety laws

h) Strengthening Enabling Legal, Institutional and Financial Environment for Road Safety

Taking appropriate measures to ensure that the required legal, institutional and financial environment for road safety is further strengthened

3.1.2 National Road Safety Council Report on Road Safety Education at 2011

The following 12 strategic issues need immediate attention by the government to launch the campaign to make people safer on roads. With a view to achieve 50 percent reduction in road accidents by 2020, it is imperative to prioritize an Action Plan encompassing:

a) Formulation of a National Road Safety Policy

In Citizen's Charter of Ministry the public commitment is adopt for National Road Safety Policy in the year 2006-07. A Policy Statement by the Government is a resolution of the government to promote its intent to do something. Such a specific policy then becomes the backbone and a sounding board for measures to be taken to fulfil the objects of the policy. Hence it is urged that a time bound plan be adopted by the government to design and adopt such a policy through wide consultations. Once this is done then legislative backup should be provided to implement its recommendations, rather than be left as best endeavor measures.

b) Targeting drivers to have social responsibility

If one looks at the accident data, more than half of the accidents and more than two-thirds of the deaths in the country occur on national and state highways. Assuming that 80 percent of the accidents are caused due to the driver's fault, one critical and immediate issue is to target all drivers, and particularly heavy vehicle drivers,most of whom are illiterate. Besides car drivers, three wheeler and two wheeler riders too need to be targeted in specific campaigns. Drivers need to be cautious and sensitive to all the rules and safety regulations. Safe habits need to be adopted and practiced continuously.

c) Improving data reporting system

Reforming and strengthening of data collection system is required. Data reporting and compilation of

road accident statistics need to address road accident causes in greater detail in terms of road geometry, drivers' fault, vehicle condition, design and so on.

Example from Tamil Nadu

In Tamil Nadu, a software called Tamil Nadu Road Accident Data Management System (RADMS) is used. RADMS requires filling up of 68 parameters. This software helps in the comprehensive and accurate collection of data and facilitates timely dissemination.

d) Imparting safety education to children

Road safety education should begin from the childhood. If safety awareness is imparted in childhood, safety will become a habit and a way of life.

e) Broadening ambit of Road safety education

Road safety education should not be confined to educational institutions but should be expanded to cover a range of activities and road users in association with all stakeholders. Apart from students, it should include: paramedics, nurses and persons involved in evacuation and post-accident care; traffic police and road transport personnel engaged in regulation of road transport sector; NGOs and civil society activists; organizations maintaining large fleet of buses, cars, road freight carriers.

f) Outreach and awareness generation

Situation movies and field trips should be used as effective learning tools for children at school. Safe road user awards at the school level would provide an incentive for many children to follow road safety rules.

Example of Delhi

In Delhi, the traffic police have used celebrities to raise awareness at busy road crossings, thus, catching the attention of all. One can see the result of the efforts made by Delhi Police which has been witnessing a fall in road accidents4

g) Rural-urban divide

Discussions and prescriptions should address both city-centric with addressing the rural scenario also, with distinct and tailor-made approach.

h) Mobilizing resources related to funding and budget through innovative means and monitoring mechanism

i) Strengthening laws and their enforcement

The Motor Vehicle Act needs to be amended to ensure that the Road Safety Awareness Fund is created at the Centre and in all States, as mentioned above and be dedicated to awareness generation and outreach programs.

j) Education to be accompanied with enforcement as a key role in encouraging improved road-users behavior

k) Examples of good practices and rewarding them

Tamil Nadu has adopted its own Road Safety Policy

l) Political will and support crucial to achieve changes

3.1.3 Twelfth Five Year Plan 2012–2017by Planning Commission (Government of India) 2013

Transport Safety has been identified as an important area, especially for Road Transport. It is suggested, in order to strengthen the data, there is need to set minimal road death and injury data reporting requirements in accordance with standards set by the International Accident Database Group (IRTAD) for national level data. Furthermore, Web based data systems is suggested to be established and be made operational in the Twelfth Plan period. For that, following issues is identified to be addressed; (i) Awareness, Education and Driver Training and (ii) Vehicle Safety.

3.1.4 Road safety policy by Government of Tamil Nadu, GOI

A Road Safety Council has been established in Tamil Nadu under Section 215 of the Motor Vehicles Act 1988 under the Chairmanship of the Transport Minister. The vision is identified as Stop and reverse the increasing trend in number of accidents, number of deaths and number of injuries through comprehensive measures covering engineering, enforcement, education and emergency care.

Required actions for Road safety in Tamil Nadu is identified as follows:

a) Accident data

Improve the system of accident data collection and carry out comprehensive analysis.

b) Road environment

Identify accident prone areas known as black spots on the basis of accident intensity and severity using appropriate indicators and make appropriate improvements. Furthermore it is require to remove encroachments and obstructions affecting the full use of roads.

c) Safe Driving

Undertake safety campaigns and vigorously motivate drivers to wear crash helmets and fasten seat belts.

d) Safety of Vulnerable Road Users

Pedestrians, cyclists and children are identified as vulnerable and are involved in a large number of accidents.

e) Safe Speed

Introduce or revise speed limits after scientific assessment of stream speeds in different areas and install proper signs indicating the speed limits.

f) Institutional and Financial Mechanism

Strengthen the Road Safety Council and the office of the Road Safety Commissioner by creating the necessary institutional structures needed to provide effective coordination.

g) Increased Funding

Identify measures for augmenting funding for road safety.

h) Emergency Medical Response (EMR)

Upgrade and disseminate awareness about the system of accident care and health management through effective publicity campaigns.

Chapter 4
Summary of Case Studies Best Practices and Lessons, Options and Way Forward

4.1 Summary of Case studies

Application of road safety audit for urban road safety audit requires identification of indicators. In order to understand each indicator related to RSA in urban area international practices in road safety audit and different procedures in implementation of RSA in different countries has been overviewed. The expected outcomes have been defied as:

- Safer formal crossing facility for pedestrians
- Change in pedestrian behavior, lower speed
- Higher driver awareness of vulnerable road users
- Awareness of speed limits and route environment
- Change in cyclist's attitude and behavior
- Reduction of risk of serious injuries in road traffic accidents
- Reducing exposure of pedestrians to conflict with vehicular traffic and change in road user attitudes to appropriate speed and behavior Detail study over best practices in RSA has been given in APPENDIX 1.

4.2 Best Practice Example

Good and Bad examples of issues in Urban road safety (See Below Photographs)

Chapter 5

Inventory and Present Status and Planning, Design and Impact Assessment

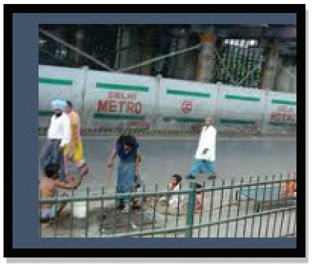
5.1 Indicators for Urban Road Safety Audit

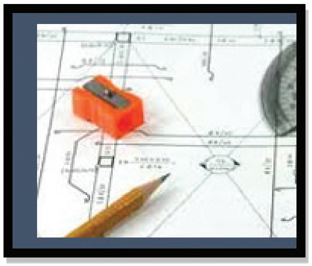
After literature review and best practice comparison from different countries (See Appendix 1), 12 major indicators are identified that are the most crucial in urban areas. The exhaustive list of indicators which can be processed based on availability of more data are given in detail.

- Speed measures
- Accident trends
- Road network
- Traffic volume
- Road infrastructure and its relation to Vulnerable Road Users
- Alcohol usage in driving
- Crossovers for pedestrians
- Children usage of road
- Location of schools, hospitals and service roads
- Accessibility between bus stops,, cycle tracks and stations
- Roadside development
- Geometric design of roads, streets and intersection

Figure 5.1: Urban road safety indicators

Location of Schools & Hospitals	Accessibility	Roadside	Geometric





5.2 Detailed Urban Road Safety Audit Indicators

All indicators are identified from road safety audits in highway projects and rural areas projects in which P1 explains the priority data required for audit in urban areas also. It should be noted that all of these data are not available or not required.

P1 = First Priority data

Table 5.1 Detail urban road safety indicators

Speed	Standard deviation of speed for light vehicles during day
	(P1)Max speed Average speed for light vehicles during night
	Average speed for light vehicles during day
	Standard deviation of speed for light vehicles during night
	85th percentile of speed for light vehicles during day
	85th percentile of speed for light vehicles during night
	Percentage of light vehicles over the speed limit during day
	Percentage of light vehicles over the speed limit during night
	Percentage of light vehicles 10 km/h over the speed limit during day
	Percentage of light vehicles 10 km/h over the speed limit during night
	The percentage of drivers exceeding the speed limit on various road types
	The percentage of surveyed (car) drivers exceeding the speed limit on various road types
	The average (free flow) speed per road type and vehicle type during daytime
	The average (free flow) speed per road type and vehicle type at night
	The variation in speed per road type and vehicle type
	The median (or another percentile) of the set of observed speeds divided by the speed limit of the road class
	the percentage of drivers with an inappropriate headway on various road types


Social cost of crashes in VRUs (Low P)	Loss of life and life quality
	Loss of output due to temporary incapacitation
	Medical costs
	Legal costs
	Property damage costs
Road network	(P1)the share of intersections per type (e.g. roundabout, signalized T-junction
	(P1)network density
	(P1)Percentage of road length with bicycle facilities
	(P1)Percentage of road length with a pedestrian facilities
	(P1)Percentage of the road network satisfying the safety design standard
	Safety hazards by infrastructure layout and design
Protective systems indicators	Percentage of persons wearing a seat belt in the front seats of a car or van
	Percentage of persons wearing a seat belt in the rear seats of a car or van
	Percentage of children under 12 years (correctly) sitting in a child's seat, in the front or rear seat of a car
	Percentage of persons wearing a seat belt in the front seats of a bus (above 3.5 tons) or a truck
	Percentage of persons wearing a seat belt in the passenger seats of a bus
	Percentage of cyclists wearing a helmet
	Percentage of moped riders wearing a helmet
	Percentage of motorcyclists wearing a helmet.
Accidents	(P1)Crashes per 100 million per user of mode
Accident Severity	(P1)Crashes per 100 million vehicle kilometres travelled for Cyclists, Pedestrians and Motorcyclists
Accident Rate	(P1)Casualties per 100 million vehicle kilometres travelled for Cyclists, Pedestrians and Motorcyclists
	(P1)Crashes per 10000 people VRUs
	(P1)Casualties per 10000 people VRUs
	(P1)Road Network Effects
	Functional classification of the road
	Location and spacing of intersections
	Terminal problems
	Environmental Considerations
	(P1)Geometric of roads
	(P1)Network structure and hierarchy
	Topography and environment
	Route continuity
	(P1) Fatality rate (Casualties / 100 000 Population)

User Safety: fatality/injury risk per trip	Fatality or injury/1 million passenger km travelled,
	Fatality or injury/ 100,000 population
	Fatality or injury /10,000 vehicles
Fatality/ injury risk per trip can be disaggregated to	Risk during access trip,
	Risk as occupant of the vehicle and
	Risk imposed to other vehicles/users on the road
	Number of fatalities and serious injuries per 100,000 population
	Number of fatalities and serious injuries for relevant NMT-groups per 100.000 motor vehicles
Vehicle Safety indicators:	Fatality or injury/10,000 vehicles traditionally estimated for motorized vehicles
Safety indicators	(P1)Fatality/injury/km,
	(P1)Fatality or injury/passenger km
	(P1)Fatality or injury/vehicle km
Risk exposure	(P1)Number of Fatal accidents per 100000 users of the mode
Risk Imposed	(P1)Number of accidents involving different vehicles and victims per 100000 of all road users
Overall safety	(P1)Number of fatal accidents per 100000 populations
Quality of footpath infrastructure	(P1)Percentage of roads with >= 2 m (adds up to safety and comfort of walking)

5.3 Definition of Hotspot

Detecting hot spots is a first step towards understanding the process for road safety audit. By characterizing the nature of the processes, we can learn more about the complexity of the system and indicators. Hot spots are spatially explicit, in that they are detected at geographic locations and may be mapped. Definitions of hot spots may be based on thresholds that are spatially global or spatially local (**See Box 15.1**). Spatially local definitions involve comparing the value for a given observation with locations in the vicinity of the observation. *(Nelson and Boots 2008)*

5.4 Hot Spot Selection Techniques

All of the techniques depend on optimizing various statistical criteria, but the techniques differ among themselves in their methodology as well as in the criteria used for identification.


The different type of techniques are:

Numerical definitions

Statistical definitions

Model-based definitions

Black spot determination using reaction level

Rate – Quality – Control Method

Kernel density estimation

Network analysis

Census Output Area estimation

Density Clustering

Density clustering has been suggested for urban road safety audit hot-spot selection in this Toolkit. (See Details in Section 5.7)

Box 5.1: Definitions

Hotspot

Concentrations of incidents within a limited geographical area that appear over time*(Nelson and Boots 2008)*

"Hotspots," "black spots," or high crash locations are sites on a section of a highway that have an accident frequency significantly higher than expected at some threshold level of significance (*Michael Sørensen and Elvik, 2008)*

A "Black Spot" can be defined as a hazardous location that has been defined as a priority location for treatment following analysis of the accident data base

➢ **Techniques for determination of Hotspots**

Spatial-statistical techniques Anderson (2012)

1. Kernel density estimation

   Kernel density estimation is an interpolation technique, which is a method for generalizing incident locations to an entire area. In short, interpolation techniques generalize the collisions over the study region.

2. Network analysis
3. Census Output Area estimation

Based on an OECD report (OECD Road Research Group 1976) and more recent work (Persaud et al. 1999, Haueret et al. 2002, Vistisen 2002, Overgaard Madsen 2005, 2005a) a distinction can be made between the following common definitions of Hot spots (See **Box 5.2**, **Box 5.3** and **Box 5.4**)

Box 5.2: Technique 1

Numerical definitions

a. Accident number, Accident rate , Accident rate and number

Simple numerical definition is the official Norwegian definition of a black spot: "A black spot is any location with a maximum length of 100 meters, at which at least four injury accidents have been recorded during the last five years". This definition does not make any reference to traffic volume or to the normal number of accidents, nor does it specify the type of location considered.

Statistical definitions

b. Critical value of accident number, Critical value of accident rate

A statistical definition of a black spot relies on the comparison of the recorded number of accidents to a normal number for a similar type of location. Depending on how the normal number of accidents is estimated, a statistical definition may come close to a model based definition of a black spot.

Model-based definitions

c. Empirical Bayes , Dispersion value

Model-based definitions of black spots are derived from a multivariate accident prediction model. Models were developed for intersections and road sections, and the 20 highest ranked locations were identified according to the estimate of the expected number of accidents

Source: Cardoso et al., (2007)

Box 5.3: Technique 2

Analytical process of back spot determination:

1. Studying accident data to define and rank problems
2. Define a reaction level that is the number of accidents at which an investigator should take action
3. Setting reaction level against following aspects of the accident data:
   - Number of accidents, including all injury accidents, or pedestrian injury accidents
   - Type of area unit, a junction, a kilometer of road, or urban area
   - Time period, (Between 1 to 5 years)

UK reaction levels defining black spots:

- Urban junctions with more than 5 injury accidents in previous 3 years
- Any residential area with more than 3 pedestrian injury accidents in previous year

Source: ADB (2003)


Box 5.4: Technique 3

Rate – Quality – Control Method

It is a statistical method for identifying black spots. It consists of calculating 3 different parameters for each road section.

a. accident rate

b. accident frequency

c. severity index

Each of these values is compared with a critical value. Thus the accident rate is compared with one critical value, the accident frequency with another critical value and the severity value with a third critical value. If a certain road section shows higher values than the critical ones for all these three parameters, the section is considered to be a black spot.

Source: SWEROAD, (2001)

5.5 Stages within the Process of URSA

- Feasibility stage
- Preliminary design
- Detailed design
- Construction Phase
- Monitoring (Post construction phase)

5.5.1 Feasibility stage

This stage is a desk audit where urban road safety audit is carried out before a route gets chosen. Stage looks for consistency of standards with the existing network.

Important issues that should be covered in this stage are:

1. Category of road in which the feasibility study is being carried out
2. Does the specified road category intended for high speed traffic or local needs?
3. Does the chosen road category and standards offer safety to all vulnerable road users with respect to speed and traffic density?
4. Check for appropriate design standards and geometric design
5. Check for accessibility of public transport and emergency vehicles to specified road category
6. Check for consistency of horizontal and vertical alignments with visibility requirements
7. Check for appropriate design for vulnerable road users including pedestrians and cyclists
8. Check for road safety problems based on available accident data

5.5.2 Preliminary design

This stage is desk audit. If urban road safety audit for particular area has not been undertaken, site visits should be carried out to establish if there are any particular groups of road users whose needs should be considered according to safety indicators.

Important issues that should be covered in this stage are:

1. Have all recommendations of previous stages been followed? If not, why?
2. Is desired speed compatible with other design elements?
3. Is there appropriate separation between various groups of road users?
4. Is there adequate space for all groups of road users?
5. Does proposed alignment satisfy demands on visibility at intersections?
6. Does visibility is blocked by any traffic signs, guardrails, buildings and plantations?
7. Are the lane width, medians and other cross section features based on standards design and function of the road?
8. For junctions, are crossing facilities for pedestrian and cyclists adequate and safe?
9. For junctions, does car parking creates problems?
10. For junctions, is there adequate space for all types of vehicles?
11. For pedestrians, have their needs (crossing, lighting, safety and security, pavement, pathway) being considered?
12. For pedestrians, is the layout of footpath is safety based on standards?
13. For pedestrians, are subways or footbridges in maximum use?


14. For pedestrians, does need of disabled road users provided?
15. For public transport users, are the bus stop position is safety based on standards?
16. For public transport users, does lighting is provided?
17. For public transport users, are there any factor requires specific road safety provision like maintenance?

5.5.3 Detailed design

This stage considers layout of junctions, position of signs, carriageway markings, lighting, and footpaths.

Important issues that should be covered in this stage are:

1. Have all recommendations from previous stage been followed? If not, why?
2. For visibility, confirm if standard adopted for provision of visibility in the design
3. For cross section, lighting, signs, are all safety requirements been considered?
4. For existing intersections, junctions are appropriate continuity of edge marking, provided?
5. Check for requirements for traffic measurement of construction site and safety measures for workers and road users
6. Check for design considered for needs of persons with disabilities

5.5.4 Construction Phase

This stage is a site inspection by day and at night at time of construction. Placement of, signing, lighting, etc. can be checked in site and particular attention should be given to checking that needs of all users including pedestrians, cyclists as well as motorized users.

Important issues that should be covered in this stage are:

1. Have all recommendations from previous stage been followed? If not, why?
2. Check for provision of appropriate information regarding construction zones
3. Check for adequacy of site and stopping distances at site of work and intersections
4. Check for appropriate location of bus stops and clearance from traffic lanes for safety and visibility
5. Check for appropriate provision of marked lanes for safe and clearly guiding road users
6. Check for appropriate safety provisions for elderly, disable persons, pedestrians and cyclists
7. Check for provision of suitable speed reduction measures at work zones

5.5.5 Monitoring (Post construction phase)

This stage involves monitoring a road after opening to ensure that operating is based on safety principles. It can also be used to assess whether an existing road or a road network is operating safely.

<u>Important issues that should be covered in this stage are:</u>

1. Have all recommendations from previous stage been followed? If not, why?
2. Check for appropriate operation of signs, their visibility and traffic control devices
3. Check for appropriate operation of effective lighting for pathway and crossings for vulnerable road users
4. Check for appropriate functioning of speed reduction measures
5. Check for appropriate design of medians and islands width
6. Check for appropriate operation of bus stops and visibility of bus bays
7. Check for appropriate operation of safety measures for educational facilities like hospitals and schools
8. Check for appropriate operation of safety measures for conflict between motorized and VRU
9. Check for appropriate operation of safety measures at midblock and intersections

5.6 Methodology for Design and Post-Construction stages

Urban Road safety audit here will be applied in two phases of general road safety audit procedure. First is in design phase and second is in post construction (Monitoring) phase. The checklist is prepared both for design and post construction stages. Following will explain the whole procedure for conducting urban road safety audit.

STEP 1 - Identify Audit team, responsibility and description of audit area.

