CyLOS

CyLOS
Cycling Level Of Service Evaluation Tool

Final Report

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1 Project Overview:

Project Title:	**Comprehensive Cycle Infrastructure Auditing and Design Tool (CyLOS)**
Technical Advisor:	Transport Research Injury Prevention Programme (TRIPP), IIT Delhi
Project Consultants:	SGArchitects, New Delhi.
Project Web tool Developer:	Fazio Engineerware.
Project Sponsor:	Shakti Sustainable Energy Foundation.
Project Duration:	360 days (1 Year).
Project Start Date:	June-15th 2013.

2 Background:

It can be expected that the government's policies for boosting cycle use in the cities would attract investments in street infrastructure improvement along with other measures, increasing the potential of using cycling to combat GHGs in India. To realize the full potential of these efforts, the infrastructure design would need to evolve around a detailed understanding of user requirements as well knowledge to convert this understanding in to an effective design, which would attract the desired use. To make this possible designers, planners, engineers etc., would need to be equipped with relevant toolkits, guidelines and manuals. So far; in the absence of any detailed regional design and evaluation tools, it is estimated that more than 75% of the NMV infrastructure development under JnNURM (and other funded schemes) fails to meet user requirements and expectations and thus attracts negligible or dismal use. Planning and engineering solutions failed to integrate cycling in urban infrastructure; resulting in either over segregation to block motorized two wheelers thus mostly excluding use; or reduced priority resulting in bicycle network being compromised to motorized vehicular parking or lanes.

Recent efforts to produce such guidelines and toolkits include the 'Planning and Design Guidelines for Cycle Infrastructure' developed by TRIPP, IIT Delhi. This effort furthers the work on 'Manual for Cycling Inclusive Urban Infrastructure Design' initiated by I-Trans in association with SGArchitects.

This guideline provides an inventory of approaches and solutions for planning and designing of NMT infrastructure in Indian cities. It is felt that this information along with NMT infrastructure audit benchmarks (included in the guidelines) can be moulded in to a feature based, user friendly interactive tool, which can accurately predict and/or evaluate the performance of a proposed or existing infrastructure. The outputs from the tool can also be used to improve plans/designs such as cross section arrangements, intersection details, etc., which will ensure an increased attractiveness and usability of the infrastructure.

2.1 Need of the Study

This project outcome offers a tool to help planners and designers develop an effective Non-motorized transport (NMT) infrastructure, which attracts both choice and captive riders and shall be called CyLOS or short for 'Cycling Level of Service.' The availability of such a tool will direct attention and corrective action towards specific development, implementation and operation issues, resulting in a user appropriate infrastructure. Such efforts in the long term, when replicated across the city, would ensure better utility of investments made in non-motorized transport, generating higher use and better public image. This tool will also be useful to CSO's, NGOs, students, academicians and researchers, seeking to quantify the merits and demerits of developed facilities; as well, effect policy level interventions to address identified critical issues, which are beyond the limits of design solutions. These include, funding of projects, capacity building, dis-incentivising private transport use, etc.

2.2 Goal and Objectives

The final goal of the project is to develop a user friendly cycle infrastructure audit tool which shall provide planners, designers and decision makers; information on infrastructure planning and design shortcomings as well possible improvement strategies for both existing and planned cycle infrastructure. However, this cannot be realized without exploring the tool to its maximum potential. Hence to achieve the stated goal, the tool needs to be disseminated amongst city officials, consultants, practitioners and the user groups, so the primary objectives which can be drawn and needed to be fulfilled are:

1. Creating a comprehensive and user friendly web based tool which can evaluate detailed Cycle infrastructure analysis for all the project cities. This tool would result in development and creation of general set of context specific recommendations for Cycle infrastructure development. Based on various alternative design scenario analyses of the cities the data generated by the tool, could be used in toolkits and manuals.

2. Appraising city officials and consultants on the availability of CyLOS tool in order to ensure its utilization including that for decision makers who may use it for comparative analysis of various alternative designs. The target audience would include state and city level Civil Society Organizations (CSOs), city officials, engineers, along with consultants involved in the development of NMT corridors, etc.

3. Enabling the cities/officials to provide the project monitoring and sanctioning committees with a detailed comparative analysis with respective outcomes to evaluate different alternative design scenarios and their implications.

2.3 Scope and Limitations

As the idea of the project is to develop a user friendly tool for auditing cycle infrastructure and design therefore the project is limited only to cycling infrastructure and users including bi and tri cycle users and does not cover pedestrian infrastructure. Also the tool focussed on commuting cyclists and not on recreational cycle use.

3 Literature Study

Evaluation of cycling infrastructure needs to be comprised of various elements and features in terms of cycling requirements. These cycling requirements are categorized under five major categories: Coherence, Directness, Safety, Comfort and Attractiveness.

Coherence – Coherence relates to the legibility and connectivity of the bicycle network. In design, this implies that the segments in the network should look similar to improve the legibility and usability of the bicycle infrastructure and there is provision of good connectivity between all origins and destinations. Constant width ensured through design with adequate widening at turns and rendering the same texture for typical scenarios across the network shall help not only the cyclists to identify with it but also ensure motorists to be cautious at potential locations .Elimination of any missing segments as well as standardization of intersections i.e. the shape, size and form of each category of junction solution should be similar to help the cyclist be aware of vehicular behaviour in the traffic mix. Also, use of various measures like marking, signs and traffic calming measures across intersections improves coherence.

Safety – Relates to safety from accidents and security from crime. Prevention of collisions and reducing the conflicts and their impact shall result in a safer travel. Provision of adequate and uniform lighting ensures enhanced usability as well as safer streets. Integration of spaces for hawkers and vendors, support facilities provides security and the necessary eyes on street. Design of minimal conflicts (and sub-conflicts), introducing traffic calming and resolving complexity by eliminating segregated left turning lanes, etc., makes safer intersection.

Directness – Directness of bicycle infrastructure has to do with the amount of time and effort required by a cyclist to undertake a journey. Therefore, major detours from their natural path should be avoided. As mentioned in **'Design manual for bicycle traffic'** (CROW, June 2007)**,** directness has two components: in terms of distance and time. At intersections, directness in time may be achieved by eliminating stopping/waiting for cyclists by introducing bicycle specific grade separated infrastructure, defining the cyclists right of way and signals which eliminate or reduce staged crossing and delays. Directness in distance for NMV users can be achieved by eliminating any detours or long bends for cyclists at intersections, and by reducing or eliminating stages in a crossing.

Comfort – Relates to physical comfort experience by cyclist, example shade and smooth ride. Riding comfort is essential to bicycle infrastructure therefore the surface should be even and free of cracks and potholes. Riding surface for cyclists at the intersection should be smooth to reduce inconvenience. Water logging in the path of cyclist areas is uncomfortable and therefore it is important that proper drainage should be provided with regular maintenance. Also at intersections, traffic nuisances should be minimum. Segregation terminating up to the stop line at high speed roads or high volume distributor and access roads will ensure cyclists their Right Of Way (ROW) not obstructed by vehicular traffic.

Attractiveness – Relates to visual and physical attractiveness of the route environment. To ensure attractiveness, it should be taken care that the path of the cyclist should be clean and devoid of any material dumped that blocks movement. Else, it shall prevent the cyclist from using the cycle infrastructure from the initial point and use the carriageway in unsafe conditions. Location of spaces for hawkers and vendors, well integrated bus shelters, green areas, resting spaces, etc. and shaded NMT infrastructure is definitely attractive

The understanding of such features and elements can be consolidated by combing the findings and inferences from the various cycling infrastructure planning and design related guidelines, manuals, thesis etc and for the purpose the following studies presented in the **Table 1** have been followed to develop the CyLOS tool.

Table 1: Literature studies

S.No	Literature Study
1	Urban Road Safety audit (URSA)
2	Public Transport Accessibility Toolkit (PTA)
3	Parisar- Cycle track assessment report - Pune
4	H.C.M based tool developed by Dr. Joseph Fazio
5	Ph.D thesis by J.Himani
6	Bicycle Design Manual for Indian Subcontinent

The chapter focuses on the above mentioned literature reviews undertaken to extract the significant indicators and parameters that can be used for evaluation of cycling infrastructure.

3.1 Evaluation Frame work

For the evaluation of any kind of infrastructure the foremost thing required is to develop an evaluation frame work. This frame work is a methodology to approach the evaluation process. As the prime objective is evaluation, it is observed that each study (listed above) had a unique evaluation frame work to rate the cycle infrastructure. **Table 2** below presents the objective of the studies and the evaluation frame work adopted by each.

Table 2: Literature study –Objective and Evaluation Frame work

S.No	Literature Study	Objective	Frame work
1	Urban Road Safety audit (URSA)	Identifying the indicators of safety in urban areas and provide comprehensive solution for urban road safety audit.	Frame work based on the street typology and the context.

2	Public Transport Accessibility Toolkit (PTA)	To define exact parameters, that can be used to describe Public Transport Accessibility.	Frame work based on the street typology and the context.
3	Parisar- Cycle track assessment report - Pune	Evaluation of cycle tracks based on the parameters- Continuality, safety and comfort.	Suggests a feature based evaluation frame work system.
4	H.C.M based tool developed by Dr. Joseph Fazio	To develop a tool for the purpose of evaluation of cycle infrastructure.	Reveals an evaluation network based on type of road and the infrastructure settings.
5	Ph.D thesis by J.Himani	To integrate critical parameters influencing cycling, including land use and street environment aspects.	Focuses on an evaluation frame work based on the user perception and context including road hierarchy and adjacent land use.
6	Bicycle Design Manual for Indian Subcontinent	To develop a cycling friendly manual in context to Indian subcontinent.	Suggests a context and user perception based evaluation frame work system including road hierarchy, adjacent land use and infrastructure settings.

It is observed from the literature reviews, that each frame work for evaluation is based on components which influence cycling requirements. Reviews of above mentioned documents and guidelines have been broken down in the following components which are found to be vital for evaluating cycle infrastructure:

- **Evaluation unit** - This refers to the unit of evaluation such as city, Station area network route or corridor etc.
- **Context** -This refers to the situation or the background of evaluation unit with respect to the surroundings and the conditions on ground.
- **User type** -Indicates type of commuters using the cycle infrastructure.
- **Infrastructure Settings**– this deals with treatment to the NMV users in order to meet cyclist requirements at intersections and mid blocks separately, based on planning and design approaches (in different contexts)
- **Geometrics** - The infrastructure requirements needed to suffice all the needs of NMV users in terms of space and geometrics requirements.
- **Environment and Enforcement** - A good Cycling Environment and Enforcement is required not to force the cyclist with in a cycle infrastructure, but to prevent its misuse by the other modes and functions.
- **Special conditions** – this refers to the site limitations in the form of encroachment, existing trees, culverts, and religious structures, location of bus shelters and insufficient right of way etc. causing obstructions and hindrance in an infrastructure.