Steps	Responsible
Select the audit team	Client or designer
Size of an audit team depends on the size of the audit task	
Provide background information	Designer
Hold commencement meeting	Client or designer or Audit team
Assess the documents	Audit team
Write audit report	Audit team
Hold completion meeting	Audit team and Client and Designer
Write the responses	Client and designer
Implement the changes	Designer


STEP 2 - Identification of Urban Road Safety Audit Stages

Important Note: Generally, there are 5 stages in urban road safety audit. Important issues that should be covered in each stage are briefed explained in Section 5.5. The detailed checklist is only provided for Design stage and Post construction Stage.

STEP 3 - Checklist preparation for Hotspots

Problem of urban road safety will be based on 2 complementary aspects:

- Problems based on Road type
- Problems based on Locations

Roads will be divided into 3 different types with 4 different modes

- Arterial roads
- Collector roads
- Local roads

Modes:

- Pedestrian and bicycle
- 2 Wheelers
- Public transit (Bus, or heavy vehicles like truck)
- Light vehicle (Car, Taxi, Jeep, SUV)

Each type of the roads would have a common checklist for urban road safety audit plus specific area checklist

- Arterial roads will be divided into midblock and junctions with separated lanes
- Collectors roads may or may not have separate lanes
- Local roads do not have separate lanes

To conduct an audit, 3 different points of view for each of these roads will be integrated with 12 identified indicators. Such a checklist will be used for pre and post construction.

- Pedestrian point of view
- Cyclist point of view
- Motorized vehicles point of view

Note: Defining essential indicators make it possible to differ between the each hot spot traffic safety problems and to get a fundamental decision for each spot. Such approach will allow us to define each hot spot based on its local factors.

Each of these points of views will be integrated to usual locations identified as hot spots

- Educational facilities like Schools and Hospitals
- Intersection or Midblock (Cyclists Paths, Foot paths)
- Bus stops and metro stations (Public Transit related)

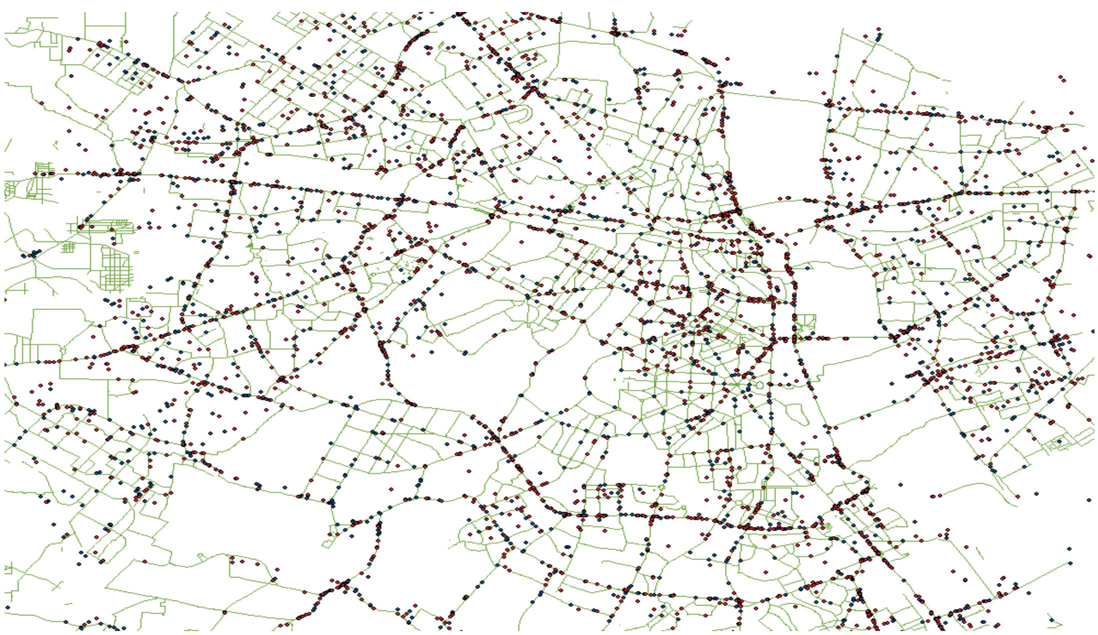
Finally, **Prepare Checklist for each site (See APPENDIX 2)**

5.7 Detail Methodology for Density Clustering for HOTSPOT using GIS

STEP 1

1. Import digital road map of study area in the data frame of the Arc Map window as “roads” layer
2. Prepare Excel sheet with all accident details taken from Police data
3. Import all data into X and Y coordinates of each accident into the GIS
4. For every point marked, a Feature Identity (FID) should be created automatically on GIS, which is a whole number

Example



STEP 2

1. At this stage the purpose would be the determination of locations where “accident clusters” or specific accident types occur. A cluster is defined as a group of crashes that is in relatively close proximity to a single location (point) or corridor (line).

2. "Neighbouring" feature is within the specified distance of the target feature, then that pair will be assigned a weight of 1; else, the pair will be assigned a weight of 0. Then, the statistic is calculated as follows:

STEP 3

Hot-spot analysis was done for major roads to see the sections of road where there is clustering of accidents. This tool identifies statistically significant spatial clusters of high values (hot spots) and low values (cold spots).The Hot Spot Analysis tool calculates the Getis-OrdGi statistic (pronounced G-i-star) for each feature in a dataset. The resultant z-scores and p-values tells where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighboring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbours is compared proportionally to the sum of all features; when the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, statistically significant z-scores results.

It creates a new Output Feature Class with a z-score and p-value for each feature in the Input Feature Class.

A high z-score and small p-value for a feature indicates a spatial clustering of high values. A low negative z-score and small p-value indicates a spatial clustering of low values. The higher (or lower) the z-score shows the more intense the clustering. A z-score near zero indicates no apparent spatial clustering.

The G-statistic is calculated using a neighbourhood based on a distance that we specify. If the "neighbouring" feature is within the specified distance of the target feature, then that pair will be assigned a weight of 1; else, the pair will be assigned a weight of 0. Then, the statistic is calculated as follows:

$$G(d) = \frac{\sum_{i}\sum_{j} w_{ij}(x_i)(x_j)}{\sum_{i}\sum_{j}(x_i)(x_j)}$$

where xi = the measured attribute of interest at location i

xj = the measured attribute of interest at location j

wij = a weight indexing the location of i relative to j (this is 1 if locations i and jare within the distance you specified and 0 if not)

Box 5.5: Hotspot selection - Getis-OrdGi an ArcView toolbox

> The Hot Spot Analysis (Getis-OrdGi*) tool (ArcToolbox) - Spatial Statistics - Mapping Clusters) calculates the GetisOrdGi* statistic for each feature in a dataset. The resultant Z score tells you where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighbouring features. A feature with a high value is interesting, but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value & be surrounded by other features with high values as well. The local sum for a feature & its neighbours is compared proportionally to the sum of all features; when the local sum is much different than the expected local sum, & that difference is too large to be the result of random chance, a statistically significant Z score results.
>
> **Interpretation**
>
> The Gi* statistic returned for each feature in the dataset is a Z score. For statistically significant positive Z scores, the larger the Z score is, the more intense the clustering of high values (hot spot). For statistically significant negative Z scores, the smaller the Z score is, the more intense the clustering of low values (cold spot).

Source: Getis and Ord (1992) and Mitchell (2005)

STEP 4

1. Polygon features around the road should be created by giving defined buffer on both sides of centerline of the road.
2. Spatial join tool should be used to count the number of accidents in each polygon.
3. The resultant field containing the number of accidents in each polygon becomes the Input field for analysis
4. Fixed distance band option should be chosen for spatial relationship
5. Threshold distance or distance band chosen should be defined in meters for analyzing the features within distance
6. The output of the Gi function is a z score for each feature. The z score represents the statistical significance of clustering for a specified distance

STEP 5

Map would represent the critical sections of the road based on clustering of accidents.

All types of Roads can be included in Hot spot analysis based on scope of study like Arterial, sub-arterial, collector roads and minor roads

1. Accident locations can be identified now
2. Accuracy of location of accidents is critical and depends on data available.

Example

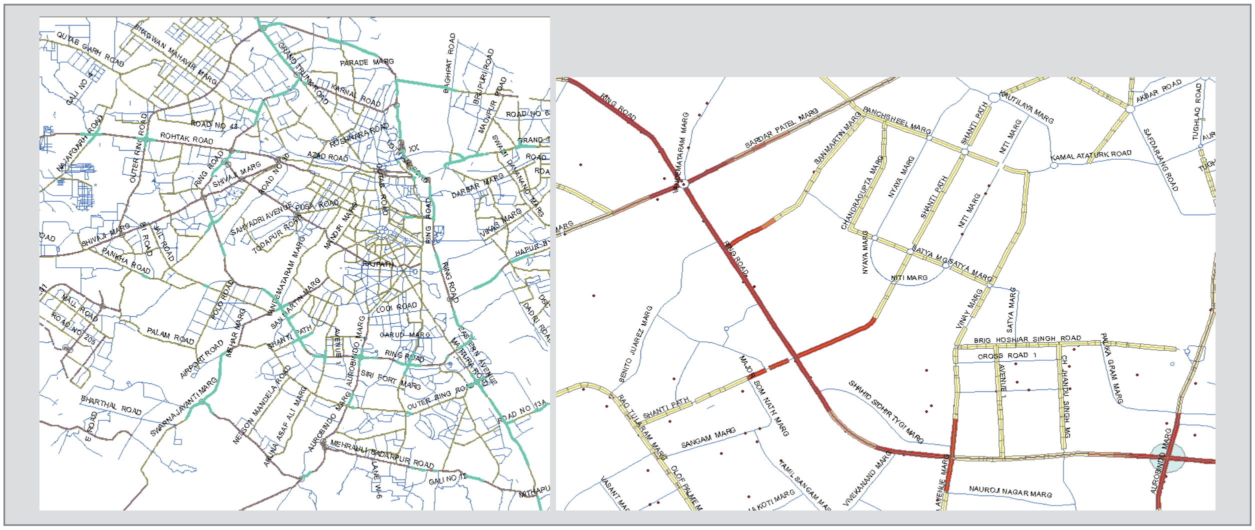
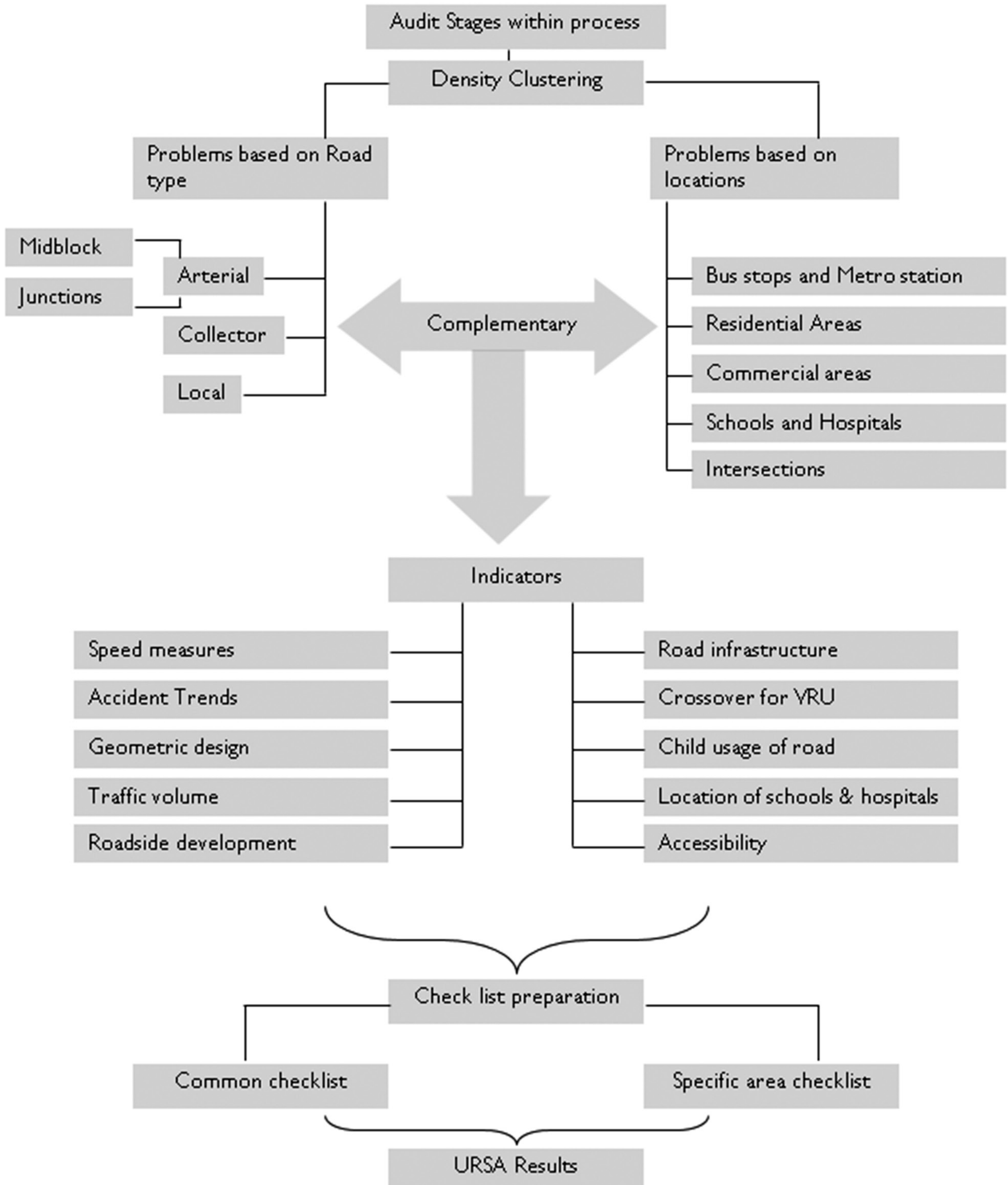


Photo (left) - Critical Road sections for pedestrian accidents and Photo (Right) - Critical Road sections for pedestrian accidents

5.8 Methodology for URSA



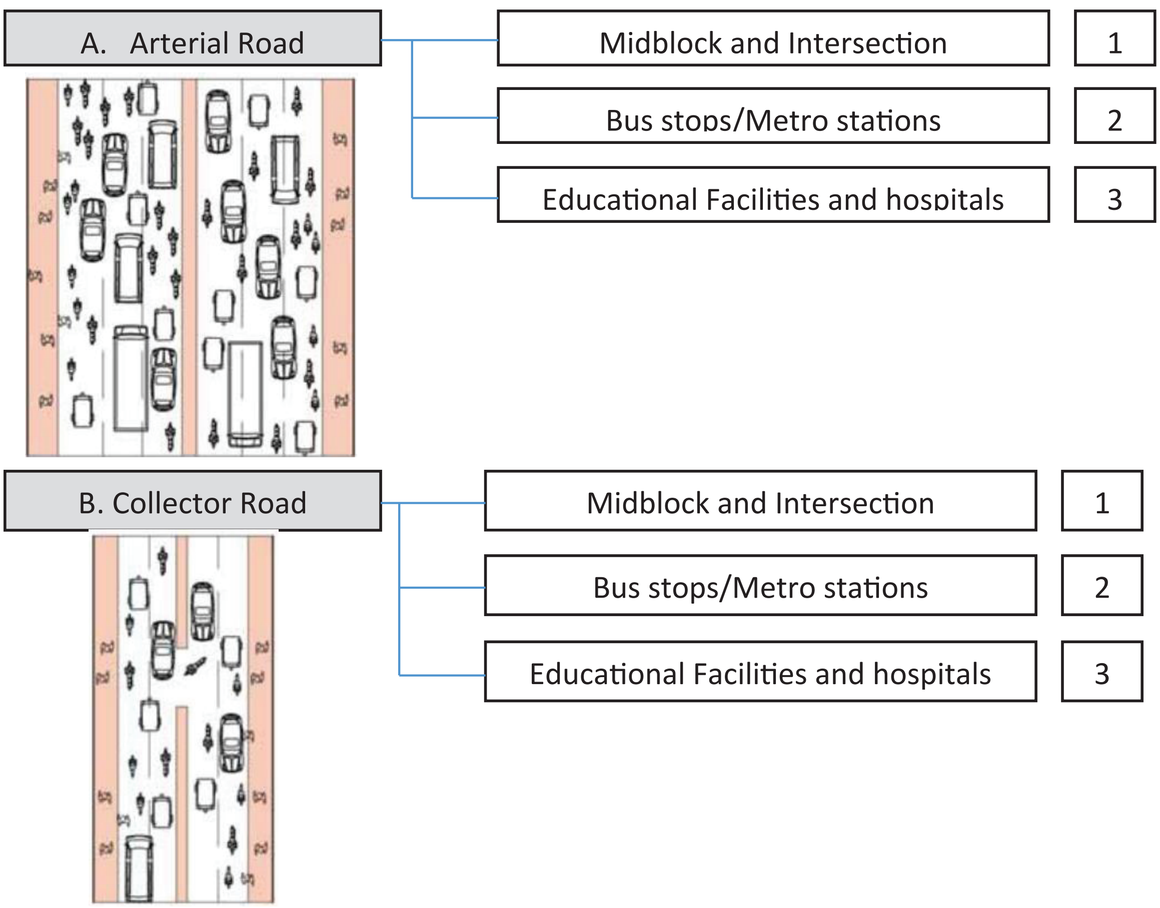
Chapter 6

Implementation (Checklist Preparation)

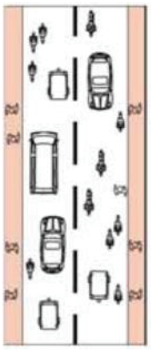
6.1 Integration of Road Types and Locational Points of View

Roads are divided into three types; (A) type as Arterial roads, (B) type as Collector roads and (C) type as Local roads.

Figure 6.1: Facilities to be audited for arterial, collector & local roads.



C. Local Road



Midblock and Intersection	1
Educational Facilities and hospitals	2

6.2 Checklist Preparation Procedure

1. Identify objective of your urban road safety audit in an urban arterial, collector or local roads
2. Collect the data required for audit using indicators list
3. Start filling the checklist
4. Start evaluating the Scores based on weightages
5. Identify problems and recommendations for particular hotspot in urban area

6.2.1 After identification of Critical Road sections, collect the data required for audit using identified indicators

- Traffic Volumes
- Pedestrian Volumes
- Location Map of Key Pedestrian Generators or Nodes (i.e., schools, Hospitals, parks)
- How is the Traffic Control at specified Locations
- Pedestrian Collision - Collision History, and Collision Reports
- Aerial Photographs of specified Locations
- Speed Limits and Speed Surveys
- Future Planned Improvements Public and Private (Commercial, Residential, and Business)
- Inventory of Missing Sidewalks, Informal Pathways, and Pedestrian Opportunity Areas
- Key land use features that influence crossings
- Location of bike lanes


6.2.2 Define your area:

- **Arterials** emphasize mobility for through movements over long distances
- **Collectors** offer approximately balanced service for both mobility and access
- **Local** road emphasize the access function

6.3 Technical Notes for Checklists:

6.3.1 Speed measures for arterial, collector and local roads

Most traffic engineers believe that speed limits should be posted to reflect the maximum speed considered to be safe and reasonable by the majority of drivers using the roadway under favourable conditions. Procedures used to set speed limits have evolved through years of experience and research. Most States and localities set safe and reasonable maximum speed limits based on the results of an engineering and traffic investigation. While all States and most jurisdictions use the 85th percentile speed as a major factor (n) selecting the appropriate speed limit for a given street , other factors such as roadside development, accident experience, and design speed are often subjectively considered. (ADB, 2009)

Technical Note 1: Speed is one of the most urgent problems of urban road safety. It is a complex road safety indicator. Both excessive speed (exceeding the posted speed limit) and inappropriate speed (faster than allowed by the prevailing conditions) are important accident causation factors. It can be measured as percentage of roads within city limits having speed limit exceeding 50km/hr. for arterial road, 30 km/hr. for collector road and < 30 km/hr. for local roads. These roads are more prone to accidents in urban areas. Furthermore it is 20 km/hr near schools or hospitals.

Technical Note 2: Where to measure speed?

Locations for speed measurement are infinite because speed of a vehicle varies along its journey constantly. Therefore it is required to define a sampling procedure to help select a restricted set of locations that can produce speed data that are representative for bigger parts of the network. However, road characteristics are so variable that it is not meaningful to set as objective computing indicators that are representative of whole road network. Roads should display some specific characteristics in terms of road design to be suitable for speed measurements. Furthermore, different speed indicators should be computed for different classes of roads.

Road design characteristics and the surrounding environment influence speeds at which drivers operate their vehicles. In order to ensure reliability and comparability of speed data, the locations at which speed measurements are carried must be chosen carefully. **All places where vehicles are likely to stop accelerate or brake, should be avoided.** In order to obtain measures of speed in reasonably good conditions, the first thing to do is to avoid measuring speed where and when congestion is most likely to occur.

Technical Note 3: Road types

Operating speed which is the speed at which a vehicle is driven on a road is highly dependent on the characteristics of this road, including its posted speed limit and its design speed. The relation between road design and operating speeds is complex to define. TRB (2003) lists several design variables that influence operating speed, including the access density, median type, parking along the street, pedestrian activity level, curvature, grade, lane width and roadside developments. But even for a given design speed, there is a variability in driven speeds. Aggregating measures of speed taken on different roads with very

different designs is not meaningful. Furthermore Separate road types should be defined based on their design characteristics and compute separate indicators for separate road types.

Technical Note 4: Traffic conditions have a significant impact on the speeds at which drivers operate their vehicles. Similarly, a vehicle's speed depends on the traffic density

Technical Note 5: Selection of relevant data

Data which are collected during congested traffic conditions or during bad weather should be removed from the dataset.

Box 6.1: Effects of speed on crashes and crash severity

- The higher the speed of a vehicle, the shorter the time a driver has to stop and avoid a crash.
- A car travelling at 50 km/h will typically require 13 meters in which to stop, while a car travelling at 40 km/h will stop in less than 8.5 meters.
- An average increase in speed of 1 km/h is associated with a 3% higher risk of a crash involving an injury.
- In severe crashes, an average increase in speed of 1 km/h leads to a 5% higher risk of serious or fatal injury.
- For car occupants in a crash with an impact speed of 80 km/h, the likelihood of death is 20times what it would have been at an impact speed of 30 km/h.
- Pedestrians have a 90% chance of surviving car crashes at 30 km/h or below, but less than a 50% chance of surviving impacts at 45 km/h or above.
- The probability of a pedestrian being killed rises by a factor of 8 as the impact speed of the car increases from 30 km/h to 50 km/h.

Source: Peden M et al. (2004)

6.3.2 Accident measures for arterial, collector and local roads

Technical Note 6 The amount and level of severity of road accidents on sections of the road network depend on average daily traffic volumes and the traffic composition, the design features (cross section, junction type and form, and alignment), the roadside furnishings (roadside design, traffic sign, protective facilities, traffic installations and markings), the road condition (structure and surface condition), and the roadside environment (lateral obstacles. The level of safety of the road section is defined by the accident rate and accident cost (World Road Association PIARC Technical Committee, 2007).

Technical Note 7: The Accident Rates is defined as the average number of accidents along a road section with a 'kilometrage' of 1 million vehicle km (World Road Association PIARC Technical Committee, 2007). The Accident Cost Rate is defined as the corresponding average costs to the economy as a whole, as the result of road accidents which have occurred along this road section with a 'kilometrage' of 1000 vehicle km (World Road Association PIARC Technical Committee, 2007).


6.3.3 Educational facilities

Technical Note 8: Road design and the general environment in which roads are constructed have a strong influence on road safety.

- Important attributes of road environments and user movements that is particularly important to providing safety in the vicinity of schools:
- Traffic speeds should be low – desirably 20km/h or less during school hours (the road configuration and geometry should be such that it creates the expectation of a low speed environment).
- Access to schools should be from local roads and access from high speed roads should be avoided as far as possible.
- Parking should be adequate and appropriate to the location to allow safe picking up and setting down of children (sufficient parking has to be provided by schools for staff, casual and parent assistants and visitors to ensure that there is no overflow impact on pick up and set down requirements).
- Paths (footpaths and shared paths) should be provided on the school side of the road for children walking and cycling to and from school, bus stops and places where they are picked up or dropped off.
- Roads should generally be free from high levels of congestion.
- Traffic circulation should be enhanced by treatments that encourage vehicles to travel in a direction that enables dropping off and picking up on the school side of the road.
- Sight lines for drivers to see children and be seen by children should be clear at intersections and all places where children might cross a road.
- Road crossing places for children should be safely located and adequately signed.
- Attention should be given to ensuring visibility is adequate for drivers to safely enter and leave parking areas and see children on intersecting paths.
- All pedestrian and bicycle access ways should be free from visibility constraints.

6.3.4 Bus stops, Metro stations

Bus stop checklists are commonly used to inventory bus stops and roadway characteristics

- Sidewalk presence and condition near the bus stop
- Roadway crossing treatments near the bus stop (crosswalks, pedestrian signals, pedestrian push-buttons, pedestrian signal timing, and audible warning signals)
- Path of access between the sidewalk and bus stop boarding area
- Readability of bus stop signs, Bus stop shelters and seating
- Obstructions at bus stop
- The share of intersections per type (roundabout, signalized T-junction)
- Intersection density (City)
- Percentage of road length with bicycle facilities
- Percentage of road length with pedestrian facilities
- Percentage of the road network satisfying the safety design standard
- Safety hazards by infrastructure layout and design

6.3.5 Intersections

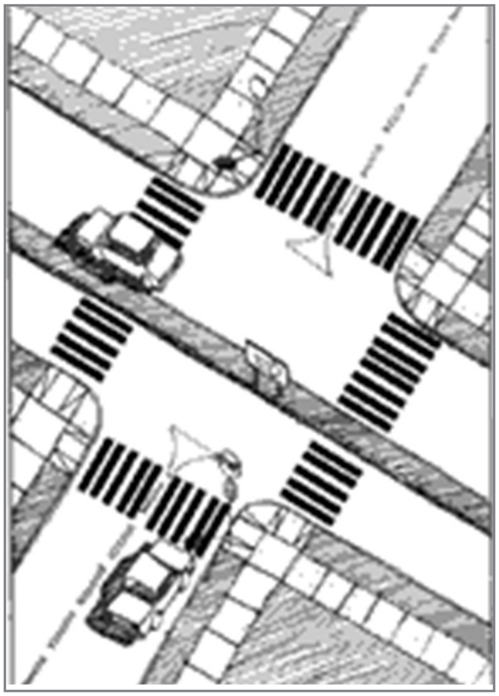
An intersection is a planned point of conflict in the roadway system. With different crossing and entering movements by both drivers and pedestrians, an intersection is one of the most complex traffic situations that motorists encounter. Dangers are compounded when we add the element of speeding motorists who disregard traffic controls. (Source: The Federal Highway Administration; http://safety.fhwa.dot.gov/intersection/vuln_users/)

Signalized intersections

At signalized intersections and midblock crossings, the vehicle stop line can be moved farther back from the pedestrian crosswalk for an improved factor of safety and for improved visibility of pedestrians. In some places, the stop line has been moved back by 4.6 to 9.1 m (15 to 30 ft.) relative to the marked crosswalk with considerable safety benefits for pedestrians. Advanced stop lines are also applicable for non-signalized crosswalks on multi-lane roads to ensure that drivers in all lanes have a clear view of a crossing pedestrian.

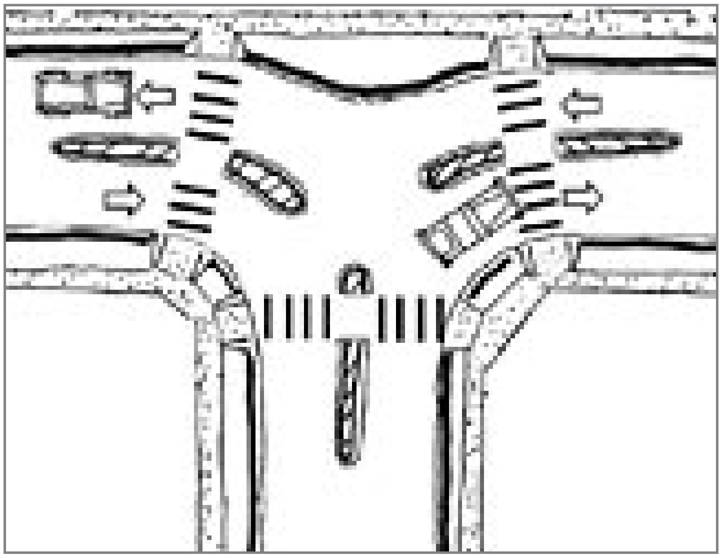
Intersection Median Barriers

This shortened version of a raised curb median extends through the intersection to prevent cross-street through movements and left turning movements (right turn in case of India) to cross-streets from the main street.This treatment can benefit pedestrians who need to cross any leg of the intersection, but restricts vehicle entry into and out of neighbourhoods and can therefore greatly reduce cut-through traffic. However, since this treatment can dramatically influence traffic patterns and have potentially negative consequences caused by shifting traffic, it should be used cautiously.



Modified T-Intersections

This design treatment is intended for certain T-intersections on lower-volume streets in residential areas where there is a need to reduce the speeds of through traffic. It involves a gradual curb extension or bulb at the top of the T, such that vehicles are deflected slightly as they pass straight through the intersection (see diagram). This type of design can help to discourage cut-through traffic in a neighbourhood and can reduce speeds at the intersection.



6.3.6 Geometric design

The crucial elements in geometric design for Improvements for Urban Road Safety (Source: Great Britain, 1994) are as follows:

Design speed

Roads are designed according to a ‘design speed’ which is constant for a given stretch of roadway. Thus a vehicle must be able to comfortable and safely travel the length of a given stretch of road at the design speed

Super elevation

Super elevation is the rotation of the pavement on the approach to and through a horizontal curve. Super elevation is intended to assist the driver by counteracting the lateral acceleration produced by tracking the curve. Inadequate super elevation can cause vehicles to skid as they travel through a curve, potentially resulting in a run-off-road crash. Trucks and other large vehicles with high centers of mass are more likely to roll over at curves with inadequate super elevation.

Widening of curves

Transition curves

A transition curve differs from a circular curve in that its radius is always changing. Circular curves are limited in road designs due to the forces which act on a vehicle as they travel around a bend. Transition curves are used to introduce those forces gradually and uniformly thus ensuring the safety of passenger. Although transition curves can reduce the effect of radial force on a vehicle this can also be further reduced or even eliminated by raising one side of the road relative to the other.

Annexure

1. Introduction to State of the Art

The international development of the road safety audit resulted in a number of guidelines, supported by audit checklists and audit procedures being implemented and tested in different countries, but only for highway projects or rural areas. UK, New Zealand, Australia and Denmark are some of these countries. In India also road authorities are responsible for safety of their road design, rehabilitation and improvement operations. As a result, they should apply safety principles in all of their road projects as a means of accident prevention and safety of their vulnerable road users.

Vulnerable road users dominate, with pedestrians being the most vulnerable group, bicyclists, and motorized two-wheeler riders who are accounted for 60-90% of all traffic fatalities in India which is increased by about 5% per year from 1980 to 2000, and since then have increased by about 8% per year for the four years(Tiwari, 2011)In European countries, vulnerable road user fatalities are accounted for 36% of all road deaths(ETSC, 2005). Since, urban road networks contribute to a significant proportion of countries' national road traffic crash problem, safety considerations and identification of safety performance indicators in urban areas would become the priority at starting of any phases of projects; requiring RSA to complete a comprehensive traffic safety study. The logic behind RSA specific for urban areas has been detailed by(AECOM, 2011). The logic defines its rational with objective of reinforcing motorist's speed considering vulnerable road users and accidents.

2. International Review on Road Safety Audit

To identify Urban Road Safety indicators, two different approaches are considered. Part 1 looks into different road safety audits, conducted by different countries and Part 2 looks into different reports from different authorities for road safety audit.

Chapter 1 - Country case study

Chapter 2 - Different aspects for Road Safety Audit

2.1. Malaysia Road Safety Audit

Government policy

Currently Malaysian's strategies to reduce disabilities from injuries and accident are accident reduction and prevention; and injury reduction. Accident reduction and prevention involves the application of "Three Es": education, engineering and enforcement whereas injury reduction involves the application of appropriate safety policies, vehicle and road engineering approaches, and medical and trauma management.

Primary data	Indicators	
Population	Road fatalities, serious injuries, road accidents	Deaths per 100,000 people
Vehicle Registered		Deaths per 10,000 vehicles
Vehicles involved in road accident	Road accident deaths of children less than 5 years	
Road length	Fleet safety records of public or private organization	Deaths/100,000 km
Number of Accidents	Death Rate per 10,000 vehicles and per 100,000 people	Fatal Injury
Casualties (Death, Serious, Slight)		Serious Injury
		Light Injury
	Pedestrian deaths rate	per 100,000 people
		per 10,000 vehicles
	Motorcycle deaths	(per number of motorcycles)
	Type of Accidents	Fatal accidents
		Fatalities
		Serious accidents
		Hospitalized
		Slight
		Minor Injury

Source: ESCAP 2010,WHO2004

2.2. Turkey Road Safety Audit

Government policy:

1. To have divided highway network for 36.500 km (%52) (includes motorway) under the scope of Emergency Action Plan.
2. Removal of black spots on roads and to improve the conditions of the black spots.
3. To build infrastructure projects that contains traffic fatalities under 1 per 100 million vehicle-km.
4. To apply safer road design countermeasures that promotes forgiving roads.


5. To set up emergency stations for ambulances along roadside to reach the accident points as soon as possible.

Source: National Traffic Safety Program, Road Improvement and Traffic Safety Project, Ministry of Interior, Ministry of National Education, Ministry of Public Works and Settlement, Ministry of Health, GaziUniversity, 2011

Primary data	Indicators	
Total Accidents	Pedestrian deaths	per head of population
Total Fatalities		per 10,000 vehicles)
Total Injured	Motorcyclist deaths	per number of motorcycles
Number of passenger cars, buses	Road accident deaths of children less than 5 years	
Number of trucks, motorcycles, 3-wheelers	Numbers of the drivers with alcohol	Rate over than % 0.50
	Rate over than % 0.50	

Source: PWS (2006)

2.3. Sweden Road Safety Audit

Primary data
Compliance with speed limits, national road network
Compliance with speed limits, municipal road network
Safe national roads
Use of seat belts
Sober traffic
Use of helmets
Safe vehicles (Safe passenger cars, Safe heavy vehicles, Safe motorcycles and mopeds)
Safe municipal streets (Safe pedestrian, cycle and moped passages in urban areas)
Safe crossings in urban areas
Quick and qualitative rescue
High valuation of road safety

Indicators
Number of fatalities on the roads
Number of persons seriously injured on the roads
Percentage of traffic volume within speed limits, national road network
Percentage of traffic volume within speed limits, municipal road network
Percentage of traffic volume with sober drivers
Percentage of those wearing a seat belt in the front seat of passenger cars
Percentage of cyclists wearing a helmet
Percentage of new heavy vehicles with automatic emergency braking system
Percentage of safe pedestrian, cycle and moped passages in the municipal road network
Percentage of safe crossings in main municipal road network for cars
Valuation of road safety index
Percentage of traffic volume on roads with speed limits of more than 80 km/h & median barrier

Source: TRAFIKVERKET (2010)

2.4. Germany Road Safety Audit

Primary data	Indicators
Identifying 3 different accident severity	Serious injury accidents
	Slight injury accidents
	Property damage only accidents
Accident density	Number of accidents per km of road per year
Accident cost density	Total societal cost of accidents per km of road per year
Accident rate	Number of accidents per million vehicle-km of travel
Accident cost rate	Societal cost of accidents per million vehicle-km of travel

SOURCE: TOI (2007)


3. Aspect 1: Characteristics of Road Safety Audit

- Safety audits are not technical audits - they are only concerned with road safety and they do much more than check on compliance with standards
- Safety audits are not informal checks or design reviews - these may still be useful
- Safety auditors will not redesign aspects of the scheme that they consider to be unsafe - this is the responsibility of the designer
- Safety audits are not just for big schemes - even small projects can give rise to serious safety problems
- Safety auditing helps sensitize road engineers to safety issues, and feedback from audits will lead to improved design standards
- Final responsibility for changing the design rests with the client - it is not necessary for the client to have the agreement of the auditor or the designer.

4. Aspect 2: Identification of Safety Principles

1. Principles of Road Safety: Road users and their behaviour as a part of road accidents and requirement to identify different groups of road users (Vulnerable road users (VRU)); pedestrians and cyclists, especially in urban areas
2. Geometric Design having special influence on road safety including Access control (entry to a roadway of traffic); Cross-section (includes the carriageway or roadway, shoulders, kerbs,

   Drainage features, and cut and fills batters); Horizontal and vertical Alignment (Vertical curves and gradients) and design of junctions.
3. Road Surface Characteristics
4. Pavement markings, vertical signs, and delineation
5. Intersections (different road users (vehicles, pedestrians, cyclists) are required to use the same space)
6. Restraint Devices
7. Provision For Vulnerable Users
8. Traffic control during construction
9. Illumination (introduction of adequate street and road lighting)
10. Drainage

Source: (Rodrigues and Bezerra, 2005)

5. Aspect 3: - Factors that Contribute to VRU Crashes

NZTA(2010) defined Vulnerable Road Users as pedestrians (including persons on skateboards, roller-skates, foot scooters and using mobility aids such as powered wheelchairs), cyclists and motorcyclists (including mopeds). To identify road safety issues for Vulnerable Road Users NZTA, 2010 specified following requirements:

- Numbers and trends in reported crashes and casualties
- Characteristics and types of crashes and casualties
- Factors contributing to crashes
- Locations with bad crash records
- Characteristics of crashes on council authority roads

These requirements in detail are:

1. Crashes per 100 million vehicle kilometers travelled for Cyclists, Pedestrians and Motorcyclists
2. Casualties per 100 million vehicle kilometers travelled for Cyclists, Pedestrians and Motorcyclists
3. Crashes per 10000 people VRUs
4. Casualties per 10000 people VRUs
5. Social cost of crashes in VRUs
6. The social costs of a road crash and the associated injuries include a number of different elements:

- Loss of life and life quality
- Loss of output due to temporary incapacitation
- Medical costs
- Legal costs
- Property damage costs

7. Fatal crash and casualty numbers
8. Serious crash and casualty numbers
9. Minor crash and casualty numbers

In other study of **Lancashire County Council, Study over Vulnerable Road Users** LCC, (2007) aim was increasing awareness of the needs of VRU to ensure they are adequately taken into consideration and catered for in the design process of highway and transportation schemes. They structured the study into Defining VRU, VRU Audit and its purpose, policies that should be taken into consideration to reduce the accidents and summarizing VRU Audit process. Based on their definition, VRU are anyone who is using the road network who is not within a car, lorry or other large vehicle.

VRU Audit Procedure:

- Audit should be undertaken at the start of the key stages of the design process of a project
- The scheme design should be cross referenced with a series of checklists to ensure that Vulnerable Road Users have been considered within the design process
- When the design has been completed it should be forwarded to the Safety Engineering Group for the appropriate stage of Road Safety Audit (RSA).
- At the start of each VRU audit the auditor should review the previous VRU audits to ascertain whether there are any outstanding issues or not.
- VRU Auditor should be aware of the latest Health and Safety Issues

Source: NZTA (2010) and LCC, (2007)

Box 5-1: Road Safety Performance in the Russian Federation

- Road deaths and pedestrian deaths versus fleet number of motor vehicles
- Fleet number of motor vehicles versus population
- Road deaths and crashes per 10,000 vehicles and death per 100,000 population
- Socio-economic cost of road traffic crashes
- Road deaths by different types of road user (Pedestrians, Truck drivers and passengers, Motorcycle drivers and passengers, Car drivers and passengers, Bus drivers and passengers and Cyclists)
- Trends in road crashes, deaths and Injuries
- Mortality Rates from Road Traffic Injuries per 100,000 population
- Intermediate outcomes: e.g. speed levels, excess alcohol, seat belt use
- Speed, Drinking and driving, Seat belt use, Safety quality of vehicle fleet
- Institutional outputs: e.g. numbers of breath tests, number of speed and seat belt checks

Required interventions:

- Planning, design, operation and use of the road network
  - Speed management:
  - High-risk sites
  - Safety audit
  - Excess alcohol
  - Seat belt use
- Entry and exit of vehicles and users
  - Vehicle standards
  - Driver/ rider licensing, testing and training
- Recovery and rehabilitation of victims

Source:OECD (2011)

6. Aspect 4: - Items that should be provided to Road Safety Audit Team

- Design Brief
- Departures from Standard
- Scheme Drawings
- Other scheme details, e.g. signs schedules, traffic signal staging
- Collision data for existing roads affected by the scheme
- Traffic surveys
- Previous Road Safety Audit Reports
- Designer Responses /Feedback Form
- Previous Exception Reports
- Start date for construction and expected opening date

Source: NRA (2009)

7. Aspect 5: - Factors that Contribute to Pedestrian Crashes

Table below explains the factors that are effective in crashes of pedestrians that includes behavioral, location, physical and access factors.