3.2 Evaluation Unit

For any evaluation to be undertaken, a unit or boundary conditions of the same is needed to be fixed. This is termed as the evaluation unit. An evaluation unit may refer to city, station area network, route or corridor, etc as the cycle infrastructure cannot exist or planned in isolation. When city is considered as an evaluation unit, macro level indicators such as accessibility to safe cycling infrastructure, cycling trips as a proportion of total trips in the city, etc. are used. For station area access evaluation, an evaluation of all corridors leading station area need to be conducted. Such an evaluation is broader and may involve aggregation of evaluation for access by all modes including cycling (**Bicycle Design Manual for Indian Subcontinent**). When a corridor or route is desired to be evaluated the evaluation can be conducted for cycling infrastructure independent of the context or in relation to the context. Where the evaluation is independent of context it looks at infrastructure details such as curb heights, widths, segregation type, number of constructions, etc. irrespective of the setting or the road category along which the infrastructure is developed (**Parisar- Cycle track assessment report**). Where a cycling infrastructure is appraised with reference to the context, each of the infrastructure features and performance indicators are evaluated in relation to the context they are placed in. For example the kind of pathway required by cyclist is specific to different road classifications (**Urban Road safety Audit (URSA)** and **Public Transport Accessibility toolkit (PTA)**).

3.3 Context

Context forms the base for development of any kind of infrastructure whether it is public transport pedestrian or cycle infrastructure. The design and development of a cycle infrastructure begins by understanding the surrounding context (**Bicycle Design Manual for Indian Subcontinent**). The relationship between the existing built environment and the cycling infrastructure is important to achieve a comprehensive and cohesive cycling package of a city or a street. Therefore, it is essential to identify indicators which can measure and evaluate the context. The features of the surrounding context of an existing or proposed infrastructure are street typology available right of way (ROW), road geometrics, abutting land use, traffic composition on the streets, road cross sections etc. (**Urban Road safety Audit (URSA)** and **Public Transport Accessibility toolkit (PTA)**).Context can also vary differently on either side of the road (Left hand side and Right hand side) customized to the street framework, strengthening the need to evaluate the streets separately for both directions.

3.4 User Type

The evaluation of an infrastructure largely depends on the type of users using it. This requires understanding the difference between the characteristics and requirements of different non-motorized modes as well understanding the requirements of different types of NMV users. The different NMV modes are further classified into Bicycles, cycle rickshaws for passengers and goods. Cycle rickshaws have different requirements from cyclists as they are much heavier and require higher effort to maintain a desirable speed and integrate with other modes of transport (**Bicycle Design Manual for Indian Subcontinent**). Hence cycle rickshaws have completely different requirements of access and travel. On the other hand the cyclist can also be further divided into two categories; potential cyclist and captive cyclist. One who bicycles by choice is termed as potential cyclist where as a 'captive cyclist' is bound by economic constraints and do not have a choice. Surrounding land uses and destinations play an important role in determining the type of users of the infrastructure (**Ph. D thesis by J. Himani**) . The proportion of categories of anticipated end-users is important to consider while selecting appropriate bicycle infrastructure and facilities (**H.C.M based tool developed by Dr. Joseph Fazio**).

3.5 Infrastructure Settings - Mid block and Intersections

NMV connections consist of a series of road cross sections and intersections. Intersections and mid-blocks play an integral role in providing continuity to the NMV users (**Parisar- Cycle track assessment report – Pune**). Since the issues associated with roads differ from those related to intersections, Evaluation of infrastructure for cyclists require that intersections be evaluated separately from mid blocks segments. This is because intersections require different planning and design approaches (in different contexts) in order to meet cyclist requirements (**Bicycle Design Manual for Indian Subcontinent**).

3.6 Geometrics

The infrastructure designed must be such that it suffices all the needs in terms of space and geometry specific to land use and the user type. Different land use characteristics shall result in different geometrics requirements on either side of the road such as width of the cycle tracks, continuity of the tracks, curving radius, height, slope etc (**H.C.M based tool developed by Dr. Joseph Fazio**). The needs of different user types will also result in different geometric design requirements such as slopes and gradients to ease steering at low speeds, good surface type to protect the rider from shocks of the road, segregation type etc. Therefore it is essential to identify the percentage of users using the infrastructure and different components of land uses (**Ph. D thesis by J. Himani**) along the streets and subsequently use the data to evaluate the geometrics (**Urban Road safety Audit (URSA)** and **Public Transport Accessibility toolkit (PTA)**).

3.7 Environment and Enforcement

A good environment and strict enforcement strategies are required as motivations for cycling and also ensure that NMV commuters do not switch to other modes of transport. Incompatibility of motorized traffic with NMV commuters is responsible for a significant proportion of the safety issues (**Bicycle Design Manual for Indian Subcontinent**). It is recognized from the literature reviews that if goals to encourage cycling are to be met, then the environment they occur in must be safe & comfortable (**Parisar- Cycle track assessment report – Pune**). Therefore it is important to comprehensively evaluate the host of the cycling environment such as shade during the day, light after dark, barrier free cycle tracks, traffic calming measures, presence of buffer zone to physically segregate from the motorized traffic, ensuring safety and security for cyclists etc (**Urban Road safety Audit (URSA)** and **Public Transport Accessibility toolkit (PTA)**).

In addition to the environment, establishing effective regulatory and enforcement mechanisms to assist various state and other government bodies to strengthen and improve the cycle riding experience. There exists a vicious cycle between the enforcement issues and NMV commuters. Generally the cycle infrastructure remains unutilized due to the issues like missing lengths, low maintenance, and encroachment by hawkers, parking on cycle paths, etc (**Parisar- Cycle track assessment report – Pune**).Hence for the purpose of evaluation of cycling facilities, the enforcement strategies play a very critical part in the provided or proposed infrastructure. These strategies shall include design and training applications of appropriate safety policies, implement bicycle related laws, speed enforcement for all modes of traffic, prohibition of others modes in NMV infrastructure, implementation of cycling oriented signage and markings etc for enhanced safety of bicycle users (**Bicycle Design Manual for Indian Subcontinent)**.

3.8 Special Conditions

Site limitations in the form of encroachment, existing trees, culverts, religious structures, location of bus shelters, insufficient right of way etc presents bottleneck conditions in an infrastructure. These can be termed as special conditions as these can vary according to the route or corridor (evaluation unit), site conditions, relative context, street typology, adjacent land use etc. For evaluation process to be undertaken, these constraints require special attention and design judgment accordingly. However it can be observed that each of the study has taken care of these special conditions according to the features of their respective evaluation framework. Where the evaluation is independent of context, these above mentioned obstructions or bottlenecks form a part of geometry (**Parisar- Cycle track assessment report**).In case of context oriented evaluation the special conditions are been distributed as part of street typology, land use etc (**Urban Road safety Audit (URSA)** and **Public Transport Accessibility toolkit (PTA)**).Similarly if the evaluation network is based on infrastructure settings the site specific constraints are being discussed in terms of intersections and mid blocks located on the existing infrastructure(**Bicycle Design Manual for Indian Subcontinent)**.But to create a better cycling infrastructure the proposed evaluating tool must pursue these special conditions separately as an essential part of input data to rate an infrastructure.

The methodology for evaluation of cycling infrastructure, adopted in CyLOS tool is based on the evaluation strategies identified from the literature studies discussed above.

4 Methodology

This section discusses the CyLOS tool methodology in two parts. The first part briefly details out the methodology used in the development of the tool, while the second part discusses the functional methodology or the working of the tool.

4.1 Development Methodology

The CyLOS project is planned to be undertaken in 4 different parts under two stages or phases; i.e. tool development and appraisal respectively. As shown in **Figure 1** first 3 parts of the project fall under tool development stage where as the last part comprising of appraisal of the tool and feedback collection is incorporated in the stage2.

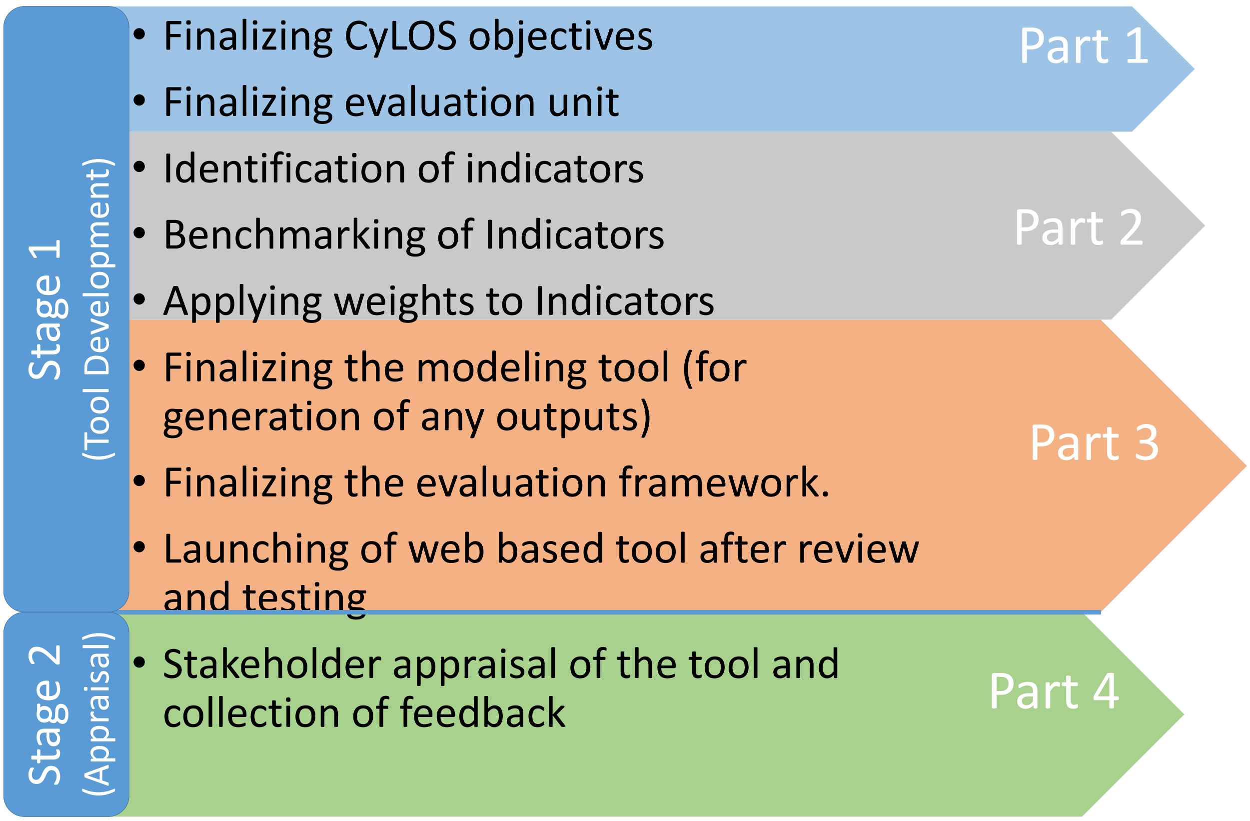


Figure 1: CyLOS development Stages

The cycling infrastructure audit and design tool has been conceived as a web based interactive and user friendly tool. A web based approach not only ensures better access but also allows a user friendly interface. 'www.cylos.in' was selected as the domain name to host the site containing the tool. The site was planned to not only host the evaluation framework of the tool but also background information and reports on the working of tool as well the cycle infrastructure design guidelines on which the tool is based.