Behavioral Crash Factors	behavioral typing of crashes to gain a beer understanding of potentially hazardous behaviors of both drivers and pedestrians
Location Factors	locations where pedestrian crashes may occur
	At an intersection (where pedestrian is crossing).
	At a midblock location (where pedestrian is crossing).
	Along the road (where pedestrian is not trying to cross).
	Not in the roadway.
Physical Crash Factors	The physical qualities of the roadway and pedestrian network may affect pedestrian safety
	Vehicle Speed—The geometric design of streets
	System Connectivity (or lack of a system altogether)
	Pedestrian activity may make it necessary to provide sidewalks along both sides of the road - All pedestrian facilities should be continuous, consistent, and connected along direct routes to major pedestrian traffic generators
Crossings	Compared to motorists, pedestrians are often exposed to greater risks of injury, and risks increase in relationship to motor vehicle speeds.
Transit Stop Placement	A well-planned transportation network can use intersection elements to reduce the potential conflicts while accommodating all modes.
Access Management	Vehicles turning into and out of driveways will conflict with pedestrians walking along roadways, presenting opportunities for crashes.

Source: OECD (2011)


Annexure 2

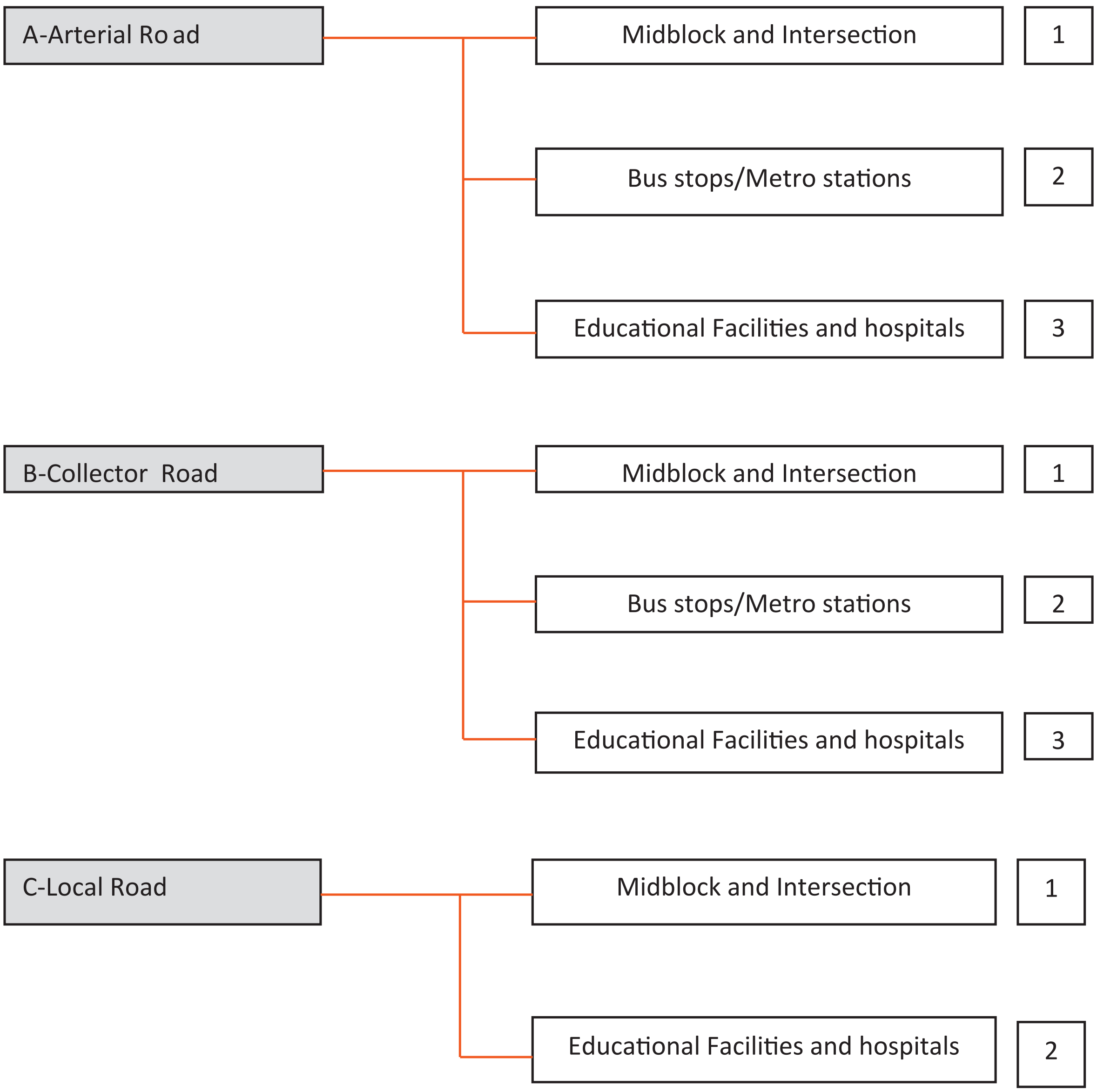
General Instructions

- Familiarize yourself with the route/corridor to be audited.
- Conduct accessibility audits, on the relevant mode of travel. That is accessibility to pedestrian surveys are to be done after covering the service area on foot and similarly accessibility to cyclist survey should be done after covering the relevant service area on a cycle.
- It may be helpful to take photos of the deficient element to document your findings on the checklist.
- Maintain a log of all photographs taken by noting the photograph number on a sketch of the facility layout.
- Organize your checklists in the order that you will encounter elements along the route. If you are doing the audit on paper, make sure you have enough copies of each of the spreadsheets.
- You require 5 copies for “Footpath and Pedestrian accessibility” audit for one side of road. It means for each approach you need 10 copies in all.
- You require 3 copies for “Cyclist accessibility” auditfor one side of road.
- Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the point of observation (i.e. either intersection or midblock etc.) for “Footpath and Pedestrian accessibility” audit.
- Audit is to be repeated every 300 meter on a 1500 meter stretch on the selected road starting from the point of observation (i.e. either intersection or midblock etc.) for “Cyclist accessibility” audit.
- Though the checklist may be completed at any time of day, certain audits like security of cyclists and pedestrians should be conducted at late evenings or the night time.
- You will require equipment such as Speed gun, Measuring Tape/ Measuring Wheel.
- While doing survey,if for example,cycle track is absent then its score will be zero out of total. It will not be a “not applicable” case.
- The Following checklists are for urban road safety audit for post construction phase. The part of checklists where is coloured in **Grey** will be used for design phase of road safety audit.
- It is recommended to go through the check lists to be used before going for audit.

Checklist description

- The checklist is basedon type of road and area which needs to be audited as shown in Figure 1.
- For example, (a) If you want to audit an intersection on arterial road, go to checklist number A-1. (b)If you want to audit Educational facilities and hospitals on local road then choose the checklist number C-2.

Figure 1: Facilities to be audited for arterial, collector and local roads




Read before starting audit using Checklists

What to assess in this checklists

Speed

- Exceeding speed limit results in unsafe conditions. Speed limit signage, traffic calming measures are required to control speed.

Traffic volume

- It is required to understand proportion of different users present on the road which has influence on specific infrastructure requirements. For example, pedestrian crossing facilities etc.

Pedestrian, cyclist and motorist safety

- Pedestrians are mostly concerns about shortest path; they are not willing to wait beyond 60 seconds at signalized junctions. Cyclists mostly look for continuity and riding quality of road surface. Both for pedestrian and cyclist security (Crime) is important. They avoid lonely and poorly lit places.

- For motorized vehicles, any trees, side railing, raised median (more than 150 cm) or any vertical objects etc. is a hazard.

Road geometry for pedestrian, bicyclist and motorist

- Minimum pedestrian and cyclists geometric design requirements should be meet. For motorized vehicles, horizontal and vertical curves should be designed for safe speed limits.

Bus stops/stations

- Bus stops require because of large number of commuter’s boarding and alighting. Specific checklist is provided to look into safety of bus stops or metro stations.

Educational facilities

- Educational facilities are required because of presence of children and teenagers. Specific checklist is provided to look into safety of educational facilities.

How is the scoring of checklist

- Each section of checklist has a total scoring and at the end overall score can be calculated. Different indicators are given weights to calculate the overall coring. Further instructions on how to do scoring is providedlater.

Weightage of indicators

Access Mode Type	Weight
Speed	4
Footpath and Pedestrian accessibility	4
Cyclist accessibility	3
lighting	3
signage	2
Motorized vehicles safety	1
Intersections and Midblock	1

Guide to the way problem would be identified after area is audited

- Problem areas can be identified based on overall scoring of problem location or can be evaluated based on total score of audit.

Example 1:

Identified Problem area: Pedestrian footpath near intersection at arterial road

Identified Victim: Non-Motorized vehicles / Pedestrians

Summary of problem: The footpath alignment may still attract pedestrians to cross at a location with limited visibility. Location is attractive to pedestrians crossing the intersection. There is limited visibility due to poor lighting of footpath and lighting of intersection.

Recommendation

Modify landscaping, increase lighting at the edge of the bypass based on standards.

Example 2:

Identified Problem area: Approach to road junction nearby school

Identified Victim: Non-Motorized vehicles / Pedestrians

Summary of problem: The road layout on the approach to the junction does not speed down the vehicles. Traffic speeds are likely to be high. Speed limit signs are not provided. The current design does not adequately address these issues.

Recommendation

Provide "SLOW" carriageway markings on the approaches to the junction from both directions to moderate speeds through the junction.

Reposition the speed sign approximately 150m from the junction to warn traffic travelling at higher speeds.

Arterial Road and Midblock/Intersection Checklist – A1

Checklist A - 1

A. Arterial Road	Midblock and Intersection	1
	Bus stops/Metro stations	2
	Educational Facilities and hospitals	3

Important issues for Arterial roads

- Audit is to be conducted in all approaches of the junction in both directions
- Service road is required
- Signage for pedestrians and cyclists for arterial roads are required
- Bicycle track and pedestrian pathway for arterial roads are required
- Arterial Road speed limit is 50 km/h

Audit area

Intersection: All approaches for 100 m (for 4 way junction 4 approaches, etc.)

Midblock : One road to be audited (Both sides)

Audit Stage

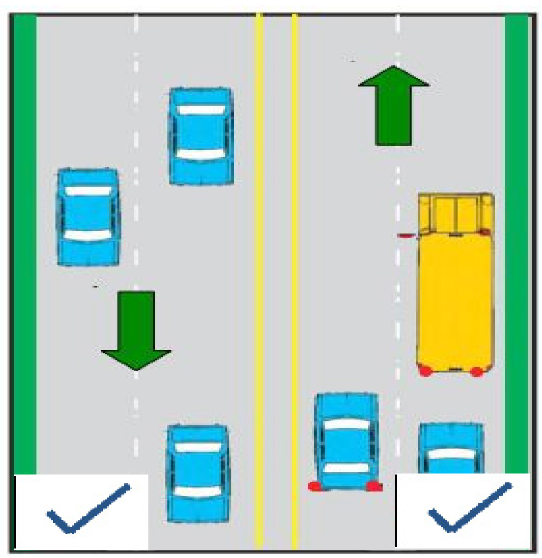
Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Important Notes

- **Audit area :** For 100m

Intersection (on all approaches both sides for 100m)



Midblock (on both sides for 100m)

- **<u>Equipment Required</u>**

Speed gun, Metallic tape/Measuring Wheel.

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist A – 1.1 – Speed and Hourly Volume Measure

Note 1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/ 3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 40 km/h	40-60 km/h	> 60 km/h		
	Truck		< 40 km/h	40-60 km/h	>60 km/h		
	Bus		< 40 km/h	40-60 km/h	> 60 km/h		
	LCV		< 50 km/h	50-70 km/h	> 70 km/h		
	Car/Jeep		< 50 km/h	50-70 km/h	> 70 km/h		
	Auto Rickshaw		< 50 km/h	50-70 km/h	> 70 km/h		
	Scooter/Motor cycle		< 50 km/h	50-70 km/h	> 70 km/h		
Total							

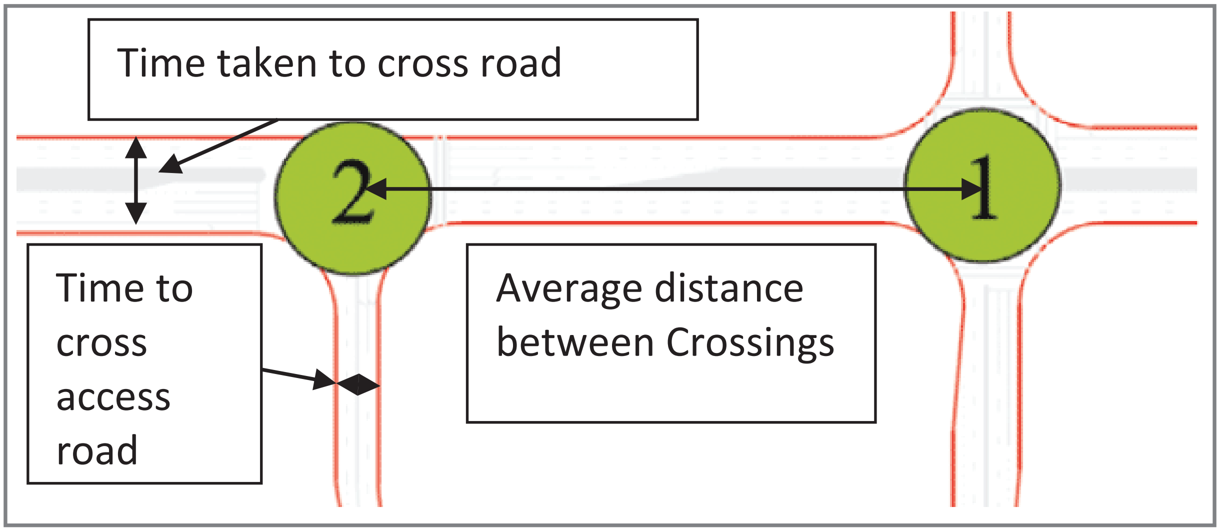
Score for Speed =Total of cells in column (C) / 7

Checklist A – 1.2 - Footpath and Pedestrian accessibility

Instructions

1. Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.
2. Audit is to be conducted in both directions on the route selected.

Explanation of Indicators



Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A) X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Arterial and Sub arterial roads: 1.8 to 5.0m	Arterial roads: 1.5 - 1.8m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Arterial Roads: Maximum < 100mm (4”)	Arterial Roads: 100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		


Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges without elevators or completely covered subways without proper lighting		

Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist A – 1.3 – Cyclist accessibility

- Audit is to be repeated every 300 meter on a 1500 meter stretch on the selected road starting from the point of observation (i.e. either intersection or midblock etc.) for "Cyclist accessibility" audit.
- Audit is to be conducted in both directions on the route selected.

Explanation of Indicators

Lighting after dark (Visibility to ride after dark)


Cyclist accessibility

Indicators	(A)	(B) Quality			(C)	Remark
	Absent:0pt Present:1 pt	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	Total (A)X(B)	
Comfort of Cyclist / Quality of Cycle Track						
Pavement type (Track surface)		Concrete or Asphalt or Tar	Interlocking Blocks	Unpaved/ non metaled surface		
Width of cycle track (Sizes of cycle track- Standard width for footpath is 2.5 m)		1.8 to 5.0m	1.5 - 1.8m	< 1.5m		
Height of Cycle track (Sizes of cycle track- standard height is 150 mm)		< 100mm (4”)	100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		
Slope of cycle track		Comfortable (Does not require extra effort to cycle)	Moderate (Require more extra effort to cycle)	Steep (Cannot be cycled)		
Shade		Complete	Mostly shaded	Mostly not shaded		
Tapering of cycle track at intersections (reducing width for cyclists to increase turning radius for MV’sand it is not good for cyclist)		No reduction in width at any intersection	Reduction in width at some intersections	Cycle track merged with turning vehicles at most intersections		
Parking facility for cycles		within 250m of the station / bicycle are allowed in the transit	Provided between 250 - 500 m of the station	Informal parking avai-lable within 500 m of the station		
Parking cost for cyclists		Free	Less than MV parking fee	Same as motor vehicle parking fees		

Signage for bicyclists		Frequently Present and Visible	Present Sometimes	Present Rarely or hardly visible		
Total					/9.0	
Safety of cyclists						
Buffer Zone/ Segregation from MV Lane		Width of 0.3 m and Height of 0.15m	Width is 0.15m -0.3 m	Width is <0.15m		
Lighting after dark (Visibility to ride after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Traffic Calming at T- Junctions (Speed breakers, raised crossing, rumble strips, etc.)		Present at all T- junctions	Present at most T-Junctions	Absent at most T-Junctions		
Land use along the footpath		Commercial/ Residential Area	Educational and Institutional area(safe during day time and unsafe during nights)	Located in sparsely populated area like newly developed suburbs/ vacant land		
Total(safety is given weight of 2)					( )*2/8	
Continuity for cyclists/ cycle tracks(Should be checked for every 300m on 1500m stretch)						
Barrier Free cycle track		No obstructions	Some obstructions	Mostly Obstructed		
Cycle track signage		Present at all junctions	Present almost everywhere	Present at some junctions		
Markings showing the continuity of cycle tracks at intersection		Present at all junctions	Present almost everywhere	Present at some junctions		


Ramps to get off/ on at intersections		Present at all junctions	Present almost everywhere	Present at some junctions		
Total					/4.0	
Total score for cyclist accessibility					/21.0	

Score for Cyclist Accessibility = Total of cells in column (C) / 21

Checklist A – 1.4 –Lighting for Pedestrian

Indicators	(A)	(B) Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A)X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

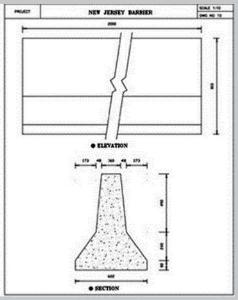
Score for Lighting =Total of cells in column (C) / 2

Checklist A – 1.5 –Signage

Signage	Explanation	Yes	No
		(1 pt)	(0 pt)
Signage for Pedestrian	In arterial roads signage for pedestrian and cyclists are important		
Signage for bicyclists			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 5

Checklist A – 1.6 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			
Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells

Checklist A – 1.7 – Intersections

Indicators	(A)	(B)Quality			Remark
Type of intersection	Present/Yes (1 pt)	Good	Fair	Poor	
	Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)	
Signalized		With Pedestrian phase	-	Without Pedestrian phase	
Round about		-	Two lane	more than two lanes)	
Manually controlled		-	Police controlling	No Police controlling	
Un-signalized		With traffic calming	With stop sign	None of the above	

<Description >	<Map Display>

Score for Intersection = (A)x (B) (Only one of the above is applicable)

Score A -1

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Cyclist accessibility			3	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			18	

Calculations: Overall Score for one side of road = Total of cells in Column D/18

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example,if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.
- Average of scores for 5 segments (each of 300m) is to be done to get the score for “Cyclist accessibility” audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.


Arterial Road, Bus Stops and Metro Stations Checklist – A2

Checklist A - 2

A. Arterial Road

- Midblock and Intersection — 1
- Bus stops/Metro stations — 2
- Educational Facilities and hospitals — 3

Important issues for Bus stops:

- Pedestrian crossing has to be design carefully
- People don't like foot over options
- Arterial Road speed limit is 50 km/h

Audit area:

Bus stop: All approaches to bus stop

Arterial road: Both approaches of arterial road to evaluate crossing issues

Audit Stage

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist A – 2.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										


Indicators		**(A)**	**Quality (B)**			**(C)**	**Remark**
Speed measures for roads		**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A x B)**	
		Absent/No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 40 km/h	40-60 km/h	> 60 km/h		
	Truck		< 40 km/h	40-60 km/h	>60 km/h		
	Bus		< 40 km/h	40-60 km/h	> 60 km/h		
	LCV		< 50 km/h	50-70 km/h	> 70 km/h		
	Car/Jeep		< 50 km/h	50-70 km/h	> 70 km/h		
	Auto Rickshaw		< 50 km/h	50-70 km/h	> 70 km/h		
	Scooter/Motor cycle		< 50 km/h	50-70 km/h	> 70 km/h		
Total							

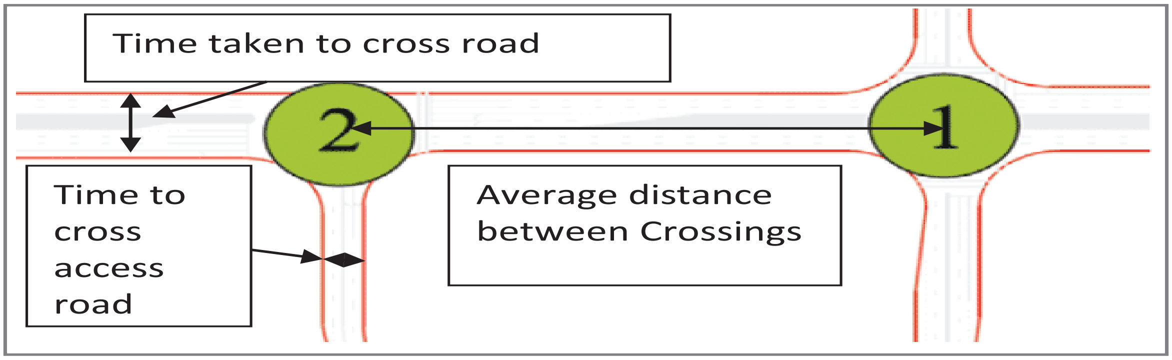
Score for Speed =Total of cells in column (C) / 7

Checklist A – 2.2 - Footpath and Pedestrian accessibility

Instructions

3. Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.
4. Audit is to be conducted in both directions on the route selected.

Explanation of Indicators




Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A) X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Arterial and Sub arterial roads: 1.8 to 5.0m	Arterial roads: 1.5 - 1.8m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Arterial Roads: Maximum < 100mm (4”)	Arterial Roads: 100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		


Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges without elevators or completely cov-ered subways without proper lighting		
Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist A – 2.3 – Cyclist accessibility

- Audit is to be repeated every 300 meter on a 1500 meter stretch on the selected road starting from the point of observation (i.e. either intersection or midblock etc.) for "Cyclist accessibility" audit.
- Audit is to be conducted in both directions on the route selected.

<u>Explanation of Indicators</u>

Lighting after dark (Visibility to ride after dark)

Cyclist accessibility

Indicators	(A)	(B) Quality			(C)	Remark
	Absent:0pt Present:1 pt	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	Total (A)X(B)	
Comfort of Cyclist / Quality of Cycle Track						
Pavement type (Track surface)		Concrete or Asphalt or Tar	Interlocking Blocks	Unpaved/ non metaled surface		
Width of cycle track (Sizes of cycle track-Standard width for footpath is 2.5 m)		1.8 to 5.0m	1.5 - 1.8m	< 1.5m		
Height of Cycle track (Sizes of cycle track-standard height is 150 mm)		< 100mm (4”)	100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		
Slope of cycle track		Comfortable (Does not require extra effort to cycle)	Moderate (Require more extra effort to cycle)	Steep (Cannot be cycled)		
Shade		Complete	Mostly shaded	Mostly not shaded		
Tapering of cycle track at intersections (reducing width for cyclists to increase turning radius for MV’sand it is not good for cyclist)		No reduction in width at any intersection	Reduction in width at some intersections	Cycle track merged with turning vehicles at most intersections		


Parking facility for cycles		within 250m of the station / bicycle are allowed in the transit	Provided between 250 - 500 m of the station	Informal parking available within 500 m of the station		
Parking cost for cyclists		Free	Less than MV parking fee	Same as motor vehicle parking fees		
Signage for bicyclists		Frequently Present and Visible	Present Sometimes	Present Rarely or hardly visible		
Total					/9.0	
Safety of cyclists						
Buffer Zone/ Segregation from MV Lane		Width of 0.3 m and Height of 0.15m	Width is 0.15m -0.3 m	Width is <0.15m		
Lighting after dark (Visibility to ride after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Traffic Calming at T- Junctions (Speed breakers, raised crossing, rumble strips, etc.)		Present at all T- junctions	Present at most T-Junctions	Absent at most T-Junctions		
Land use along the footpath		Commercial/ Residential Area	Educational and Institutional area(safe during day time and unsafe during nights)	Located in sparsely populated area like newly developed suburbs/ vacant land		
Total (safety is given weight of 2)					( )*2/8	
Continuity for cyclists/ cycle tracks (Should be checked for every 300m on 1500m stretch for bus stop and every 500m on 2500 stretch for metro station)						
Barrier Free cycle track		No obstructions	Some obstructions	Mostly Obstructed		

Cycle track signage		Present at all junctions	Present almost everywhere	Present at some junctions		
Markings showing the continuity of cycle tracks at intersection		Present at all junctions	Present almost everywhere	Present at some junctions		
Ramps to get off/ on at intersections		Present at all junctions	Present almost everywhere	Present at some junctions		
Total					/4.0	
Total score for cyclist accessibility					/21.0	

Score for Cyclist Accessibility = Total of cells in column (C) / 21

Checklist A – 2.4 –Lighting for Pedestrian

Indicators	**(A)**	**(B)Quality**			**(C)**	**Remark**
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A) X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

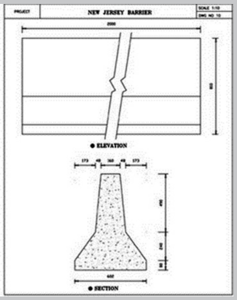
Score for Lighting =Total of cells in column (C) / 2


Checklist A – 2.5 –Signage

Signage	Explanation	Yes	No
		(1 pt)	(0 pt)
Signage for Pedestrian	In arterial roads signage for pedestrian and cyclists are important		
Signage for bicyclists			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 5

Checklist A – 2.6 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1	Yes	No
		If not applicable 0	(1 pt)	(0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			

Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells

Checklist A – 2.7 - Bus stop and other stations

Indicators	(A)	(B) Quality			(C)	Remark
Bus stop	Present/Yes-1 pt)	Good	Fair	Poor	(A)X(B)	
	Absent/No-0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Lighting at Bus Stop for pedestrians/ Cars/Light vehicles/heavy vehicles		Feel safe	Slightly uncomfortable at late nights	Unsafe		
Readability of bus stop signs by pedestrians by indication such as (Shelters/Seating) and Comfortable		Very readable and comfortable	Lessreadable and uncomfortable	Not readable and User unfriendly		
Total					**/2.0**	


Bus Stop	**Explanation**	**Yes (1 pt)**	**No (0 pt)**
Sidewalk presence at bus stop			
Roadway crossing treatments near the bus stop	Existence of crosswalks, pedestrian signals, pedestrian push-buttons and audible warning signals		
To monitor pedestrian behaviour at each bus stop: (Give attention in scoring)			
Bus Stop	**Explanation**	**Yes (0pt)**	**No (1 pt)**
Crossing outside crosswalk			
Not waiting for traffic to stop before crossing			
Dashing out into the street			
Running to catch a bus			
Disobeying traffic signals			
Walking/running along roadway			
Motorist Behaviour toward Pedestrians at Bus stop			
Exiting and entering driveways without yielding to pedestrians			
Failing to stop for pedestrians in crosswalks			
Stopping at STOP speed reduction signs			
Running red light signals			
Stopping or Parking in crosswalks			
cell phones usage			
Total		14.0	
Bus stop Total score		16.0	

Score for Bus stop at Arterial roads = Total of cells in column (C) / 16

Score A -2

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Cyclist accessibility			3	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			18	

Calculations: Overall Score for one side of road = Total of cells in Column D/18

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example,if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.
- Average of scores for 5 segments (each of 300m) is to be done to get the score for “Cyclist accessibility” audit in case of bus stop.
- Average of scores for 5 segments (each of 500m) is to be done to get the score for “Cyclist accessibility” audit in case of bus stop.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.


Arterial Road and Educational facilities and Hospitals Checklist – A3

Checklist A -3

A. Arterial Road	Midblock and Intersection	1
	Bus stops/Metro stations	2
	Educational Facilities and hospitals	3

<u>Important issues for Ed ucational facilities and hospitals:</u>

- Children and teenage crossing has to be design carefully
- Speed control measures should be design carefully
- Arterial Road speed limit is 50 km/h

<u>Audit area:</u>

Educational Facility: All approaches to school or college or hospitals

Arterial road: Both approaches of arterial road to evaluate crossing issues

<u>Audit Stage</u>

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist A – 3.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Note: The speeds given in this table are applicable if service road is provided for access to schools otherwise use table on next page

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/ Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 40 km/h	40-60 km/h	> 60 km/h		
	Truck		< 40 km/h	40-60 km/h	>60 km/h		
	Bus		< 40 km/h	40-60 km/h	> 60 km/h		
	LCV		< 50 km/h	50-70 km/h	> 70 km/h		
	Car/Jeep		< 50 km/h	50-70 km/h	> 70 km/h		
	Auto Rickshaw		< 50 km/h	50-70 km/h	> 70 km/h		
	Scooter/Motor cycle		< 50 km/h	50-70 km/h	> 70 km/h		
Total							

Score for Speed =Total of cells in column (C) / 7

No service lane

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/ Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 15 km/h	15-30 km/h	> 30 km/h		
	Truck		< 15 km/h	15-30 km/h	> 30 km/h		
	Bus		< 15 km/h	15-30 km/h	> 30 km/h		
	LCV		< 15 km/h	15-30 km/h	> 30 km/h		
	Car/Jeep		< 15 km/h	15-30 km/h	> 30 km/h		
	Auto Rickshaw		< 15 km/h	15-30 km/h	> 30 km/h		
	Scooter/Motor cycle		< 15 km/h	15-30 km/h	> 30 km/h		
Total							

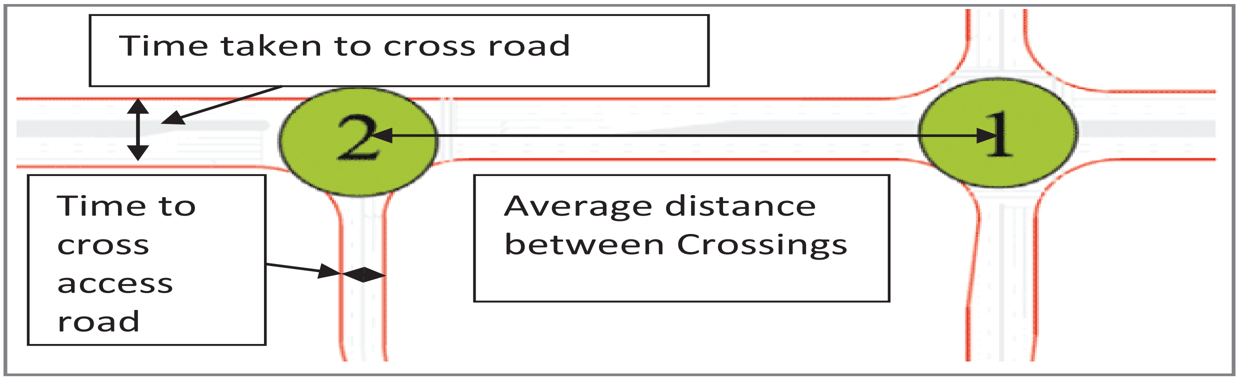
Score for Speed = Total of cells in column (C) / 7

Checklist A – 3.2 - Footpath and Pedestrian accessibility

Instructions

5. Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.
6. Audit is to be conducted in both directions on the route selected.

Explanation of Indicators



Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt) Absent/ No (0 pt)	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	(A) X(B)	
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Arterial and Sub arterial roads: 1.8 to 5.0m	Arterial roads: 1.5 - 1.8m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Arterial Roads: Maximum < 100mm (4”)	Arterial Roads: 100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		


Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges without elevators or completely covered subways without proper lighting		

Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist A – 3.3 – Cyclist accessibility

- Audit is to be repeated every 300 meter on a 1500 meter stretch on the selected road starting from the point of observation (i.e. either intersection or midblock etc.) for "Cyclist accessibility" audit.

Explanation of Indicators

Lighting after dark (Visibility to ride after dark)


Cyclist accessibility

Indicators	(A)	(B) Quality			(C)	Remark
	Absent:0pt Present:1 pt	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	Total (A)X(B)	
Comfort of Cyclist / Quality of Cycle Track						
Pavement type (Track surface)		Concrete or Asphalt or Tar	Interlocking Blocks	Unpaved/ non metaled surface		
Width of cycle track (Sizes of cycle track- Standard width for footpath is 2.5 m)		1.8 to 5.0m	1.5 - 1.8m	< 1.5m		
Height of Cycle track (Sizes of cycle track- standard height is 150 mm)		< 100mm (4”)	100mm (4”) – 300mm (12”)	Very user unfriendly (>300mm)		
Slope of cycle track		Comfortable (Does not require extra effort to cycle)	Moderate (Require more extra effort to cycle)	Steep (Cannot be cycled)		
Shade		Complete	Mostly shaded	Mostly not shaded		
Tapering of cycle track at intersections (reducing width for cyclists to increase turning radius for MV’sand it is not good for cyclist)		No reduction in width at any intersection	Reduction in width at some intersections	Cycle track merged with turning vehicles at most intersections		
Parking facility for cycles		within 250m of the station / bicycle are allowed in the transit	Provided between 250 - 500 m of the station	Informal parking available within 500 m of the station		
Parking cost for cyclists		Free	Less than MV parking fee	Same as motor vehicle parking fees		

Signage for bicyclists		Frequently Present and Visible	Present Sometimes	Present Rarely or hardly visible		
Total					/9.0	
Safety of cyclists						
Buffer Zone/ Segregation from MV Lane		Width of 0.3 m and Height of 0.15m	Width is 0.15m -0.3 m	Width is <0.15m		
Lighting after dark (Visibility to ride after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Traffic Calming at T- Junctions (Speed brea-kers, raised crossing, rumble strips, etc.)		Present at all T- junctions	Present at most T- Junctions	Absent at most T-Junctions		
Land use along the footpath		Commercial/ Residential Area	Educational and Institutional area(safe during day time and unsafe during nights)	Located in sparsely populated area like newly developed suburbs/ vacant land		
Total (safety is given weight of 2)					( )*2/8	
Continuity for cyclists/ cycle tracks (Should be checked for every 300m on 1500m stretch for bus stop and every 500m on 2500 stretch for metro station)						
Barrier Free cycle track		No obstructions	Some obstructions	Mostly Obstructed		
Cycle track signage		Present at all junctions	Present almost everywhere	Present at some junctions		
Markings showing the continuity of cycle tracks at intersection		Present at all junctions	Present almost everywhere	Present at some junctions		


Ramps to get off/ on at intersections		Present at all junctions	Present almost everywhere	Present at some junctions		
Total					/4.0	
Total score for cyclist accessibility					/21.0	

Score for Cyclist Accessibility = Total of cells in column (C) / 21

Checklist A – 3.4 –Lighting for Pedestrian

Indicators	**(A)**	**(B)Quality**			**(C)**	**Remark**
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A)X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

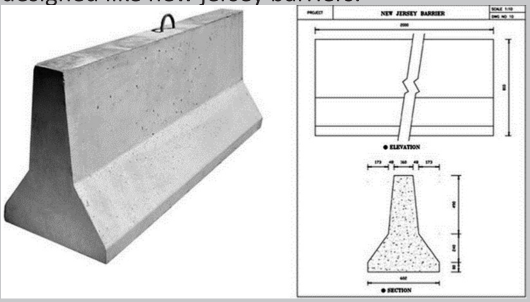
Score for Lighting =Total of cells in column (C) / 2

Checklist A – 3.5 –Signage

Signage	**Explanation**	**Yes**	**No**
		(1 pt)	**(0 pt)**
Signage for Pedestrian	In arterial roads signage for pedestrian and cyclists are important		
Signage for bicyclists			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 5

Checklist A – 3.6 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers. 			
Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

<u>Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells</u>

Checklist A – 3.7 - Educational facilitates (schools and hospitals)

Schools and Hospitals	Explanation	Yes(1 pt)	No (0 pt)
1. Is a school/Hospital crossing provided?			
2. Are warning signs are provided for Hospital and school children?			
3. Is there any parking (legal and illegal) that cause visibility obstruction to the crossing?			
Total		/3	
Educational facility and hospitals total score		/4	

Score for Educational facilities = Total of cells in column (C) / 3

Score A -3

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Cyclist accessibility			3	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			18	

Calculations: Overall Score for one side of road = Total of cells in Column D/18

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example, if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for "Footpath and Pedestrian accessibility" audit.
- Average of scores for 5 segments (each of 300m) is to be done to get the score for "Cyclist accessibility" audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.


Collector Road and Mid Block and Intersection - B1

Checklist B - 1

B. Collector Road	Midblock and Intersection	1
	Bus stops/Metro stations	2
	Educational Facilities and hospitals	3

Important issues for Collector roads

- Audit is to be conducted in all approaches of the junction in both directions
- Signage for pedestrians and cyclists for collector roads are preferable
- Collector Road speed limit is 30 km/h

Audit area

Intersection: All approaches for 100 m (for 4 way junction 4 approaches, etc.)

Midblock: one road to be audited (Both sides)

Audit Stage

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist B – 1.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/ Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 30 km/h	30-60 km/h	> 60 km/h		
	Truck		< 30 km/h	30-60 km/h	>60 km/h		
	Bus		< 30 km/h	30-60 km/h	> 60 km/h		
	LCV		< 30 km/h	30-70 km/h	> 70 km/h		
	Car/Jeep		< 30 km/h	30-70 km/h	> 70 km/h		
	Auto Rickshaw		< 30 km/h	30-70 km/h	> 70 km/h		
	Scooter/Motor cycle		< 30 km/h	30-70 km/h	> 70 km/h		
Total							

Score for Speed =Total of cells in column (C) / 7

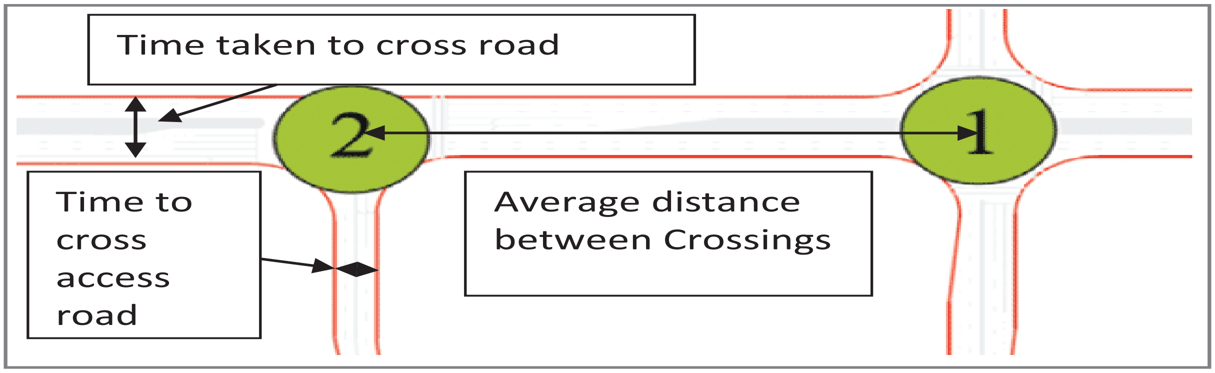
Checklist B – 1.2 - Footpath and Pedestrian accessibility

Instructions

7. Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.