The evaluation framework of the tool was developed based on discussions with TRIPP, IIT Delhi. It was agreed that the evaluation framework will be built against the backgrounds of cycling infrastructure planning and design recommendations included in the 'Planning and Design Guidelines for Cycle Infrastructure'. The criteria or heads under which evaluation shall be undertaken is based on the literature review and has been discussed in the previous section. This led to the finalization of evaluation units in the tool. The three broad evaluation units in the tool were cycling corridor or route evaluation, cycling access in transit influence zone evaluation and the overall city level cycling infrastructure evaluation.

Based on the evaluation units, indicators for evaluations under different categories, related to standard cycle infrastructure design principles; were identified. A total of 33 indicators under five categories, viz. coherence, safety, directness, comfort and attractiveness were identified route or corridor as well transit access zone evaluation. Seven of these indicators were repeated under two categories while the rest were represented in single category. City cycling infrastructure evaluation unit uses ten indicators in two categories. These two categories are the current city status and potential for the city. Evaluation against both these categories is independent and the results are not aggregated.

Following the identification of indicators, each of the indicators were benchmarked and assigned weights to allow an aggregated output. It was decided that the tool shall present both, disaggregated output against each indicator as well aggregated output for the overall cycling infrastructure. A weighted aggregation was preferred. This require determining weights not just for individual indicators within each category but also category weights. Combined this would allow weightage of each indicator in the overall evaluation. Benchmarking of indicators was undertaken based on literature review. Because of our evolving knowledge on the measure of different indicators and their impact on the cycling infrastructure design, it was decided that all weightages and scaling values (against the benchmark for each indicator) shall be presented in the default form and be open to editing during evaluation. However edited values can always be compared against the default values in the tool.

Three methods were used to estimate the weightages for all indicators. They were either derived using an AHP based questionnaire presented to either experts or potential cyclists; or these were derived using discussion format with experts at TRIPP, IIT Delhi. The details of indicators used in each evaluation unit as well as their weightages have been discussed in detail in sections 6.1 and 7.2.

After finalization of weightages in each category for each evaluation unit, the algorithms for evaluation were developed. As a part of developing evaluation algorithms, input variables required for evaluation all the indicators were identified, along with the parameters which define their relationship to each other as well to weightages and the scale used for evaluation (refer section 6.2). These input variables were subsequently organised in sequential forms on the basis of the order in which one variable effects or defines the other. This sequence was clubbed and arranged under logical heads such as design and context inputs, so as the same could be presented in specific forms for each evaluation unit on the web site user interface. The content of the forms is explained in detail in the CyLOS user manual, while its architecture and order of presentation in the web site has been presented in Chapter 5 of this report.

In stage two of the CyLOS tool development the tool was presented and discussed with stakeholders such as civil services organizations (CSO), city officials (Transport Department, Municipal Corporation, etc.), planners, engineers, consultants, etc; through a series of four workshops held at different parts of the country. The objective of these workshops present the finished tool was not only to spread awareness about the tool but also to discuss its working along with contents of evaluation output; in order to gather feedback and recommendations on any changes required. The proceeding of these workshops has been presented in section 8 of this report.

4.2 Working Methodology

Working of CyLOS tool can be explained as a six stage linear process (Figure 2). To initiate an evaluation of cycling infrastructure using CyLOS tool the user has to click the getting started button on the website, following which he/she needs to login to the functional part of the tool. First time users would need to register by inputting their credentials including name, email address and contact details. User login is an essential requirement to use the tool in order to allow repeat users to access previously evaluated information and data.

After login, the users can select one of the three evaluation units based on their requirements. These units are route/corridor, transit station access area and city wide network evaluation. Each of the evaluation units has its own data requirements and evaluation methodology. The getting started page includes observations sheets and list of such data requirements along with general instructions on how to use the tool.

Selection of evaluation unit is followed by user input forms which allow data input for evaluation. The first of these forms presents questions to gather basic data, to allow cataloguing of the evaluation file in the web server. Hence this form collects basic information such as file name, city, corridor/route info, basic demographic data, etc. Along with this information the route and corridor as well transit station access area evaluation unit requires the user to input number of evaluation segments or links respectively. This information determines the number of sets of data forms that will be presented to the user in subsequent pages, and allows disaggregated segment/link level evaluation for a route or transit station access area cycling infrastructure. This is useful in situations where the entire route or area does not have similar environment (context) or planning/design details.

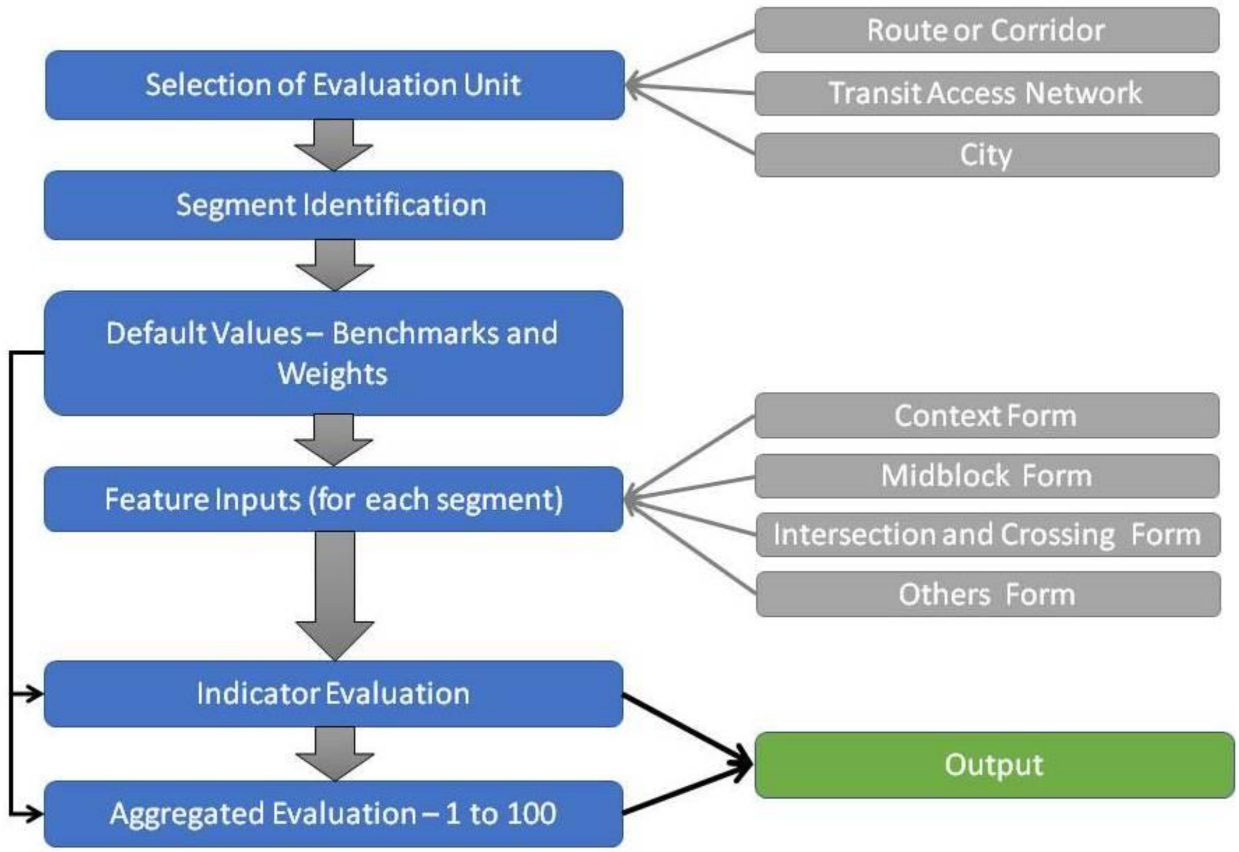


Figure 2: Flow chart showing the working methodology of CyLOS Tool

After filling in the basic information the user may choose to review and/or edit the default values used in the evaluation. These default values have been presented as four different categories. These are standard, which includes standard values such as walking speed; scaling, which includes the scale used for evaluation of different features such as bicycle infrastructure width; matrix, which includes some feature scales in a matrix format; and weightages, which includes weights applied to different indicators and their categories for the overall aggregation of evaluation scores. The weightages used for different indicators and the method of determining the same has been discussed in section 7 of this report. All values listed included in the defaults page have been presented in the user manual which can be accessed on the CyLOS web site.

Users may also skip accessing the default value page (which is reached through a separate link on the forms page) and continue inserting information in the input forms which follow the basic information form. These data input forms collect two types of information in separate set of forms. This information concerns the context and planning/design details. Context details include information about the environment (corridor/area or city) in which the infrastructure being evaluated has been developed. This information includes corridor ROW, no. of lanes, speed limit, lighting levels, etc. Planning and design forms include information on the infrastructure features such as cycle path surface type, cycle path width, etc. Forms are arranged sequentially and have been designed with self-filling capabilities in order to reduce effort from the user and to increase its user friendliness. Each input field in the form includes an "i" icon, which allows display of information about the field through a mouse over action.

After filling information in data forms indicator and overall segment level evaluation for that particular segment is presented. The set of data input forms are repeated for each segment, but allow the users to mirror information from any of the previous forms. This is designed to increase the user friendliness of the tool, and reduces user effort and input time, especially in conditions when only limited changes exist between any two segments. Segment level evaluation for each of the segments is presented after specific segment forms are filled in. After inserting data for all segments an overall route or area level evaluation is presented which also included the segment evaluation details along with an aggregated evaluation score. The tool allows user to print all output results (segment or overall).

5 CyLOS Tool – User Interface

CyLOS tool proposes a comprehensive evaluation of cycle infrastructure. The evaluation process of cycle facility, adopted by CyLOS tool is designed in two broad parts, i.e. 'front end' and 'back end'. The front end or the user interface of the evaluation incorporates the entire data requirement and input process while in the back end part; or the tool algorithms compute and evaluates the cycle facility based on the information provided by the user along with default data stored in server. The 'Front end' mainly relates to the actual user interface and therefore includes all the control buttons and input forms on the mentioned website designed for the tool. To avoid any mystification at the user interface level, the tool is devised with an applied architecture, which can be helpful to the user, to understand the various stages of the evaluation process with all its permutations. The architecture is applied throughout evaluation process performed by the tool. **Figure 3** presents a flowchart showing the CyLOS tool architecture.

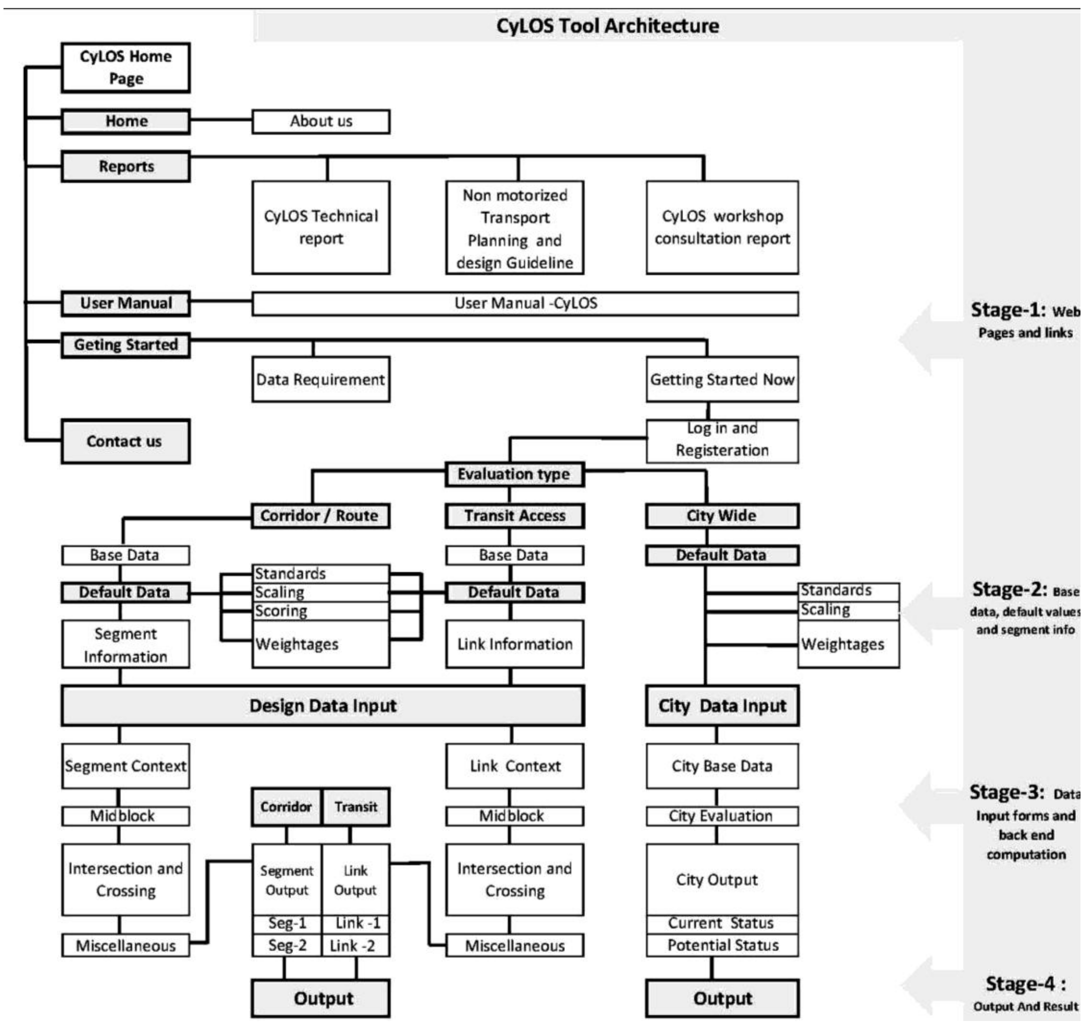


Figure 3: CyLOS Tool Architecture

It can be observed from the above flowchart that the user has to encounter a series of different types of web pages and forms, through the evaluation process. Each of these web pages and forms has a different role to perform such as initial web pages, inform user how to use the tool whereas some of the web pages provide links related to cycle facilities, some web pages appear as input forms collating data for the purpose of analysis of the selected cycling facility whereas the web pages presenting the overall result of the evaluation are different. Therefore, In order to enhance the user friendliness, the tool architecture categorizes these user interface forms under four broad stages.

- Stage-1: Comprises of all the Web pages and links.
- Stage-2: Comprises of Base data, segment Information and default values forms.
- Stage-3: Comprises of the Data input forms.
- Stage-4: Comprises of Output and results forms.

The tool architecture also ensures that the front-end part appears to the user in the mentioned hierarchal order. More details on the forms, input fields, etc.; used in the under interface have been presented in the user manual, which can be downloaded from the CyLOS web site. **Figure 4** shows the home page, with the user manual button to access the same.

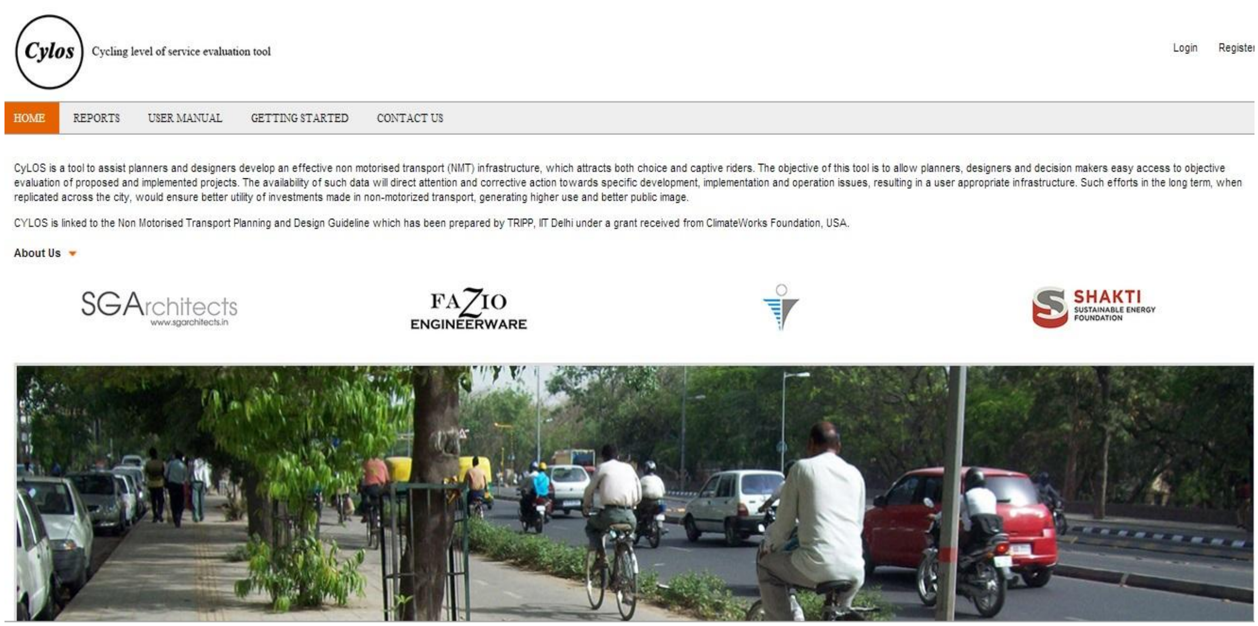


Figure 4: CyLOS Tool Main page or Home Page

6 Computation Framework for Evaluation

'Computation Framework' refers to the algorithms built in to the tool for estimation and generation of evaluation outputs or score at the back (server) end of the tool. Back end evaluation combines and computes different data input in the form, along with inserted default values; with a goal to provide an evaluation unit specific assessment of cycle infrastructure.

6.1 Evaluation Methodology

CyLOS tool proposes to evaluate cycling infrastructure at three broad levels. These are:

1. Cycling Route or Corridor.
2. Transit (or specific function) access network.
3. City wide cycling infrastructure availability assessment.

The proposed base for evaluation in case cycling route evaluation and transit access network is cycling route (or corridor), which is evaluated based on detailed design inputs. Therefore, multiple cycling routes can be graded, and an overall grading of these routes is provided using weighted means method. In case of cycling route evaluation, a individual cycling route is considered as a segment whereas in case of transit access network evaluation a individual cycling route/corridor is considered as a link. The evaluation of each cycling route, (segment or link, based on the evaluation type) has been broken down in to indicators influencing cycling requirements. These indicators derived from the multiple sub indicators developed from the data inserted by the user in the front end web pages.

Each of indicators involved in the evaluation process contributes to the five well known categories affecting cycling requirements. These are:

1. **Cohesion** – relates to continuity and readability of infrastructure
2. **Directness** – relates to directness in space (no detours) and directness in time (reduced travel time).
3. **Safety** – Relates to safety from accidents and security from crime.
4. **Comfort** – Relates to physical comfort experience by cyclist, example shade and smooth ride.
5. **Attractiveness** – Relates to visual and physical attractiveness of the route environment.

The evaluation is proposed to be presented as disaggregated results under each indicator in each of the above categories. To arrive at an aggregated result or score, these results are needed to be aggregated, for which they are assigned with defined weightages. Current evaluation method uses assumed weightages assigned as default in the tool. However the default values form in the tool allows users to change these weightages. It is proposed that the default value of each of these weightages be arrived at using inputs from experts and stakeholders in bicycle infrastructure planning. The same is proposed to be undertaken using a questionnaire based survey (to be analysed using AHP method).

While city wide cycling network assessment is undertaken by directly inducing indicators impacting the cycling status and prospective of a city and inserting their assessment along with inputs, an overall representation of the city is done.

6.2 Evaluation Framework: Cycling Route and Transit Station Access Area

Assessment of cycling route is based on a segment based evaluation method. Each route can be broken in to distinct segments (based on features as well planning and design conditions), and input separately. The tool shall undertake individual assessment of each segment and then aggregate the same in to an overall evaluation by giving weightages based on length and road/street category under each segment. For example infrastructure could be an independent track, on a highway, on an arterial road, on a sub arterial road, on a collector street or on an access road. Each road type presents a different context and hence weightages of indicators between these cannot be the same. The assessment is undertaken separate for each side of the road, i.e. left hand side (L.H.S) and right hand side (R.H.S), separate for mid blocks (between intersections) and intersections. These separate evaluations are then aggregated in to an overall segment evaluation (or an evaluation score). This evaluation when aggregated with their individual indicator provides and overall assessment of each segment. Further different segment assessment then combines to provide a route assessment.

6.2.1 Indicators: Cycling Corridor/Route

To simplify the process, the data points mentioned in the web forms, have been assessed under 80 multiple derived indicators. Derived indicators are indicators which are not independently used in the evaluation but assist in the evaluation of identified indicators. Each derived indicator may be used in the evaluation of more than one indicator. For example frequency of crossing is one of the derived indicators for ‘accessibility index’, while it is also a derived indicator for ‘safety index of crossings.’ These derived indicators combine and generate evaluation under different primary indicators. A total of 26 primary indicators are evaluated. These indicators combine to evaluate the infrastructure under each of the mentioned five categories. **Figure 5** presents the relationship between these derived indicators, indicators and their categories.