8. Audit is to be conducted in both directions on the route selected.

Explanation of Indicators



Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A) X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Collector roads: 1.5 to 3m (including curbs)	Collector roads: 1.0 to 1.5m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Collector Roads: Maximum <150mm (6”)	Collector Roads: <150mm (6”)-300mm (12”)	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		

Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges without elevators or completely cov-ered subways without proper lighting		


Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist B – 1.3 – Lighting for Pedestrian

Indicators	**(A)**	**(B)Quality**			**(C)**	**Remark**
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A)X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

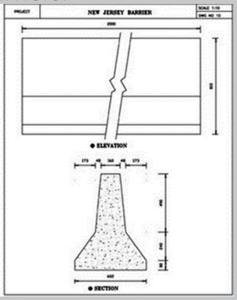
Score for Lighting =Total of cells in column (C) / 2

Checklist B – 1.4 –Signage

Signage	Explanation	Yes (1 pt)	No (0 pt)
Signage for Pedestrian	In collector roads signage for pedestrian		
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 4

Checklist B – 1.5 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			


Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

<u>Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells</u>

Note that, for example, if "Is approach of flyover safe" may not be applicable in case of collector roads so we won't consider it in denominator of total score.

Checklist B – 1.6 – Intersections

Indicators	(A)	(B)Quality			Remark
Type of intersection	Present/Yes (1 pt)	Good	Fair	Poor	
	Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)	
Signalized		With Pedestrian phase	-	Without Pedestrian phase	
Round about		-	Two lane	more than two lanes)	
Manually controlled		-	Police controlling	No Police controlling	
Un-signalized		With traffic calming	With stop sign	None of the above	

<Description >	<Map Display>

Score for Intersection = (A)x (B) (Only one of the above is applicable)

Score B -1

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	

Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example, if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for "Footpath and Pedestrian accessibility" audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.


Collector Road and Bus stops and metro stations Checklist – B 2

Checklist B -2

B. Collector Road
- Midblock and Intersection — 1
- Bus stops/Metro stations — 2
- Educational Facilities and hospitals — 3

Important issues for Bus stops:
- Pedestrian crossing has to be design carefully
- People don't like foot over options
- Collector Road speed limit is 30 km/hr

Audit area:

Bus stop: All approaches to bus stop

Collector road: Both approaches of arterial road to evaluate crossing issues

Audit Stage

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist B – 2.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Note: The speeds given in this table are applicable if service road is provided for access to schools otherwise use table on next page


Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/ Yes (1 pt) Absent/No (0 pt)	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	(A x B)	
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 30 km/h	30-60 km/h	> 60 km/h		
	Truck		< 30 km/h	30-60 km/h	>60 km/h		
	Bus		< 30 km/h	30-60 km/h	> 60 km/h		
	LCV		< 30 km/h	30-70 km/h	> 70 km/h		
	Car/Jeep		< 30 km/h	30-70 km/h	> 70 km/h		
	Auto Rickshaw		< 30 km/h	30-70 km/h	> 70 km/h		
	Scooter/Motor cycle		< 30 km/h	30-70 km/h	> 70 km/h		
Total							

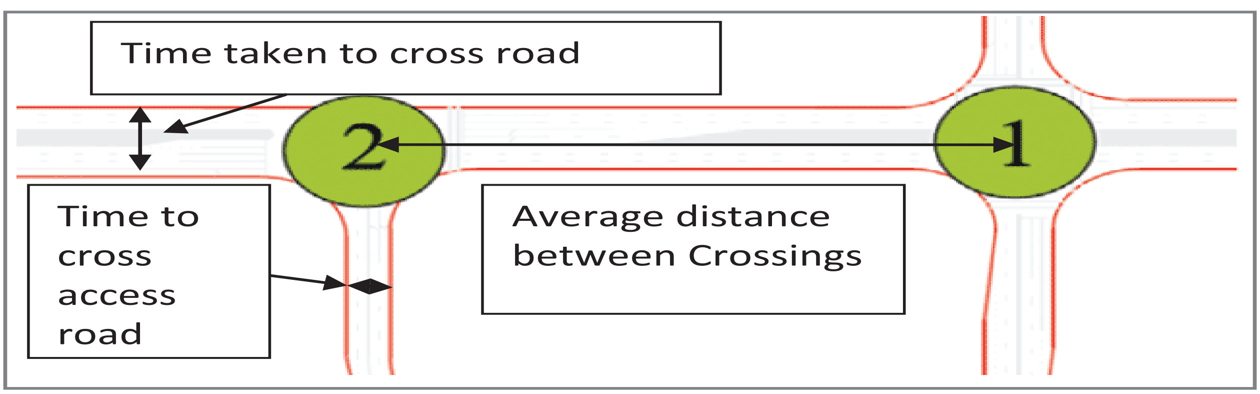
Score for Speed =Total of cells in column (C) / 7

Checklist B – 2.2 - Footpath and Pedestrian accessibility

Instructions

- Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.
- Audit is to be conducted in both directions on the route selected.

Explanation of Indicators



Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	**Present/ Yes (1 pt)** **Absent/ No (0 pt)**	**Good** **(1 pt)**	**Fair** **(0.5 pt)**	**Poor** **(0.2 pt)**	**(A) X(B)**	
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Collector roads: 1.5 to 3m	Collector roads: 1.0 to 1.5m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Collector Roads: Maximum <150mm (6”)	Collector Roads: <150mm (6”)- 300mm (12”)	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		


Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges with-out elevators or completely covered sub-ways without proper lighting		
Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist B – 2.3 –Lighting for Pedestrian

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A) X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

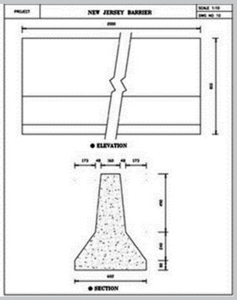
Score for Lighting =Total of cells in column (C) / 2

Checklist B – 2.4 –Signage

Signage	Explanation	Yes (1 pt)	No (0 pt)
Signage for Pedestrian	In arterial roads signage for pedestrian and cyclists are important		
Signage for bicyclists			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 4

Checklist B – 2.5 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 / If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			


Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells

Note that, for example, "Is approach of flyover safe" may not be applicable in case of collector roads so we won't consider it in denominator of total score.

Checklist B – 2.6 - Bus stop and other stations

Indicators	(A)	(B)Quality			(C)	Remark
Bus stop	**Present/ Yes-1 pt)**	**Good**	**Fair**	**Poor**	**(A)X(B)**	
	Absent/ No-0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Lighting at Bus Stop for pedestrians/ Cars/Light vehicles/heavy vehicles		Feel safe	Slightly uncomfortable at late nights	Unsafe		
Readability of bus stop signs by pedestrians by indication such as (Shelters/Seating) and Comfortable		Very readable and comfortable	Lessreadable and uncomfortable	Not readable and User unfriendly		
Total					**/2.0**	

Bus Stop	Explanation	Yes	No
		(1 pt)	(0 pt)
Sidewalk presence at bus stop			
Roadway crossing treatments near the bus stop	Existence of crosswalks, pedestrian signals, pedestrian push-buttons and audible warning signals		
To monitor pedestrian behaviour at each bus stop: (Give attention in scoring)			
Bus Stop	**Explanation**	**Yes**	**No**
		(0pt)	**(1 pt)**
Crossing outside crosswalk			
Not waiting for traffic to stop before crossing			
Dashing out into the street			
Running to catch a bus			
Disobeying traffic signals			
Walking/running along roadway			
Motorist Behaviour toward Pedestrians at Bus stop			
Exiting and entering driveways without yielding to pedestrians			
Failing to stop for pedestrians in crosswalks			
Stopping at STOP speed reduction signs			
Running red light signals			
Stopping or Parking in crosswalks			
cell phones usage			
Total		14.0	
Bus stop Total score		16.0	

Score for Bus stop at Arterial roads = Total of cells in column (C) / 16


Score B -2

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	

Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example, if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.

Collector Road and Educational facilities and Hospitals Checklist – B3

Checklist B -3

B. Collector Road	Midblock and Intersection	1
	Bus stops/Metro stations	2
	Educational Facilities and hospitals	3

Important issues for Educational facilities and hospitals:

- Children and teenage crossing has to be design carefully
- Speed control measures should be design carefully

Audit area:

Educational Facility: All approaches to school or college or hospitals

Collector road: Both approaches of arterial road to evaluate crossing issues

Audit Stage

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ……………………..

<Description >	<Map Display>


Checklist B – 3.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 15 km/h	15-30 km/h	> 30 km/h		
	Truck		< 15 km/h	15-30 km/h	> 30 km/h		
	Bus		< 15 km/h	15-30 km/h	> 30 km/h		
	LCV		< 15 km/h	15-30 km/h	> 30 km/h		
	Car/Jeep		< 15 km/h	15-30 km/h	> 30 km/h		
	Auto Rickshaw		< 15 km/h	15-30 km/h	> 30 km/h		
	Scooter/Motor cycle		< 15 km/h	15-30 km/h	> 30 km/h		
Total							

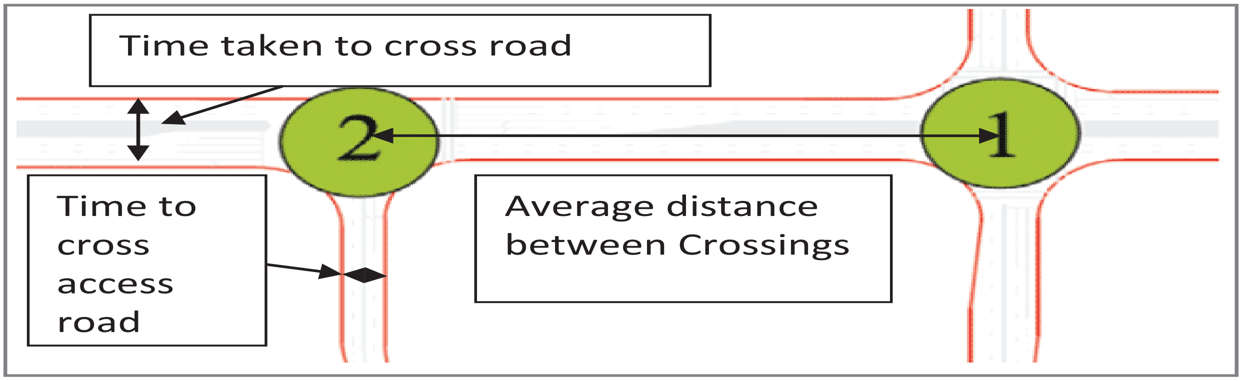
Score for Speed =Total of cells in column (C) / 7

Checklist B – 3.2 - Footpath and Pedestrian accessibility

Instructions

- Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.
- Audit is to be conducted in both directions on the route selected.

Explanation of Indicators




Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt) Absent/ No (0 pt)	Good (1 pt)	Fair (0.5 pt)	Poor (0.2 pt)	(A) X(B)	
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Collector roads: 1.5 to 3m	Collector roads: 1.0 to 1.5m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Collector Roads: Maximum <150mm (6")	Collector Roads: <150mm (6")- 300mm (12")	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pede-strians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstr-uctions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		

Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges with-out elevators or completely covered sub-ways without proper lighting		
Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11


Checklist B – 3.3 –Lighting for Pedestrian

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A)X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

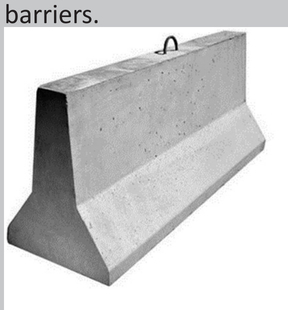
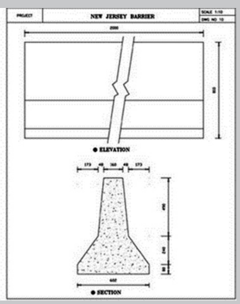
Score for Lighting =Total of cells in column (C) / 2

Checklist B – 3.4 –Signage

Signage	Explanation	Yes	No
		(1 pt)	**(0 pt)**
Signage for Pedestrian	In collector roads signage for pedestrian		
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 4


Checklist B – 3.5 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			
Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells


Note that, for example, "Is approach of flyover safe" may not be applicable in case of collector roads so we won't consider it in denominator of total score.

Checklist B – 3.6 - Educational facilitates (schools and hospitals)

Schools and Hospitals	Explanation	Yes(1 pt)	No(0 pt)
1. Is a school/Hospital crossing provided?			
2. Is warning signs are provided for Hospital and school children?			
3. Is there any parking (legal and illegal) that cause visibility obstruction to the crossing?			
Total		/3	
Educational facility and hospitals total score		/3	

Score for Educational facilities = Total of cells in column (C) / 3

Score B -2

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	

Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example, if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.


Local Road and Midblock/Intersection Checklist – C1

Checklist C -1

C. Local Road	Midblock and Intersection	1
	Educational Facilities and hospitals	2

Important issues for Local roads

- Audit is to be conducted in all approaches of the junction in both directions
- Local Road speed limit is 20 km/h

Audit area

Intersection: All approaches for 100 m (for 4 way junction 4 approaches, etc.)

Midblock: one road to be audited (Both sides)

Audit Stage

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>

Checklist C – 1.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 20 km/h	20-40 km/h	> 40 km/h		
	Truck		< 20 km/h	20-40 km/h	> 40 km/h		
	Bus		< 20 km/h	20-40 km/h	> 40 km/h		
	LCV		< 20 km/h	20-40 km/h	> 40 km/h		
	Car/Jeep		< 20 km/h	20-40 km/h	> 40 km/h		
	Auto Rickshaw		< 20 km/h	20-40 km/h	> 40 km/h		
	Scooter/Motor cycle		< 20 km/h	20-40 km/h	> 40 km/h		
Total							

Score for Speed =Total of cells in column (C) / 7

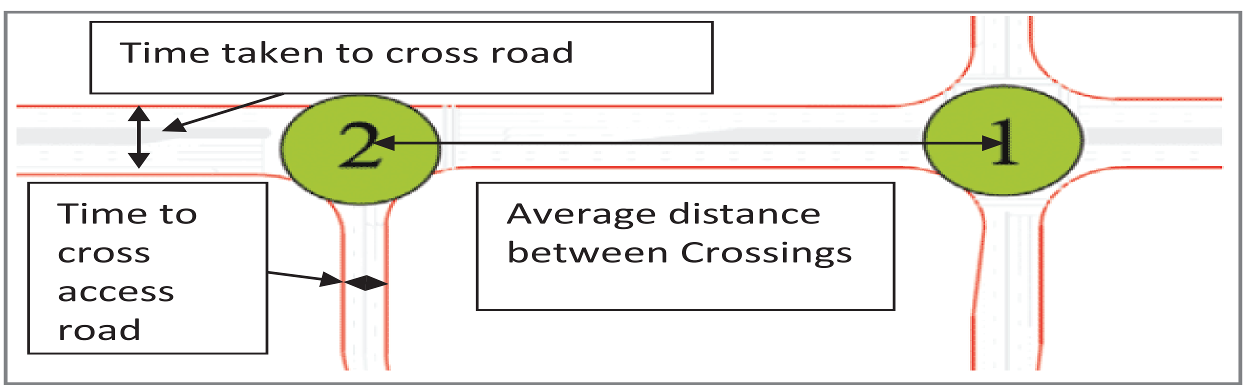
Checklist C – 1.2 - Footpath and Pedestrian accessibility

Instructions

- Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.

12.Audit is to be conducted in both directions on the route selected.

Explanation of Indicators



Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A) X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Collector roads: 1.5 to 3m	Collector roads: 1.0 to 1.5m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Collector Roads: Maximum <150mm (6")	Collector Roads: <150mm (6")- 300mm (12")	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		

Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings)(Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between cont-rolled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		
Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges with-out elevators or completely covered sub-ways without proper lighting		
Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist C – 1.3 –Lighting for Pedestrian

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	**Present/ Yes (1 pt)**	**Good**	**Fair**	**Poor**	**(A) X(B)**	
	Absent/ No (0 pt)	**(1 pt)**	**(0.5 pt)**	**(0.2 pt)**		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

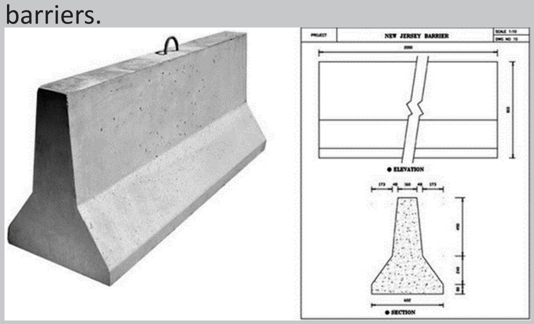
Score for Lighting =Total of cells in column (C) / 2

Checklist C – 1.4 –Signage

Signage	Explanation	Yes	No
		(1 pt)	**(0 pt)**
Signage for Pedestrian			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 4


Checklist C – 1.5 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers. 			
Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			
Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells

Note that, for example, “Is approach of flyover safe” may not be applicable in case of collector roads so we won’t consider it in denominator of total score.

Checklist C – 1.6 – Intersections

Indicators	(A)	(B)Quality			Remark
Type of intersection	Present/Yes (1 pt)	Good	Fair	Poor	
	Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)	
Signalized		With Pedestrian phase	-	Without Pedestrian phase	
Round about		-	Two lane	more than two lanes)	
Manually controlled		-	Police controlling	No Police controlling	
Un-signalized		With traffic calming	With stop sign	None of the above	

<Description >	<Map Display>

Score for Intersection = (A)x (B) (Only one of the above is applicable)

Score C -1

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	


Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example,if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for "Footpath and Pedestrian accessibility" audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.

Local Road and Educational facilities and Hospitals Checklist – C 2

Checklist C -2

C. Local Road	Midblock and Intersection	1
	Educational Facilities and hospitals	2

<u>Important issues for Educational facilities and hospitals:</u>

- Children and teenage crossing has to be design carefully
- Speed control measures should be design carefully

<u>Audit area:</u>

Educational Facility: All approaches to school or college or hospitals

Local road: Both approaches of Local road to evaluate crossing issues

<u>Audit Stage</u>

Design Stage: Part of Checklist with Grey Color will be used for Design stage

Post Construction stage: All the checklist will be used for Post –construction stage

Location name (Description) ……………………… Date ………………..

Names of auditors

1.

2.

3.

4.

5.

Location Map Name and description of area: ………………………

<Description >	<Map Display>


Checklist C – 2.1 – Speed Measure and Hourly Volume Measure

Note1. Checklist should be filled up after Speed has been measured for different modes.

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10 – 20 min										
20 – 30 min										
30 – 40 min										
40 – 50 min										
50 – 60 min										
Average Speed (km/hr)										

Note: It is to be noted that the number of observations for different modes can vary in a particular interval.

Calculations: For example, let us consider a, b, c be the speed observed for Truck Multi-Axle in the interval 0-10min. Calculate the speed for this cell by (a+b+c)/3 and then calculate the **Average speed** (the last row) by averaging the speed obtained for each cell between different intervals along the column.

Hourly Volume Measure

Vehicle	Truck Multi-Axle	Truck	Bus	LCV	Car/ Jeep	Auto Rickshaw	Scooter/ Motor cycle	Cycle	Hand Driven Rickshaw	Pedestrian
0 – 10 min										
10-20 min										
20-30 min										
30 – 40 min										
40-50 min										
50-60 min										
Hourly Volume										

Indicators		(A)	Quality (B)			(C)	Remark
Speed measures for roads		Present/Yes (1 pt)	Good	Fair	Poor	(A x B)	
		Absent/No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Existing Speed Variation (Total km/hr)	Truck Multi-Axle		< 15 km/h	15-30 km/h	> 30 km/h		
	Truck		< 15 km/h	15-30 km/h	> 30 km/h		
	Bus		< 15 km/h	15-30 km/h	> 30 km/h		
	LCV		< 15 km/h	15-30 km/h	> 30 km/h		
	Car/Jeep		< 15 km/h	15-30 km/h	> 30 km/h		
	Auto Rickshaw		< 15 km/h	15-30 km/h	> 30 km/h		
	Scooter/Motor cycle		< 15 km/h	15-30 km/h	> 30 km/h		
Total							

Score for Speed =Total of cells in column (C) / 7

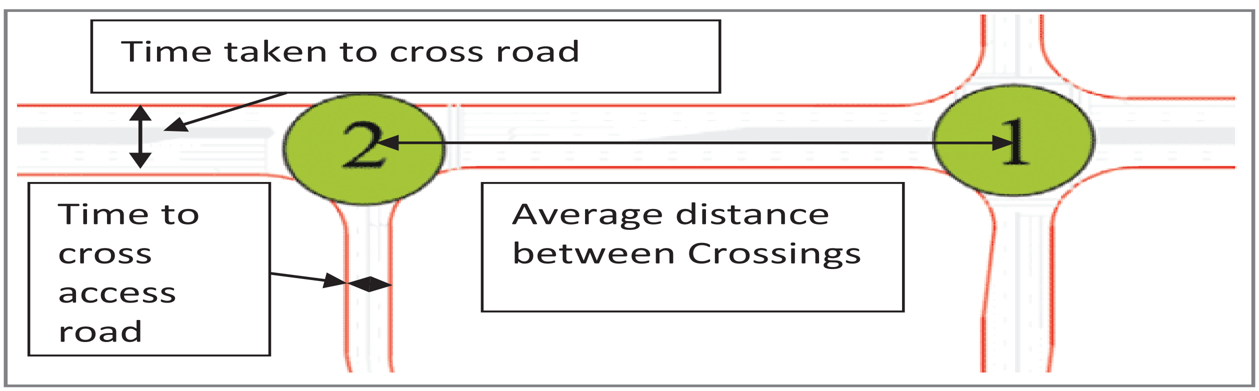
Checklist C – 2.2 - Footpath and Pedestrian accessibility

Instructions

- Audit is to be repeated every 100 meter on a 500 meter stretch on the selected road starting from the station.

13. Audit is to be conducted in both directions on the route selected.

Explanation of Indicators




Footpath and Pedestrian accessibility

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A) X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Pavement type		Concrete/ Interlocking block/ Paver blocks/ Tar/ Asphalt	Tiles	Unpaved/ non metaled surface		
How wide are the footpaths?		Collector roads: 1.5 to 3m	Collector roads: 1.0 to 1.5m	Highly congested (< 1.5m)		
Height of footpath (standard size is 150 mm)		Collector Roads: Maximum <150mm (6”)	Collector Roads: <150mm (6”)-300mm (12”)	Very user unfriendly (>300mm)		
Cleanliness and maintenance of footpath		Well maintained footpaths	Need better maintenance and cleanliness	Foot paths are not maintained		
Provision of amenities for pedestrians on path way (Hawkers exclusive zone, cover from sun and rain, etc.)		Pedestrians provided some good amenities and feel safe	Limited number of provisions for pedestrians and slightly uncomfortable at late nights	No amenities and Unsafe		
Provision of Disability friendly Infrastructure (tactile flooring, audible signals, railing, ramps)		Infrastructure for disabled is present	Some infrastructure is available	Mostly absent		
Degree of obstructions on footpaths (obstructions such as trees, parking vehicles, hawkers and vendors etc. should be absent)		There are no obstructions	Pedestrians has to slow down sometimes	Pedestrian has to slow down most of the time (not usable)		
Availability of Crossings (frequency of crossings) (Refer to instructions)		Avg. spacing between controlled crossings is < 500m	Avg. spacing between controlled crossings is between 500 m – 700 m	Avg. distance of controlled crossings is >700 m		

Type of Crossing		Level/ at grade crossing	Foot over bridges with elevators or half subways which are well lit.	Foot over bridges without elevators or completely cov-ered subways without proper lighting		
Time taken for crossing road from one end to another. (Refer to instructions)		10-30sec	30-60 sec	>60 sec		
Time taken to cross the access routes to main arterial road. These are the roads which are not signalized and leads to main road. (Refer to instructions)		10-30sec	30-60sec	>60sec		
Total						

Score for Footpath and Pedestrian accessibility = Total of cells in column (C) / 11

Checklist C – 2.3 –Lighting for Pedestrian

Indicators	(A)	(B)Quality			(C)	Remark
Footpath	Present/ Yes (1 pt)	Good	Fair	Poor	(A)X(B)	
	Absent/ No (0 pt)	(1 pt)	(0.5 pt)	(0.2 pt)		
Light after dark (Visibility to walk after dark)		Good lightning (tracks with avg. lighting level of >= 20lux)	Partial (tracks with avg. lighting level of20 to 10lux)	Poor (tracks with avg. lighting level of <10lux)		
Provision of lighting for pedestrians for crossing		To see Motorized vehicles and feel safety	slightly uncomfortable at late nights	Unsafe		
Total						

Score for Lighting =Total of cells in column (C) / 2

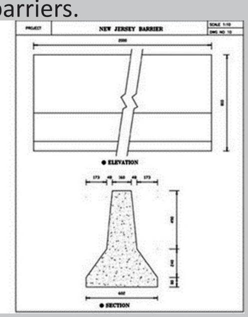
 

Checklist C – 1.4 –Signage

Signage	Explanation	Yes (1 pt)	No (0 pt)
Signage for Pedestrian			
Signage for Cars and 2W and Trucks			
Does the signage make clear the intended use facilities?			
Speed limit signage			
Total			

Score for Signage= Total of cells in column / 4

Checklist C – 2.5 – Motorized vehicles safety

For Motorized vehicles	Explanation	If applicable 1 If not applicable 0	Yes (1 pt)	No (0 pt)
Speed limits sign is provided	Example: 			
Does safety measures provided for construction at road sides				
Is the median design safe	Usually more than 150 mm median is hazardous for motorized vehicles. Higher median should be designed like new jersey barriers.  			
Kerb design safe?	Usually more than 150 mm median is hazardous for motorized vehicles.			

Is kerb free of vertical hazards?	Any tree or pole (sign pole should be at least 1 meter away from carriage way			
Is approach of flyover safe?	Approach of the flyover should have proper chevron marking 			
Overall				

Score for Motorized vehicle safety = Total of cells in column / sum of applicable number of cells

Note that, for example, “Is approach of flyover safe” may not be applicable in case of collector roads so we won’t consider it in denominator of total score.

Checklist C – 2.6 - Educational facilitates (schools and hospitals)

Schools and Hospitals	Explanation	Yes(1 pt)	No(0 pt)
1. Is a school/Hospital crossing provided?			
2. Is warning signs are provided for Hospital and school children?			
3. Is there any parking (legal and illegal) that cause visibility obstruction to the crossing?			
Total			
Educational facility and hospitals total score		/3	

Score for Educational facilities = Total of cells in column (C) / 3

Score C -2

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	


Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example, if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.

Score C -2

Access Mode Type	Score (A)	%age (B) = Score x100	Weights (C)	(D)= (A) x (C)
Speed			4	
Footpath and Pedestrian accessibility			4	
Lighting			3	
Signage			2	
Motorized vehicles safety			1	
Intersections and Midblock			1	
Total			15	

Calculations: Overall Score = Total of cells in Column D/15

Then overall score for an approach will be found by averaging the score for both the direction of road.

Average Scores of all approaches will give the score for a station.

Note:

- For example,if cycle track is absent then its score will be zero but its weight is to be considered in calculation.
- Average of scores for 5 segments (each of 100m) is to be done to get the score for “Footpath and Pedestrian accessibility” audit.

Recommendations

- If the score is greater than 80% it is good.
- If the score is between 50 to 80% it is fair.
- If the score is less than 50% it is poor.

Annexure 3

Comments of Reviewers

Reviewer: Rob Gallagher

1. Aim of the toolkit: From the material provided, I assume that the aim of the Urban Road Safety Toolkit is to assist practitioners in the urban sector to improve road safety in a comprehensive manner, and specifically to assist them in commissioning, overseeing or carrying out road safety audits.

2. The literature review reflects this approach, by considering firstly, road safety audits at a national level (Section 2.1), and secondly, different aspects of road safety audits (Section 2.2).

3. Distinguish national and site level RSA approaches: It would be helpful if the literature review distinguished more clearly the different approaches at the different levels at which road safety audits are carried out. For example, at the national or state level the 'audit' is more policy-based, focusing on accident analysis and broad policies, laws and programs to reduce accidents. At the local level, road safety audits (RSA) are much more technical and specific. The review should make these differences clear – i.e. what information and procedures are needed for national level work, and what specific information and procedures are needed for RSA's at the road / site level?

4. It might be helpful to re-organize the report along these lines (i.e. distinguishing between the national level and local level road safety approaches). Some of the strategic material currently in Section 2.2 could then be moved to Section 2.1 (national level), for example Aspect 2 (road safety performance), Aspect 5 (activities that are problem areas), and other information relating to strategic assessments and responses.

5. Include the town / metropolitan level: It might also be helpful to also consider the intermediate level between national/state and site level, namely the metropolitan or town level. At this level, road safety approaches and RSA are a combination of both (i) policies/by-laws/institutional measures and (ii) specific technical measures to provide safer road infrastructure.

6. I would suggest that the review could include a separate section covering the town/metro level. As the toolkit is aimed at urban transport practitioners, this suggested three-tier structure (national, town/metropolitan, site/road level) might also be helpful for the various users of the toolkit – for example, public decision-makers at the different levels of government, and likewise planners and engineers working at the different levels. (More on this below).

7. More info from developing countries: The review focuses mainly on RSA approaches in developed countries (UK, USA, Germany, Netherlands, Europe, New Zealand). Material from Russia and Brazil is also included. However, there is not much from developing countries (only Tanzania, and a little bit from Malaysia). While it is good to consider best practice in developed countries, more lessons from other Asian countries with similar operating environments might be helpful. The review also need analyze this experience and adapt it to local conditions in India, taking account of local constraints of staff, funding and institutional arrangements.


8. More emphasis on conclusions: Generally, there is quite a lot of overlap and repetition amongst the bullet points in the ten Aspects covered in Section 2.2. I would recommend giving more emphasis to the conclusions emerging from the review. Some of the bullet points could perhaps be moved to an Appendix.

9. Application to Indian conditions: The ToR for the Stage 1 State-of-the-Art report asks the review to *"consider the application in Indian conditions, including application of existing IRC codes/ manuals".* I am not clear whether this Interim Report 1 is intended to be the Stage 1 State-of-the-Art report, but if it is, then further sections are needed to consider the application to Indian conditions, including a review of existing IRC materials as stated in the ToR.

10. More emphasis is needed on the process of carrying out RSA's: The review has given emphasis to indicators, criteria and measurements to be considered when carrying out RSA's. However, more emphasis needs to be given to the process of carrying out RSA's, for example regarding:

    - The various stages of doing a RSA (this mentioned on the first page, but more details and explanation are needed for each of these);
    - The costs and resources needed for carrying out RSA's – e.g. what staff do you need? What is affordable?
    - How do RSA's fit into the overall planning and implementation process?
    - What scale / level of road scheme should be covered? e.g. How to treat smaller schemes?
    - Role of national standards (against which schemes can be assessed), and how mandatory / prescriptive is the RSA process?
    - How to deal with departures from standards – when is this permissible, and how to handle it?

    It is very interesting that in the UK, there is great variation between local highway authorities in how they carry out RSA's, and the type/scale of schemes they audit. The cost (of doing the audits) is a key factor limiting the extent of this work. *(See IHT document attached, page 86).*

11. Road safety at the town or metropolitan level: If the Toolkit is intended to assist road safety in a comprehensive manner then presumably it needs to be broader than just a Road Safety Audit manual, and give decision-makers, planners and engineers guidance on urban-wide approaches to improving road safety.

    It might therefore be helpful to include a section on road safety approaches at the town level. This would be different to the national level (policies, laws, etc.) and the site level (specific technical criteria), and could include aspects such as:

    - What are the main ways of improving road safety at the town / metropolitan level?
    - Role of speed management and traffic management in urban areas;

- Data availability at the urban level (e.g. speed, flow, accidents, etc.) and its accuracy;
- Institutional capacity and staff requirements for improving road safety at the urban level;
- Types and use of different road safety plans and strategies, and area-wide audits (e.g. accessibility audit, safety assessment, road user audit, etc);
- Role of targets in road safety.

12. Chapter 3: Draft Indicators for Urban Road Safety Audit: It is not clear how this list of indicators is to be used. Is it for general audits (national level, town level?), or for road/site level audits? It seems more like the former. However, the large number of potential indicators makes it difficult to know how to use this information. I would suggest:

    (i) Greatly reducing the list down to those deemed essential.

    (ii) Re-organizing this chapter into three sections: (a) national/state level assessments; (b) town/metropolitan level assessments (if this approach is adopted); (iii) site/road level audits, corresponding with the analysis/review in the earlier sections.

    (iii) Describing how these indicators are to be used in practice (i.e. having collected the data, what will be done with it?).

13. References: It would be helpful to highlight the key references that users of the toolkit should refer to. Provision of web links to specific documents and websites would also be helpful.

14. Might be useful to include a glossary of key terms (e.g. Vulnerable Users) and anagrams.

International workshop comments:

1. Best practice examples
2. Design stage checklist to be included in report
3. Issue of red light jumping improvement measures to be included in report
4. Safety at intersections-Signalized, unsignalized
5. Guidance for different indicators
6. Issues of visibility of signage to be included
7. Impact of different measures to be shown in a table


Annexure 4

Glossary

85th percentile of speed

http://www.bicyclensw.org.au

The speed at or below which 85% of vehicles travel

Accessibility

In transportation, accessibility refers to the ease of reaching destinations

Accident

http://ec.europa.eu

Occurs on a public road or on a private road to which the public has right of access.It involves at least one moving vehicle and at least one injured or killed person. It is reported by the police. Self-reporting is possible.

Accident frequency

The rate of occurrence of accidents.

This number determines how often a driver is involved in accidents, which can help predict losses and base a premium.

Accident rate

The number of accidents that occurs per million vehicle miles of travel.

Calculation of Accident Rates

The accident rate for a location is found by dividing the accident experience by the exposure:

Accident Rate = Accidents / Exposure

Arterial road

http://www.bicyclensw.org.au

A road that predominantly carries through traffic from one region to another, forming principal avenues of travel for traffic movements.

Arterial road (urban)

http://www.bicyclensw.org.au

A general term for a main traffic route, but specifically referring to certain streets so designated in a local authority's district scheme.

Assessment

http://www.bicyclensw.org.au

The technical process of identifying the outcomes of a particular action or proposal, compared with their intentions or objectives

Audit

http://www.nzta.govt.nz

An audit is a planned documentation and activity that examines compliance with the established standards or best practice requirements. An audit consists of a review, monitoring and an evaluation stage. It generally leads to a full report on compliance with best practice and provides recommendations and/or corrective actions if necessary.

Bicycle

A two or three wheeled vehicle designed to be propelled solely by human power, or a two or three wheeled vehicle that is a power assisted pedal cycle.

Black spot

A location of road where a higher than average number of accidents have occurred

Bus Shelter

A roofed structure for people to wait under at a bus stop

A structure constructed near a bus stop to provide seating and protection from the weather for the convenience of waiting passengers.

Casualty

A person killed or injured in a war or accident.

A casualty is a person who is the victim of an accident, injury, or trauma.

A person fatally injured, or who sustains injuries and is recorded as a personal injury in a collision/incident.


Cluster

http://www.bicyclensw.org.au

Several crashes at the one location which are of the same or related accident type.

Crash severity

A measure of the seriousness of a road traffic crash derived from the most severe casualty as a result of a crash, or if no casualty, from the value of property damage.

The five levels are:

1. Fatal crash
2. Hospitalization crash (injury crash requiring hospitalization)
3. Medical treatment crash (injury crash requiring medical treatment)
4. Minor injury crash (injury crash requiring no medical treatment - i.e., minor injury, first-aid only required or extent of injury unknown)
5. Property damage only crash

Crossing

A place where two roads, two railroad lines, or a road and a railroad line cross

http://www.bicyclensw.org.au

A formal area set aside for other modes of transport, pedestrians, cattle, and the like, to cross the road; usually called cycle crossing, pedestrian crossing, railway crossing, as appropriate

Density

The quantity of people or things in a given area or space

Deprivation

Deprivation can be conceptualized and measured, at both the individual and area level, in relation to: material deprivation, referring to 'dietary, clothing, housing, home facilities, environment, location and work (paid and unpaid), and social deprivation, referring to rights in relation to 'employment, family activities, integration into the community, formal participation in social institutions, recreation and education'

Dispersion

The action or process of distributing things or people over a wide area

Empirical bayes

Empirical Bayes methods are procedures for statistical inference in which the prior distribution is estimated from the data. This approach stands in contrast to standard Bayesian methods, for which the prior distribution is fixed before any data are observed. Despite this difference in perspective, empirical Bayes may be viewed as an approximation to a fully Bayesian treatment of a hierarchical model wherein the parameters at the highest level of the hierarchy are set to their most likely values, instead of being integrated out. Empirical Bayes, also known as maximum marginal likelihood, represents one approach for setting hyper-parameters.

Exposure

The state of being exposed to contact with something

Exposure of risk

An exposure to loss (property, liability etc.)

A quantification of the overall threat constituted by a risk that balances the likelihood of actual loss with the magnitude of the potential loss. It is used by the team to rate and rank risks. It is calculated by multiplying probability by impact.

Feasibility

The state or degree of being easily or conveniently done

Fatality

A fatality is recorded when a person dies within 30 days as a result of injuries sustained in a road traffic crash. Fatalities caused directly and exclusively by a medical condition, suicide or other deliberate act (such as homicide) or where the fatality is not attributable to vehicle movement (such as an insect or animal bite, or the accidental discharge of a weapon) are excluded. However, subsequent fatalities caused as a result of excluded casualties are included. For example, if a controller suffers a heart attack and subsequently dies and is involved in a road traffic crash which results in a pedestrian fatality, the pedestrian fatality is included although the controller fatality is excluded.

Intersection

http://www.tams.act.gov.au/

A place at which two or more roads at grade or with grade separation.


Kernel density

http://en.wikipedia.org

In statistics, kernel density estimation (KDE) is a non-parametric way to estimate the probability density function of a random variable.

http://webhelp.esri.com

Kernel Density calculates the density of features in a neighbourhood around those features. It can be calculated for both point and line features.

http://proceedings.esri.com

Kernel density calculates a magnitude per unit area from each hot spot feature using a kernel function. Only the accidents that fall within a certain distance are considered in calculating the density. If no accidents fall within the distance of a particular cell, the cell is not assigned a value.

Kuznets curve

A Kuznets curve is a graph with measures of increased economic development on the horizontal axis (usually GDP per capita) and measures of income inequality on the vertical axis. Kuznets (1955) hypothesized such a curve to have an inverted-U shape.

Applying the Kuznets curve to road fatalities is an outgrowth of the environmental Kuznets curve literature. It applies the Kuznets curve to a large international data set and develops projections of future traffic fatalities with it.

Environmental KUZNETS curve

http://en.wikipedia.org

The environmental Kuznets curve is a hypothesized relationship between environmental quality and economic development: various indicators of environmental degradation tend to get worse as modern economic growth occurs until average income reaches a certain point over the course of development.

Land use

http://www.bicyclensw.org.au

Use to which land is put, e.g. residential, commercial, open space. In transport analysis the term encompasses measures of social and economic activity that take place on the land, e.g. size of population, number of employees.

Median

Medians are an effective method for increasing safety and vehicle capacity on arterials and are generally considered to improve pedestrian safety.

Mode

http://www.bicyclensw.org.au

Method of transport e.g. motor vehicle travel (as driver or passenger), bus, light rail and walking.

Motorcycle

A two or three wheeled motor vehicle designed to transport people. Includes motorcycles with or without a sidecar, motor scooters, trail bikes, mini bikes, and mopeds.

Network

http://www.bicyclensw.org.au

1. Set of roads which provide a means of road based travel within a region. In transport terms it is defined in terms of links and nodes. 2. A schematic mathematical model of a road or public transport system which contains a link-by-link description of the routes covered by the public transport system and the speed and capacities of road links.'

Path

http://www.google.co.in

A way or track laid down for walking or made by continual treading

Pedestrian

http://www.google.co.in

A person who travels by foot (walker, runner for example). Also includes people in motorized and non-motorized wheelchairs and people using wheeled recreational devices or toys.

Polygon

http://en.wikipedia.org

In geometry a polygon is a flat shape consisting of straight lines that are joined to form a closed chain or circuit.