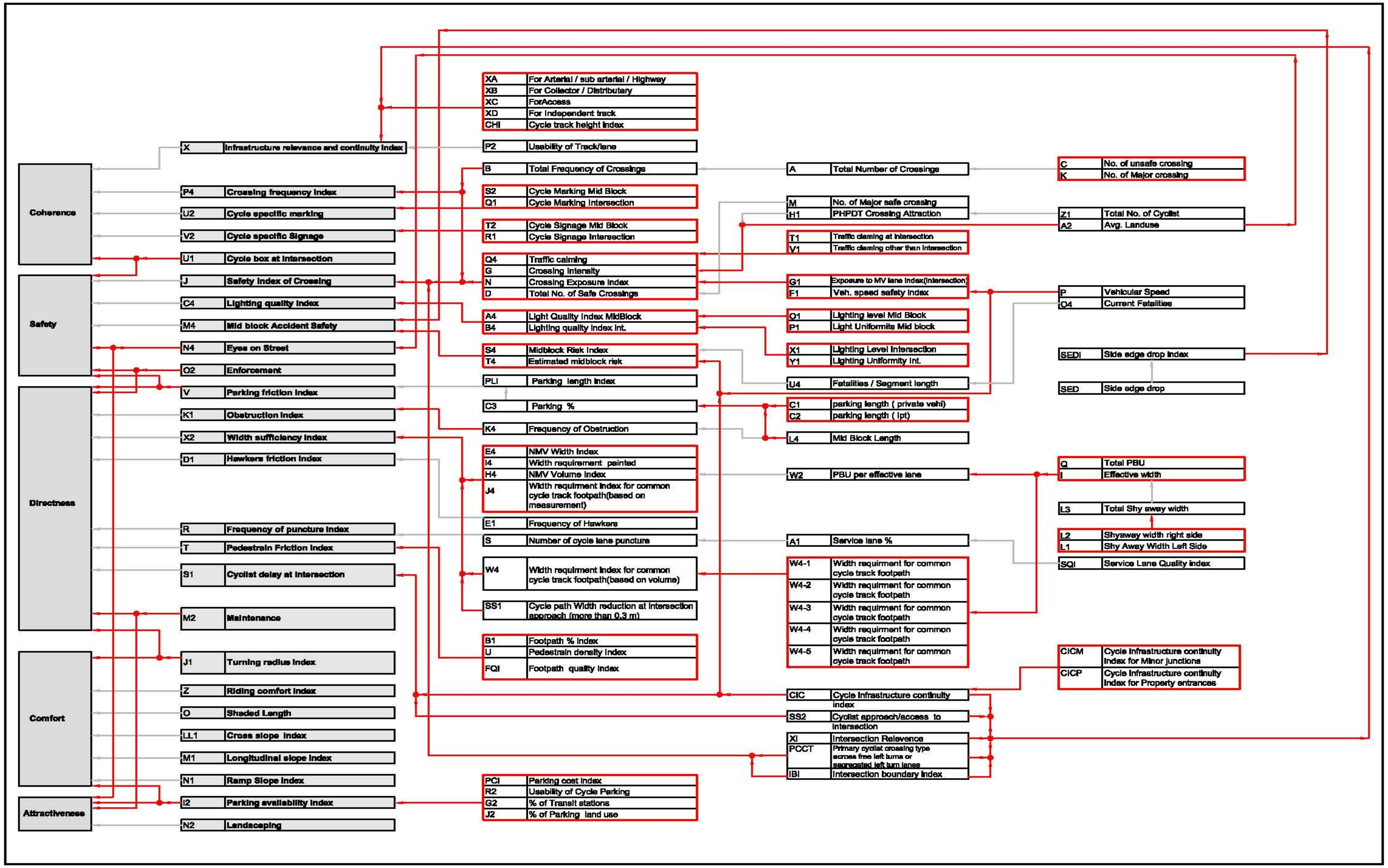


Figure 5: Flow chart showing relationship between Categories, derived indicators and Indicators

The 26 primary indicators used for the evaluation of cycling route/corridor are as follows:

1. **Infrastructure Relevance and Continuity Index:** This Indicator contributes to coherence category and refers, how relevant is planned/constructed infrastructure to its context. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:
    - Relevance of cycle infrastructure according to road typologies: Indicates the relevance of the provided cycle infrastructure based on the type of road (Arterial, Sub-arterial, Highway, collector, access and standalone track).
    - Usability of cycle tracks/ lane: Indicates the relevance of the provided cycle infrastructure based on level of usability i.e. percentage of cyclist using the facility along the segment.
    - Intersections Relevance: Indicates the relevance of the provided cycle infrastructure based on the type of intersections (Signalized, un-signalized, one lane roundabout, two lane round about, rotary and grade separated junction)
    - Primary cyclist crossing type at segregated left turns and on the intersection boundary: Indicates the relevance of the provided cycle infrastructure based on the cyclist crossing type provided on segregated left turns and on the boundaries of the intersection.
    - Cycle infrastructure continuity at minor junctions and property entrances: Indicates the relevance of the provided cycle infrastructure based on continuity of cycle path at the minor junctions and the property entrances.
    - Cyclist approach to the intersections: Indicates the relevance of the provided cycle infrastructure based on the type of infrastructure provided while approaching an intersection.
    - Cycle track height index: Indicates the relevance of the provided cycle infrastructure based on the height of the cycle facility on the segment.
2. **Crossing frequency index:** This Indicator contributes to coherence category and refers to how frequent are available opportunities for cyclists to cross the road. Crossing frequency index is based on the total frequency of the crossings existing on the cycle path.
3. **Cycle Specific Marking:** This indicator contributes to coherence category and refers to availability of adequate pavement marking to guide, warn and regulate cyclists. This primary indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring presence of cycle marking at midblock and intersections.

4. **Cycle specific Signage:** This indicator contributes to coherence category and refers to availability of adequate sign boards to guide, warn and regulate cyclists. This primary indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring presence of cycle signage at midblock and intersections.
5. **Cycle Box at Intersection:** This indicator contributes to two categories- Safety and Coherence. It indicates the availability of cycle box marking at intersection to hold crossing cyclists. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring presence of cycle box at intersections.
6. **Safety index of crossings:** This indicator contributes to safety category and refers to the level of safety in terms of crash risk and severity, at cyclist crossing facilities. This Indicator aids to evaluates, how safe are the crossings for the cyclist. This primary indicator includes other sub- indicators involved in evaluation process. These sub indicators are as follows:
    - Traffic calming: Indicates the provision of traffic calming used at intersections and other than intersections (midblock).
    - Intensity of crossings: Indicates crossing intensity of the cyclist based on the weighted average land use along the segment and crossing attraction per hour per direction.
    - Crossing exposure index: Based on cyclist exposure to MV lane and vehicular speed safety index, indicates exposure of the cyclist while crossing at the intersection.
    - Crossing attraction per hour per direction: Indicates crossing attraction of the cyclist based on total number of cyclist.
    - Exposure to motor vehicle lane index: Depending on the number of lanes provided in a segment helps in determining the exposure of cyclist at an intersection while crossing.
    - Vehicle speed safety index: This index is developed based on the vehicular speed and road type provided in the segment or the corridor indicating safety of the cyclists.
    - Total number of safe crossings: Based on the number of major safe crossing provided on the segment indicates safe crossings for the cyclists.

These sub- indicators are developed from the input inserted by the user in front end web forms like presence of traffic calming, vehicular speed and number of lanes on the carriage way etc.

7. **Lighting Quality Index:** This indicator contributes to safety category and refers to the quality of lighting in terms of level and uniformity at midblock and intersections. This

indicator includes the sub indicators - lighting quality index at midblock and intersections. These sub- indicators are derived from the input inserted by the user in front end web forms for lighting levels and uniformity at midblock and intersections.

8. **Midblock accident Safety:** This Indicator contributes to safety category and refers to the assessment of accident risk for cyclist along the carriageway. This indicator is comprised of many other sub indicators. These are:
    - Midblock risk index: The index, Indicates the amount of risk involved for the cyclist at midblock based on the total number of fatalities per segment length.
    - Fatalities per segment length: Indicates the number of current fatalities on the midblock.
    - Estimated midblock risk: This indicator estimates risk for the cyclist at midblock based on the vehicular speed at the midblock section and the primary segregation type of the cycle facility from the carriage way.
    - Side edge drop index: This index is developed on the basis of depth of the side edge such that more the depth, high is the risk for the cyclist.
    - Cycle infrastructure continuity: Indicates level of risk of the cyclist involved based on continuity of cycle path at the minor junctions and the property entrances .As more the cycle facility is discontinuous at minor junctions and the property entrances more it increases the chances for the cyclist to ply on the carriage way rather than the provided cycle infrastructure causing accidents.

These sub- indicators are derived from the input inserted by the user in front end web forms against the data points enquired side edge drop, current fatalities, cycle infrastructure continuity at minor junctions and property entrances and vehicular speed.

9. **Eyes on street:** This Indicator contributes to two categories- Safety and Attractiveness. It indicates assessment of level of activities along the segment ensuring security (safety) as well as refers to attraction of cycling infrastructure in terms of life/ activity along cycling path. Eyes on street are based on the percentage of the segment covered by hawkers and the corresponding land use present on the either side of the infrastructure.
10. **Enforcement:** This indicator contributes to two categories- Safety and Directness. It indicates the assessment of level of enforcement to ensure safety on carriageway and minimal loss of directness to cyclists. This primary indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring level of enforcement for the segment.
11. **Friction from Car Parking:** This indicator contributes to two different categories- Safety and Directness. The indicator refers to the assessment of risk posed by street parking and loss of directness from friction by street parking to commuting cyclists. This

indicator involves only one major sub indicator i.e. parking length index, which is based on the percentage of parking availability depending upon the parking length inserted by the user asked in the front end forms for the private vehicles and intermediate public transport (IPT) separately.

12. **Obstructions Index:** This indicator refers to the assessment of loss of directness caused by presence of obstruction in cycling path. Obstruction index is based on the frequency of the obstruction existing on the cycle path. It contributes to directness category.
13. **Width Sufficiency index:** This indicator refers to the assessment of sufficiency of cycling path width with respect to existing infrastructure typology. It contributes to directness category. This primary indicator includes 6 major sub indicators. These are:
    - NMV width index: This index is created depending upon minimum width provided and indicates the required width to be provided in case of segregated cycle track
    - NMV volume index: This index is created depending upon PBU per effective lane and indicates required volume in case of segregated cycle track. Passenger bicycle unit or PBU is termed to be a unit equivalent of a single cycle in comparison to other cycling modes discussed in the user input forms.
    - Width requirement for painted cycle track: Depending upon the minimum width provided The indicator shows the width requirement, for a painted track or lane
    - Width requirement for common cycle track foot path (Measurement based): This indicates requirement of width, needed for a common cycle track footpath based on minimum width provided.
    - Width requirement for common cycle path (Volume based): This indicates requirement of width needed for a common cycle track footpath based on the combined volume of non motorized vehicles (NMV) and pedestrians.
    - Cycle track width reduction at intersection approach: While approaching any intersection, this indicator shows the reduced width requirement such that if the width of the cycle facility reduces by more than or equal to 0.3 meters will reduce the directness of the cycle infrastructure.

These sub- indicators are developed from the input inserted by the user in front end web forms like total shy-away width, total passenger bicycle unit (PBU), total number of pedestrians and total number of cyclist.

14. **Hawker friction index:** The indicator contributes to directness and refers to the assessment of loss of directness due to friction from hawkers on cycling path. Hawker friction index is based on the frequency of the hawkers existing along the cycle path.
15. **Frequency of punctures Index:** This indicator contributes to directness and refers to how often is cycling lane/path crossed by vehicular path to access service lane. This

indicator is derived, based on existing number of cycle lane punctures along the corridor. The index signifies if the frequency of punctures is high then directness gets reduced for the provided cycle facility. The numbers of cycle lane punctures varies according percentage of service lane inserted by the user in the front end web forms. Hence the quality of the service lane also affects the directness as if the service lane provided is of poor quality will tend the cyclist to detour from the cycling path reducing directness. The quality of service lane is determined by the service lane quality index.

16. **Pedestrians Friction Index:** This indicator contributes to directness and refers to the assessment of loss of directness due to friction from pedestrians on cycle path. This indicator is derived, based on pedestrian density index. The index signifies if the density of the pedestrian is high i.e. space allocated to the pedestrians (sqm/person) is low, will tend the pedestrians to move into the cycle path increasing friction between the cyclists and pedestrian resulting in reduction of directness for the provided cycle facility. The pedestrian friction varies according to on the percentage of footpath provided along the cycle facility. Hence the quality of the footpath also affects the directness as if the footpath provided is of poor quality will increase the cyclist pedestrian friction on cycling path reducing directness. The quality of footpath is determined by the footpath quality index.
17. **Cyclist Delay at Intersection:** This indicator contributes to directness and refers to the assessment of loss of directness due to delay to cyclists at intersections. This indicator includes 2 other aspects or sub indicators for evaluation. These are:
    - Cycle infrastructure continuity index: This index is created depending upon continuity of cycle path at the minor junctions and the property entrances. It indicates the loss of directness of the cyclist, in case cycle path is discontinuous at the minor junctions and property entrances.
    - Cyclist approaches/ access to intersection index: This index is created depending on the type of infrastructure provided while approaching an intersection. It indicates the loss of directness of the cyclist, in case cycle path is discontinuous while approaching an intersection.
18. **Maintenance:** This indicator contributes to two categories- Directness and attractiveness. It indicates assessment of loss of directness due to friction cause by poor maintenance/cleaning cycle infrastructure and attractiveness of cycling infrastructure in terms of how well it is maintained. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the maintenance level of the cycle infrastructure.
19. **Turning Radius Index:** The indicator contributes to two categories – Comfort and Directness. This indicator refers to the assessment of loss of directness and comfort due to tight turning radiuses on cycling path. This indicator is directly derived from the input

inserted by the user in front end web forms under the data points enquiring the turning radius present on the cycle infrastructure.

20. **Riding comfort Index:** This indicator contributes to comfort category and refers to the assessment of riding comfort with reference to surface type. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the existing surface type on the cycle infrastructure.
21. **Shaded Length:** This indicator contributes to comfort category and refers to the assessment of protection from weather in terms of shade/shelter over cycling path. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the percentage of shaded length on the cycle infrastructure.
22. **Cross slope index:** This indicator contributes to comfort category and refers to the assessment of water runoff capability and comfortable riding cross slope. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the cross slope given on the cycle infrastructure.
23. **Longitudinal slope index:** This indicator contributes to comfort category and refers to the assessment of comfortable riding longitudinal slope. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the cross slope given on the cycle infrastructure.
24. **Ramp Slope Index:** This indicator contributes to comfort category and refers to the assessment of comfort of ramps provide to access egress from cycle path. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the cross slope given on the cycle infrastructure.
25. **Parking Availability:** The indicator contributes to two categories – Comfort and Attractiveness .The indicator refers to the assessment of cycling comfort and attractiveness in terms of availability of safe and secure cycle parking. This indicator is based on 4 other aspects or sub indicators for evaluation. These are:
    - Parking cost Index: The index reveals level of attractiveness, based on cost of cycle parking per day along the segment.
    - Usability of cycle parking: This indicates percentage of cyclists using the parking facility provided
    - Percentage of transit Stations: Indicates percentage of transit stations provided with parking facility on the segment.
    - Percentage of parking land use: Indicates percentage of Land use served with parking facility on the segment.

These sub- indicators are developed from the input inserted by the user in front end web forms like total parking cost, percentage of parking covered by transit stations and land use.

26. **Landscaping:** This indicator contributes to attractiveness category and refers to attractiveness of cycling infrastructure in terms of alongside landscaping/ plantation. This indicator is directly derived from the input inserted by the user in front end web forms under the data points enquiring the landscaping level on the cycle infrastructure.

6.2.2 Evaluation Algorithms: Cycling Corridor/Route

Each of the input in these forms has been assigned a distinct number/code for evaluation and the same is used in the forms. Detailed description of each input along with required information for users has already been compiled in the user manual for the tool. Based on this numbering or coding, evaluation or assessment for each of the derived indicators as well as the indicators are defined as a formula, linking inputs from the 'front end' forms (including user and default value forms).

Formula example: Formula for 'Total number of crossing' is represented as:

A= (3_3f+C+K+ ((4D_24a+4D_24b)*2_4

In the above formula, total number of crossings which is a derived indicator (and not the main indicator) is represented as 'A' Here 'A' refers to the derived indicator code. Similarly 'C' refers to Number of Unsignalized /Unsafe Crossing and 'K' refers to number of major crossings which are also derived indicators but contribute in 'A', while code type {3_3f: Number of safe crossings (Segment information form), 4D_24a and 4D_24b: number of grade separated cycle crossing fob and subways (Design input data form for intersections and crossings) and 2_4: 50% of cyclist crossing considered in case of grade separated crossing as default value(Default form)} all refers to inputs from the user form.

Likewise formulas (relationships) are developed for each indicator and derived indicators shown in **Figure 5**, which are involved in the evaluation process considering both sides i.e. L.H.S and R.H.S using the assigned codes. Each component used in formulas, worked out for the derived indicators are compiled and presented together in **Annexure9.1**

Assessment of transit access influence area is based on link based evaluation. Each route can be broken in to distinct links (based on features as well planning and design conditions), and input separately. The tool shall undertake individual assessment of each link and then aggregate the same in to an overall evaluation by giving weightages based on length and road/street category under each link. The assessment is undertaken separate for each side of the road (left hand side (L.H.S) and right hand side (R.H.S), separate for mid blocks (between intersections) and intersections. These separate evaluations are then aggregated in to an overall link evaluation (or an evaluation score).This evaluation when aggregated with their individual indicator provides and overall assessment of each link. Different link assessment then combines to provide a route assessment.

6.2.3 Indicators: Transit access Influence area

As the data points and the input web forms, are similar to that of the cycle corridor/ route evaluation type hence the indicators and the evaluation process is worked out on the similar grounds. Therefore, alike derived indicators are being deployed for transit access influence area evaluation type. Therefore web forms have been assessed based on 80 multiple derived indicators. These indicators further combine and generate evaluation under different primary indicators. Total 26 primary indicators are identified for evaluation. These indicators combine to evaluate the infrastructure under each of the mentioned five categories. But as this transit area evaluation type is based on links, in some of the derived indicators, new sub indicators are induced based on the links.

For example: Crossing frequency index contributing to coherence category in corridor/ route evaluation type is replaced by Accessibility index (coded as P4) in transit access influence area evaluation. Although this derived indicator also contributes to coherence category but includes a new sub indicator: Link density index. The 'Link density index' (coded as Y3) indicates average distance between two distinct links. This sub-indicator is developed from the input inserted by the user in front end web forms under the data points enquiring the total number of links (primary + secondary) existing in the transit area, and the catchment of the transit station. **Figure 6** presents the relationship between these derived indicators, indicators and their categories.

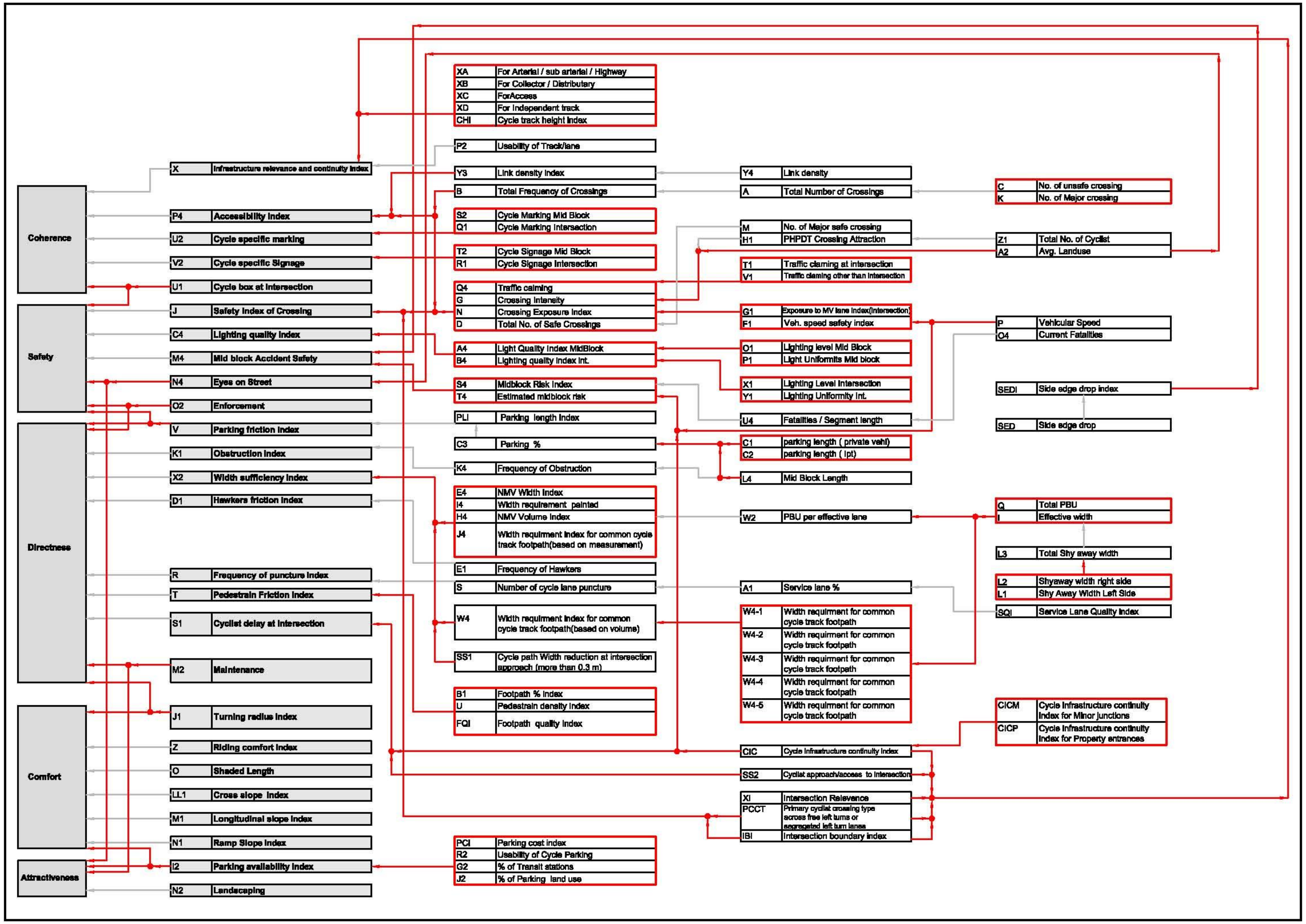


Figure 6: Flow chart showing relationship between Categories, derived indicators and Indicators (transit access influence area