Public transport

http://www.bicyclensw.org.au

Service by bus, rail, taxi or other means, which provides transport to the public on a regular basis for payment of a prescribed fare.


p-value

http://www.stat.ualberta.ca

If we test a null hypothesis against an alternative hypothesis using a dataset. The two hypotheses specify two statistical models for the process that produced the data. The alternative hypothesis is what we expect to be true if the null hypothesis is false. We cannot prove that the alternative hypothesis is true but we may be able to demonstrate that the alternative is much more plausible than the null hypothesis given the data. This demonstration is usually expressed in terms of a probability (a P-value) quantifying the strength of the evidence against the null hypothesis in favor of the alternative.

Residential area

http://www.bicyclensw.org.au

Land largely occupied for residential purposes but which includes small shopping centers and ancillary facilities and primary schools.

Risk

http://www.roadsafetyevaluation.com

Risk is the product of probability of harm and the severity of the outcome.

Risk = probability x severity

http://en.wikipedia.org

Risk is the potential that a chosen action or activity (including the choice of inaction) will lead to a loss (an undesirable outcome).

http://www.who.int

The possibility of an unwanted event occurring.

Risk exposure

http://www.google.co.in

An exposure to loss (property, liability etc.).

http://www.syque.com

A problem when you have a number of possible risks is that it can be difficult to decide which risks are worth putting effort into addressing. Risk Exposure is a simple calculation that gives a numeric value to a risk, enabling different risks to be compared.

Risk Exposure of any given risk = Probability of risk occurring x total loss if risk occurs

Road traffic accident

http://www.who.int

A collision involving at least one vehicle in motion on a public or private road, that results in at least one person being injured or killed

Road Traffic crashes

http://en.wikipedia.org

An incident, involving at least one moving vehicle that may or may not lead to injury, which occurs on a public road.

Road traffic safety

http://en.wikipedia.org

It refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. The users of a road include pedestrians, cyclists, motorists, their passengers, and passengers of on-road public transport, mainly buses and trams.

Road user

http://en.wikipedia.org

A person using any part of the road system as a non-motorized or motorized transport user.

Severity index

The crash severity is equal to the most serious injury sustained by any individual involved in the crash (i.e. a crash that involved one disabling injury and two evident injuries would have a crash severity of 'A'). The severity index (SI) of a crash is equal to the total equivalent property damage only (EPDO) divided by the number of crashes.

Social cost

The Social Cost of a road traffic crash is the average estimated cost to the community that can be applied to the crash type, crash severity, or casualty severity outcome. Social cost approximations are based on the following factors:

1. Lost Future Productivity Costs
2. Medical/Hospital Costs
3. Rehabilitation Costs

4. Funeral Costs

5. Pain and Suffering

Social deprivation

Social deprivation is the reduction or prevention of culturally normal interaction between an individual and the rest of society. This social deprivation is included in a broad network of correlated factors that contribute to social exclusion; these factors include mental illness, poverty, poor education, and low socioeconomic status.

Traffic

The passage of people or vehicles along routes of transportation

http://www.bicyclensw.org.au

A generic term covering all vehicles, people, and animals using a road.

Traffic flow

http://www.bicyclensw.org.au

The number of vehicles passing a given point during a specified period of time

Traffic lights

http://www.bicyclensw.org.au

A device designed to show a traffic light, or two or more traffic lights in a vertical arrangement and at different times, and includes any traffic arrows installed with or near the device.

Traffic volume

http://www.bicyclensw.org.au

The number of vehicles or pedestrians passing a given point on a lane or carriageway during a specified period of time

Urban road

A road within the boundaries of a built-up area, which is an area with entries and exits especially sign-posted as such.

Urban Collector System and Local Road System

Urban collector streets' main purpose is to gather traffic from local streets in residential areas or central business districts and channel it into the arterial system. Collectors, therefore, go through residential and commercial areas and ease traffic circulation through neighbourhoods and business districts. Collectors can penetrate residential neighbourhoods, distributing trips from the arterials through the area to their ultimate destinations. The urban local road system includes all other streets in urban areas that have not been included in the previous systems. The main purpose of these streets is to provide access to abutting land and furthermore to allow traffic on that land access to the collector system. This system has the lowest level of mobility, but the highest level of accessibility

Urban Arterial System

Urban arterial system is divided into principal arterials and minor arterials. Urban principal arterials serve major activity centers, which consist of highest traffic volume corridors, which carry the longest trips. They carry a high proportion of the total vehicle-km of travel within the urban areas. Principal arterials tend to bypass the central business districts and carry most of the trips entering and leaving cities. All controlled access facilities are within this system, though access control is not necessarily a condition. Principal arterials can also be further divided into subclasses based mainly on access control: (1) interstates with full access control and grade separated interchanges, (2) expressways which have controlled access but may also include at-grade interchanges and (3) and other principal arterials which have little or no access control.

Vehicle

A conveyance or device for carrying or transporting items or people

Vicinity

Proximity in space or relationship

Vulnerable road users

http://www.who.int

Road users at most risk in traffic – such as pedestrians, cyclists and public transport passengers. Children, older people and disabled people may also be included in this category.

z-score

Most statistical tests begin by identifying a null hypothesis. The null hypothesis for pattern analysis tools essentially states that there is no pattern; the expected pattern is one of hypothetical random chance. The Z Score is a test of statistical significance that helps you decide whether or not to reject the null hypothesis.

Z scores are measures of standard deviation. For example, if a tool returns a Z score of +2.5 it is interpreted as "+2.5 standard deviations away from the mean". Z score values are associated with a standard normal distribution. This distribution relates standard deviations with probabilities and allows significance and confidence to be attached to Z scores.


Annexure 5

This section has been taken from the National Cooperative Highway Research Program (NCHRP) Report 500 series which has been developed as a series of guides to assist state and local agencies in reducing injuries and fatalities in targeted areasi.e, Bicycle, Motorcycle and Pedestrian.

BICYCLE NCHRP REPORT

The Exhibit I-3 has been taken from TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 18, Guidance for Implementation of the AASHTO Strategic Highway Safety Plan: A Guide for Reducing Collisions Involving Bicycles provides strategies that can be employed to reduce collisions involving bicycles.

EXHIBIT I-3

Emphasis Area Objectives and Strategies

Objectives	Strategies
A. Reduce bicycle crashes at intersections	A1. Improve visibility at intersections (T)
	A2. Improve signal timing and detection (T)
	A3. Improve signing (T)
	A4. Improve pavement markings at intersections (T)
	A5. Improve intersection geometry (T)
	A6. Restrict right turn on red (RTOR) movements (E)
	A7. Accommodate bicyclists through roundabouts (T)
	A8. Provide an overpass or underpass (T)
B. Reduce bicycle crashes along roadways	B1. Provide safe roadway facilities for parallel travel (T)
	B2. Provide contraflow bicycle lanes (T)
	B3. Improve bicyclists' visibility (T)
	B4. Improve roadway signage (T)
	B5. Provide bicycle-tolerable shoulder rumble strips (T)

C. Reduce motor vehicle speeds	C1. Implement traffic calming techniques (P)
	C2. Implement speed enforcement (T)
D. Reduce bicycle crashes at midblock crossings	D1. Improve driveway intersections (T)
	D2. Implement access management (T)
E. Improve safety awareness and behavior	E1. Provide bicyclist skill education (T)
	E2. Improve enforcement of bicycle-related laws (T)
F. Increase use of bicycle safety equipment	F1. Increase use of bicycle helmets (P)
	F2. Increase rider and bicycle conspicuity (T)
G. Reduce effects of hazards	G1. Fix or remove surface irregularities (T)
	G2. Provide routine maintenance of bicycle facilities (T)

P = Proven; T = Tried; and E = Experimental

MOTORCYCLE NCHRP REPORT

The Exhibit V-1 has been taken from TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 22: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan: A Guide for Addressing Collisions Involving Motorcycles provides guidance on strategies that can be employed to reduce crashes involving motorcycles.

EXHIBIT V-1

Objectives and Strategies to Address Motorcycle Collisions

Objectives	Strategies
11.1 A Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices	11.1 A1. Provide full paved shoulders to accommodate roadside motorcycle recovery and breakdowns (T)
	11.1 A2. Consider motorcycles in the selection of roadside barriers (E)
	11.1 A3. Identify pavement markings, surface materials, and other treatements that reduce traction for motorcycles and treat or replace with high-traction material (T)
	11.1 A4. Maintain the roadway to minimize surface irregularities and discontinues (T)
	11.1 A5. Maintain roadway surfaces in work zones to facilitate safe passage of motorcycles (T)
	11.1 A6. Reduce roadway debris – such as gravel, shorn treads, snow and ice control treatments (sand/salt), and that resulting from uncovered loads – from the roadway and roadside (T)
	11.1 A7. Provide advance warning signs to alert motorcyclists of reduced traction and irregular roadway surfaces (T)
	11.1 A8. Incorporate motorcycle safety considerations into routine roadway inspections (E)
	11.1 A9. Provide a mechanism for notifying highway agencies of roadway conditions that present a potential problem to motorcyclists (E)
11.1 B Reduce the number of motorcycle crashes due to rider impairment	11. 1 B1. Increase motorcyclist awareness of the risks of impaired motorcycle operation (T)
	11.1 B2. Expand existing impaired driving prevention programs to include motorcycle riders and specific motorcycle events (T)

	11.1 B3. Target law enforcement to specific motorcycle rider impairment behaviours that have been shown to contribute to crashes (T)
11.1 C Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders	11.1 C1 Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders (E)
	11.1 C2 Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance (T)
	11.1 C3 Identify and remove barriers to obtaining a motorcycle endorsement (T)
11.1 D. Increase the visibility of motorcyclists	11.1 D1. Increase the awareness of the benefit of high-visibility clothing (E)
	11.1 D2. Identify and promote rider visibility-enhancement methods and technology (T)
11.1 E. Reduce the severity of motorcycle crashes	11.1 E1. Increase the use of FMVSS 218 compliant helmets (P)
	11.1 E2. Increase the use of protective clothing (T)
11.1 F. Increase motorcycle rider safety awareness	11.1 F1. Form Strategic alliances with motorcycle user community to foster and promote motorcycle safety (T)
	11.1 F2. Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies (T)
	11.1 F3. Educate operators of other vehicles to be more conscious of the presence of motorcyclists (T)
11.1 G. Increase safety enhancements for motorcyclists	11.1 G1. Include motorcycles in the research, development, and deployment of ITS (E)
11.1 H. Improve motorcycle safety research, data and analysis	11.1 H1. Develop and implement standardized data gathering and reporting for motorcycle crashes (N?A)
	11.1 H2. Include motorcycle attributes in vehicle exposure data collection programs (N/A)
	11.1 H3. Develop a set of analysis tools for motorcycle crashes (N/A)

P = Proven; T = Tried; and E = Experimental


PEDESTRIAN NCHRP REPORT

The Exhibit V-1 has been taken from TRB's National Cooperative Highway Research Program (NCHRP) Report 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan Volume 10: A Guide for Reducing Collisions Involving Pedestrians provides strategies that can be employed to reduce the number of collisions involving pedestrians.

EXHIBIT V-1

Emphasis Area Objectives and Strategies

Objectives	Strategies
9.1 A. Reduce pedestrian exposure to vehicular traffic	9.1 A1. Provide sidewalks/walkways and curb ramps (P)
	9.1 A2. Install or upgradeTraffic and pedestrian signals (P.T. & E)
	9.1 A3. Construct pedestrian refuge islands and raised medians (P)
	9.1 A4. Provide vehicle restriction/diversion measures (P&T)
	9.1 A5. Install overpasses/underpasses (P)
9.1 B. Improve Sight Distance and/or Visibility Between Motor Vehicles and Pedestrians	9.1 B1 Provide crosswalk enhancements (P&T)
	9.1 B2 Implement lighting/crosswalk illumination measures (P)
	9.1 B3. Eliminate screening by physical objects (T)
	9.1 B4. Signals to alert motorists that pedestrians are crossing (T & E)
	9.1 B5. Improve reflectorization/conspicuity of pedestrians (T)
9.1 C Reduce Vehicle Speed	9.1 C1. Implement road narrowing measures (T)
	9.1 C2. Install traffic calming – road sections (P & T)
	9.1 C3. Install traffic calming – intersections (P & T)
	9.1 C4. Provide school route improvements (T)
9.1 D Improve pedestrian and Motorist Safety Awareness and Behavior	9.1 D1 Provide education, outreach, and training (P)
	9.1 D2. Implement enforcement campaigns (T)

P = Proven; T = Tried; and E = Experimental

Reference

1. ADB (2009). Road accident black spot guidelines identification & treatment. People's Republic of China: Road Safety Improvement C. S. I. Mike Goodge, Traffic Management Bureau and Traffic Management Research Institute.
2. Aecom 2011. Road Safety Reserach Report - Delivery of Local Road Safety. London: Department of Transport
3. Anderson, T. 2012. Comparison of spatial methods for measuring road accident 'hotspots': a case study of London. *Journal of Maps*, 55-63.
4. Austroads 2002. Road safety audit, Sydney, Austroads.
5. Cardoso, L., Stefan, C., Elvik, R. & Sorensen, M. 2007. Road Safety Inspections: best practice and implementation plan Steps Sixth framework programme priority, Sustainable Development, Global Change and Ecosystem and Sustainable Surface Transport
6. DFID 2003. Development of an Urban Road safety management approach, Urban safety management, guidelines for developing countries. DFID, Department of international development, UK.
7. Draft National Road Safety Policy, Department of road transport and highways, Ministry of Shipping, Road Transport and Highways
8. Etsc 2005. The Safety of Vulnerable Road Users in the Southern, Eastern and Central European Countries (The "SEC Belt"). Brussels: European Transport Safety Council
9. G. Gururaj (2006). Road traffic injury prevention in India Bangalore, National Institute of Mental Health and Neuro Sciences.
10. Getis, A. &Ord, J. K. 1992. The Analysis of Spatial Association by Use of Distance Statistics. Geographical Analysis, 24, 189-206.
11. GIZ (2011). Urban Road Safety - Sustainable Transport: A sourcebook for policy makers in developing cities. D. G. Fur. Germany.
12. GREAT BRITAIN. 1994. *Design manual for roads and bridges*. [London], H.M.S.O.
13. JSRPRCD 2012. Detailed Project Report for Improvement, Rehabilitation, Strengthening and Widening of Gobindpur - Jamtara Road. Final Detailed Project Report. Jharkhand State Roads Project, Road Construction Department, Government of Jharkhand.
14. Koornstra, M. J. 2007. Prediction of traffic fatalities and prospects for mobility becoming sustainable-safe. Sadhana, 32, 365-395.

15. Lcc 2007. Vulnerable Road User Audit, Policy and Procedure. Lancashire County Council

16. ESCAP 2010, Status paper on road safety in Malaysia (2010)

17. Mcmanus, W. S., University of Michigan. Transportation Research Institute. Automotive Analysis, D. & Strategic Worldwide, T. 2007. *Economics of road safety: an international perspective,* Ann Arbor, Mich., University of Michigan Transportation Research Institute.

18. Michael Sørensen&Elvik, R. 2008. Black Spot Management and Safety Analysis of Road Networks – Best Practice Guidelines and Implementation Steps. *SIXTH FRAMEWORK PROGRAMME PRIORITY - Sustainable Development, Global Change and Ecosystem - Sustainable Surface Transport*.

19. Mitchell, A. 2005. The ESRI Guide to GIS Analysis. Volume 2, Spatial Measurements &Statistics, Redlands (Calif.), ESRI Press.

20. Mohan, D. 2006. Road traffic injury prevention training manual [Online]. Geneva: World Health Organization. Available: http://site.ebrary.com/id/10161479.

21. Mohan, D., Tsimhoni, O., Sivak, M. &Flannagan, M. J. 2009. Road safety in India: challenges and opportunities. The University of Michigan, Transportation Research Institute.

22. National Traffic Safety Program, 2011. Road Improvement and Traffic Safety Project Traffic Safety Project, Ministry of interior, ministry of national education, ministry of public works and settlement, ministry of Health, Gazi University

23. NCRB 2007. Accidental Deaths and Suicides in India - 2006. Ministry of Home Affairs, National Crime Records Bureau, New Delhi.

24. NCRB 2010. ACCIDENTAL DEATHS AND SUICIDESIN INDIA New Delhi: National Crime Records Bureau, Ministry of Home Affairs, Government of India.

25. Nra 2009. ASSESSMENT AND PREPARATION OF ROAD SCHEMESRoad Safety Audit. *NRA DESIGN MANUAL FOR ROADS AND BRIDGES.* Dublin: National Roads Authority

26. NZTA 2010. Vulnerable Road Users, Road Safety Report 2005 to 2009. NZ Transport Agency.

27. Nzta 2010. Vulnerable Road Users, Road Safety Report 2005 to 2009. NZ Transport Agency.

28. Oecd 1998. Safety of vulnerable road users. *In:* (RS7), S. E. G. O. T. S. O. V. R. U. (ed.). Organisation for Economic Co-operation and Development.

29. OECD 2011. Road safety performance: national peer review. Russian Federation, 2010 update. Paris: Organisation for Economic Co-operation and Development.

30. Peden M et al. 2004. World report on road traffic injury prevention. Geneva, World Health Organization.

31. Pws 2006. Status Papers On Road Financing and Improving Road Safety. TURKEY: Ministry of Public Works and Settlement, General Directorate of Highways.

32. RDP 2004. Road Safety Audit Manual. Road development program phase 2 project, Consultancy services for the production of engineering manuals and specifications as well as provision of institutional support. Ministry of works, housing and communications, The Republic of Uganda.

33. Road Safety Is No Accident, National Road Safety Council, 2011, Report of the Working Group on Road Safety Education (RSE)

34. Road Safety Policy 2007. Home, Prohibition & Excise (transport-v)
35. Rodrigues, J. L. F. &Bezerra, B. S. 2005. IMPLEMENTING ROAD SAFETY AUDITS IN BRAZIL. UNIVERSITY OF SÃO PAULO, DEPARTMENT OF TRANSPORT EESC and HIGHWAY DEPARTMENT OF SÃO PAULO, BRAZIL.
36. SURREY 1996. Road safety audit, An investigation into casualty savings. SURREY County council, Highway management division, Casualty reduction group.
37. Sweroad 2001. Safety audit handbook. General directorate of highways, Road improvement and traffic safety project, Traffic safety project. Ankara: SWEROAD, Traffic Safety Consultancy Services
38. Tiwari, G. 2011. Key Mobility Challenges In Indian Cities. Indian Institute of Technology, New Delhi
39. Toi 2007. State of art approaches to road accident black spot management and safety analysis of road networks. Oslo: Institute of Transport Economics, Norwegian Centre for Transport Reserach.
40. Toroyan, T., Peden, M. M. &Iaych, K. 2013. WHO launches second global status report on road safety. Injury Prev. Injury Prevention, 19
41. Twelfth Five Year Plan (2012–2017), Faster, More Inclusive and Sustainable Growth, Planning Commission (Government of India) 2013
42. Winkelbauer, M., Braun, E., European Commission. Directorate General For, M. & Transport 2010. Best practices in road safety : handbook for measures at the country level, Luxembourg, Publications Office of the European Union
43. WORLD HEALTH ORGANIZATION. (2009). Global status report on road safety time for action. Geneva, World Health Organisation.

Toolkit on Urban Road Safety Audit

Urban Road Safety Audit (URSA) tool kit presents a methodology to identify safety related problems in urban transport infrastructure and provides a comprehensive audit methodology to assess the safety issues on urban roads during design or post-construction phase.

This tool kit aims to develop context specific URSA. Site based or city level road safety audit would help the city engineers and planners to develop safety plans for all motorized, non-motorized and vulnerable road users. The tool kit is broadly divided into six units. Each unit provides users with information enabling them to respond to key urban road safety questions and conduction of safety audits. Each unit begins with an overview of the unit's content and list of objectives to help in assessing the achieved outcomes. The tool kit summarizes the best practices, case studies, Indian safety policies, regulations, planning, design and impact assessment. Lastly a matrix of checklists covering the broad category of urban roads: Arterial, Collector and Local roads that include the specific locations of mid blocks and intersections, transit stations (bus stops/metro stations), educational facilities and hospitals.

The proposed checklists have been tested on site and updated after incorporating the stakeholder inputs. It is hoped that the URSA tool kit would bring a fundamental change on how safety is viewed in the urban precincts by the city officials. The rational scoring system developed would help in prioritizing the location/site specific problems. Planning the remedial measures to improve the road safety would thus become less cumbersome.