It can be observed from the above indicator relationship flowchart; only one derived indicator i.e. Accessibility index (coded as P4), which has been explained in detail in above example, differs from the indicators used for evaluating cycling route /corridor. Rest all the other 25 primary indicators are identical and are already explained in detail in the previous section (**6.2.1**)

6.2.4 Evaluation Algorithms: Transit access Influence area

Since the indicators used in transit access influence area are same as the indicators used in cycle corridor/route evaluation type. Therefore the formulas developed are also identical except for the formulas developed for Accessibility index (coded as P4), where the new sub indicators 'Link density index' (coded as Y3) and Representation of Link density (coded as Y4) are induced.

These indicators formulas are developed, linking inputs from the 'front end' forms (including user and default value forms). As mentioned earlier (**Refer-Error! Reference source not found.**) in the front end user forms each input in these forms has been assigned a distinct number/code for evaluation and the same is used in the forms. Detailed description of each input along with required information for users has already been compiled in the user manual for the tool. Based on this numbering or coding, assessment for the derived indicators as well as the sub-indicators is worked out.

For example: Formula for 'Representation of Link density' is represented as:

Y4 = (2_151*4)/ (1_7-1)

In the above formula, Representation of Link density, which is an indicator is represented as 'Y4' Here 'Y4' refers to the indicator code. While code type {2_151: Accessibility influence zone radius (Default form), 1_7: number of links to be evaluated (Base data form for transit access influence area)} all refers to inputs from the user form.

Likewise formulas (relationships) are developed for each indicator and derived indicators shown in **Figure 6**, which are involved in the evaluation process considering both sides i.e. L.H.S and R.H.S using the assigned codes. Each component used in formulas, worked out for the derived indicators are compiled and presented together in **AnnexureError! Reference source not found.** Rest all the formulas developed for each primary indicator are identical to the formulas developed for corridor/ route evaluation.

6.3 Evaluation Framework: City wide cycling network

'City wide cycling network' evaluation, proposes to evaluate cycle infrastructure of a city under two different categories:

1. **Cycling Friendly City (Current Status):** This refers to the present state of the city in terms of its structure and compatibility of its cycling infrastructure.
2. **Cycling Friendly City (Potential Status):** This refers to the potential state of the city for it to achieve a higher cycling friendly status.

Taking both this categories into consideration, certain indicators are identified contributing to each category. These indicators are based on the input data provided by the user in the front end input forms. These indicators further combine and generate primary indicators. The tool undertakes the assessment of each primary indicator separately and then aggregates the same in to an overall evaluation score to provide a city level assessment separately for the both mentioned categories.

6.3.1 Indicators: City wide cycling network

The data points mentioned in the web forms, have been assessed under 11 multiple derived indicators. These indicators then combine and generate evaluation under different primary indicators. A total of 10 primary indicators are identified for evaluation of city wide cycling network. These primary indicators are distributed in two parts to evaluate the city level of service under each of the mentioned criteria's. **Figure 7** presents the relationship between these derived indicators, indicators and their categories.

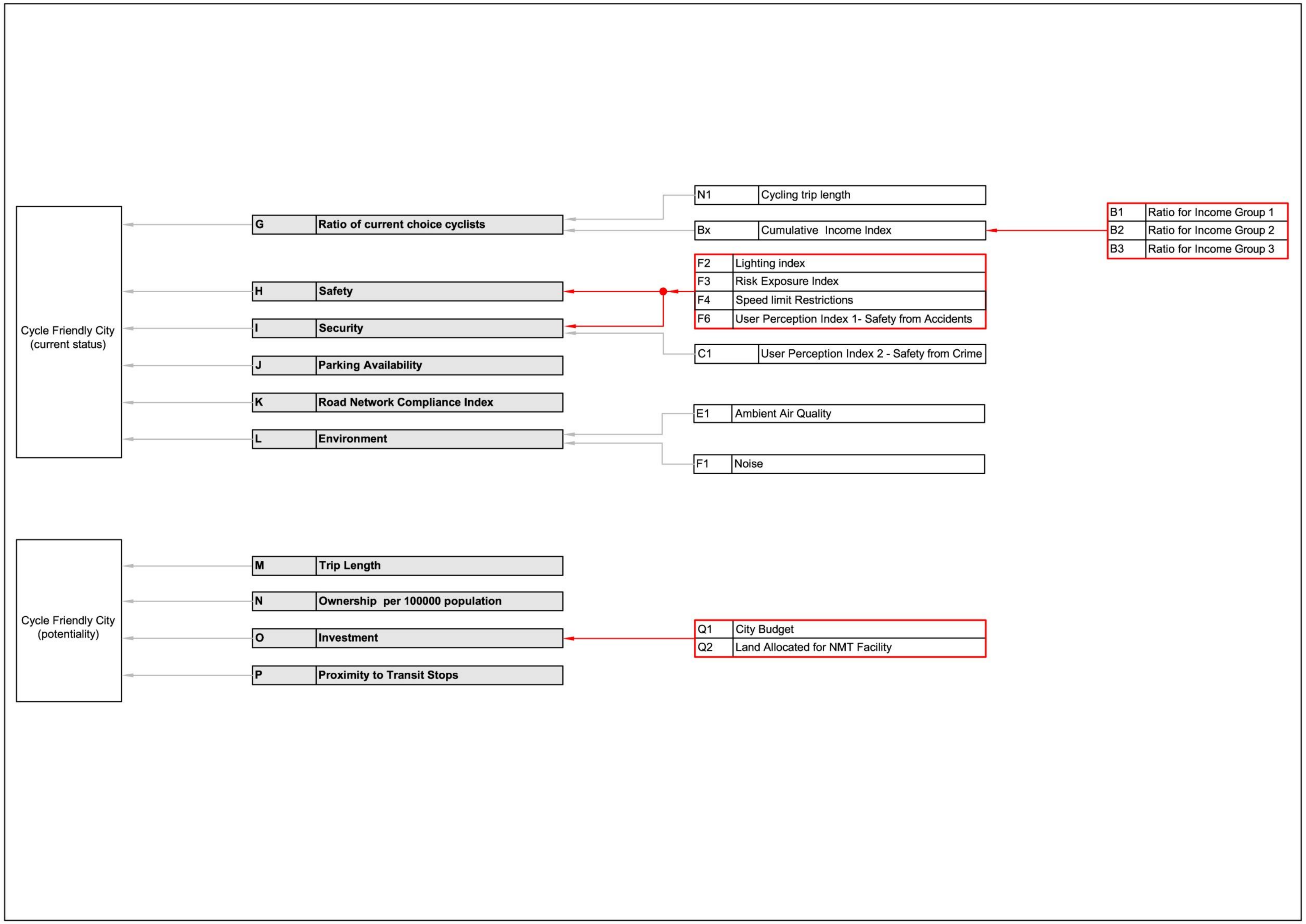


Figure 7: Flow chart showing relationship between Categories, derived indicators and Indicators (City wide cycling Network)

The 10 primary indicators used for the evaluation of City wide cycling network are as follows:

Ratio of current choice cyclist: This indicator addresses which income group is cycling (whether choice commuters are cycling) and how much is the average distance they are travelling by cycle. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:

- Cycling trip length: Indicates the trip length covered by the cyclist in the city.
- Cumulative income index: Indicates the income level of cyclist in the city.

Safety: This indicator addresses how safe the city is in terms of accidents in terms of provision of lighting, vehicle speed, etc. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:

- Lighting index: Indicates the level of lighting in the city
- Risk exposure index: Indicates the level of risk posed by the cyclist in the city.
- Speed limit restrictions: Indicates the speed limit of the motor vehicles in the city.
- User perception index-1- Safety from accidents: Indicates the level of safety for the cyclists from accidents in the city.

Security: This indicator addresses how secure the city from street crime. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:

- Lighting index: Indicates the level of lighting in the city in terms of security
- User perception index-2- Safety from crime: Indicates the level of safety for the cyclists from crime in the city.

Parking Availability: This indicator addresses the availability of parking across the city.

Road Network Compliance Index: This indicator addresses if the current road network across all road types is cycling compatible.

Environment: This indicator addresses, how the current environment i.e. ambient air quality and noise pollution of the city affecting the cycling environment. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:

- Ambient air quality: Indicates the air quality level of the city.

- Noise pollution: Indicates the noise pollution level of the city.

Trip Length: This indicator addresses the average distance a cyclist travels across the city.

Ownership per 100000 population: This indicator addresses the bicycle ownership in the city per 100000 population.

Investment: This indicator addresses the investment undertaken in the city for the NMT facilities. This indicator includes other sub indicators developed from the input inserted by the user in front end web forms. These sub indicators are as follows:

- City Budget: Indicates the budget or revenue allotted to the city.
- Land allocated for NMT facility: Addresses land availability designated for NMT facilities in the city.

Proximity to Transit Stops: This indicator addresses the number of households which lie within proximity of transit stops.

6.3.2 Indicators Formulation: City wide cycling network

Assessment for each of the primary indicators as well as the sub-indicators involved in the evaluation process are defined as formulas, with variables which are inputs from the 'front end' or user interface forms as well default value forms. These formulas (relationships) are developed for each of the indicator and sub-indicators as shown in **Figure 7** using the assigned codes. The coding process has been explained in the previous sections (**6.2.2** and **6.2.4**)

7 CyLOS - Evaluation weightages

Weightages indicate relative importance of indicators and indicator categories. They are used to consolidate scores under individual indicators into a single overall score for evaluation, comparison and decision making. Weightages are given and used as percentage values.

7.1 Need of weightages

Weightages need to be allocated to each indicator in a category and to the category as a whole, so as individual indicator scores in each category can be aggregated in order of their relative importance to provide category scores and category scores can be aggregated in order of their relative importance to provide overall infrastructure evaluation score.

Indicator weightages: Some indicators are represented in more than one category; here different weightages for the same indicator in different categories may be required. Additionally weightages need to be defined specific to each context. **For example,** infrastructure could be an independent track, on a highway, on an arterial road, on a sub arterial road, on a collector street or on an access road. Each road type presents a different context and hence weightages of indicators between these cannot be the same. All indicators within a category are given percentage weights of the sum total of which is 100 percent. Higher percentage is assigned to indicators with higher relative importance. In that sense percentage weights are representation of an indicators importance in each category.

Category weightages: Similarly percentage weight of each category is representation of the relative importance of that category in the overall cycling infrastructure assessment for a particular road type. **For example,** safety may have a higher weightages for an arterial road, and relatively lower on a collector or an access road.

Therefore, weightages have been assigned separately for indicators and indicator categories. Please note that category weights are not assigned in City cycling network unit of evaluation. Weightage of indicators for this unit of evaluation have been determined through internal discussion and literature analysis.

7.2 Indicator Weightages Assessment

Indicator weights to be used in the CylOS tool (for route/corridor and transit station area access units of evaluation) were determined for each of the four road types, i.e. Arterial/Sub arterial, Collector/Distributory, Access and Standalone cycle track (not motor vehicle carriageway only cycling path). These weights were determined based on a two part survey. A total of about 33 indicators were categorised in five principle categories. These categories are: coherence, directness, safety, comfort and attractiveness. In the first part category weights for each of the five categories was determined for each of the four road types through an Analytical Heirarchy

Process (AHP) based questionnaire presented to known NMT and urban planning experts. In the second part individual indicator weights were determined by conducting an AHP based survey of potential cyclists, and weights determined for each road type using AHP method. The final indicator and category weights presented in this section were fed in to the CyLOS tool as default weightages.

7.3 Category Weight Assessment

AHP based questionnaire was used to collect feedback on individual category weights for cycling infrastructure for each of the four road categories, from 25 experts during a workshop organised to discuss the NMT Design Guideline and CyLOS tool on December 12th and 13th 2013 at TRIPP, IIT Delhi (**Figure 8**)

Figure 8: Expert Review Workshop

The experts which provided their feedback represented academics, NMT planning and design, urban planning, research and engineering. A list of these experts is presented in **Annexure9.3** Relative preference ratings between each design principle category for each of the four roads were collected on a scale of 1 to 9 and their geometric mean determined (mean of responses from all experts). The geometric mean of the responses was fed in the AHP matrix to determine the individual category score as well over all consistency rations.

The individual category weights for each road has been presented in following charts

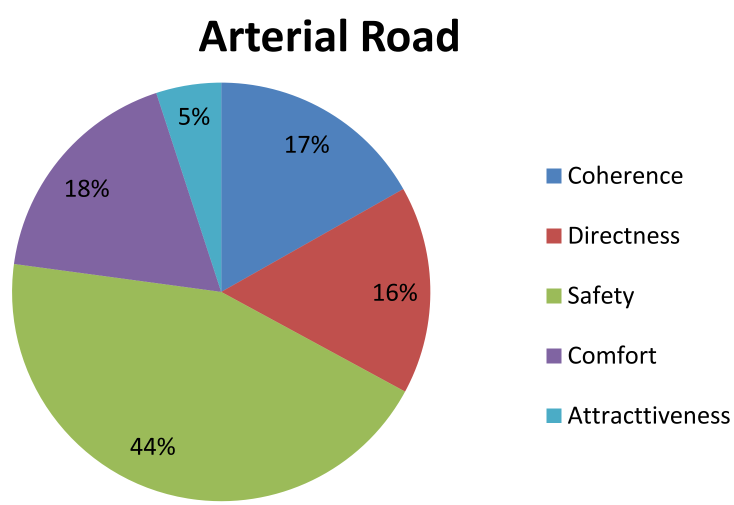


Figure 9: Individual category weights – Arterial Roads

Among Five categories mentioned in the **Figure 9**, safety predominantly resulted out to be the most weighted followed by comfort and coherence respectively for Arterial roads.

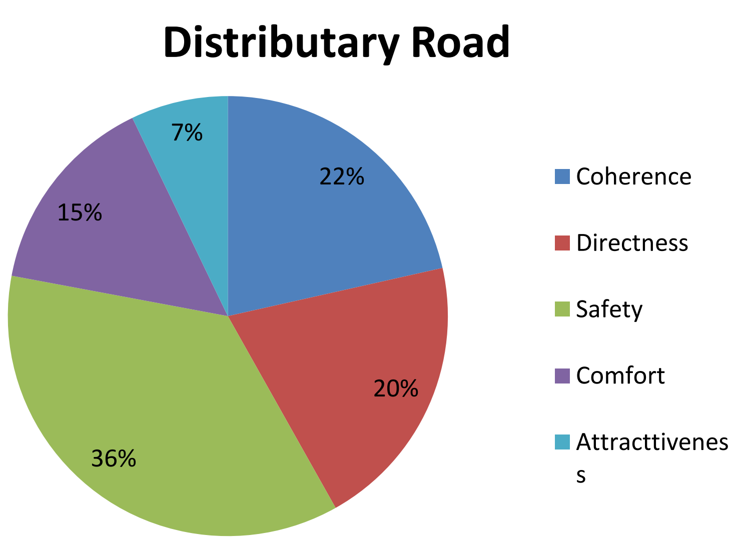


Figure 10: Individual category weights – Distributary Roads

In case of Distributary/ Collector roads, safety resulted out to be the most weighted followed by coherence and directness respectively among five categories mentioned in the **Figure 10**

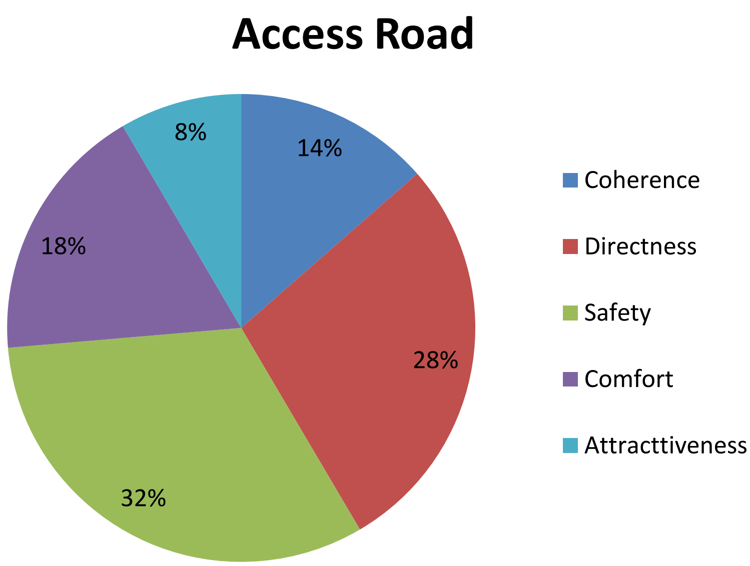


Figure 11: Individual category weights – Access Roads

In case of Access roads, again safety resulted out to be the most weighted followed by directness and comfort respectively among five categories mentioned in the **Figure 11**

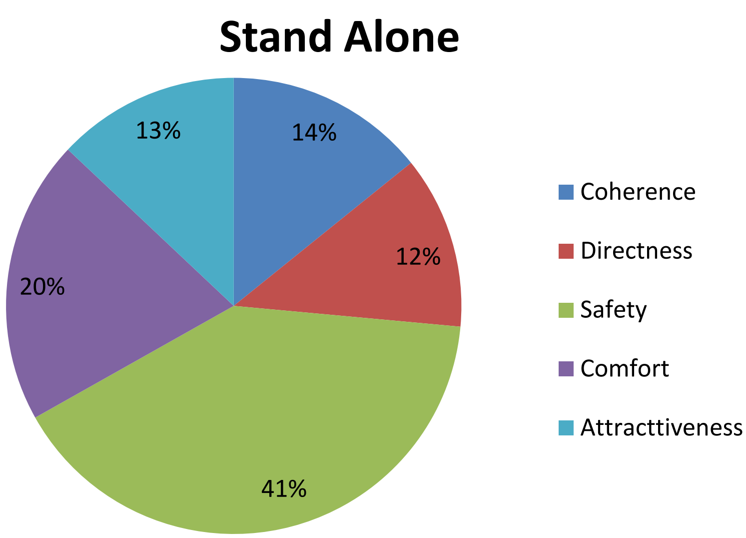


Figure 12: Individual category weights – Stand Alone

In case of Standalone also safety resulted out to be the most weighted followed by comfort and directness among five categories mentioned in the **Figure 12**.

The overall consistency ration as well as individual category weight for each road has been summarized presented in **Table 3**. Consistency ration value less than 0.1 is considered good.

Table 3: Individual Category weights and Consistency Ratio

Categories	Arterial	Collector	Access	Standalone
Coherence	17%	22%	14%	14%
Directness	16%	20%	28%	12%
Safety	44%	36%	32%	41%
Comfort	18%	15%	18%	20%
Attractiveness	5%	7%	8%	13%
Total	100%	100%	100%	100%
Consistency Ratio	-0.136	-0.168	-0.157	-0.188

These individual category scores were used for each road and multiplied to score of each indicator (for each category) to determine overall weightages of each of the 33 indicators.

7.4 Individual Indicator Weight Assessment

Weightages for indicator categories based on five design and planning principles i.e. coherence, safety, comfort, directness and attractiveness were derived for each road types using inputs from 25 experts collected on AHP based survey forms. These have been discussed in the previous section **(Literature Study)**. To estimate weightages of individual indicators within each category, for each of the four road/street categories, AHP based survey forms were designed. These forms were printed in both Hindi and English language (**Annexure9.5 and 9.6**) and distributed to about 70 schools all over India. School students (between class 8 and 10) were considered as potential commuting cyclists and are thus the ideal candidate for this survey. So far only one school i.e. Crescent International School Pune has provided the filled up forms. A total of 200 forms with inputs from 150 boys and 50 girls from class nine (three sections) of this school have been collected.

As a part of this survey school students were required to fill in basic information such as their name, class/section, school name, gender, current mode used to travel to school and the kind of road (road category) which defines majority of the route to school. Relative preference score on a scale of 1 to 9 was collected by comparing two indicators at a time. These scores were used to derive indicator weights using AHP method. The weights were derived for the road category selected by the student as the primary road type used for school access. Hence all forms were categorised as per road type defined and geometric mean of preference scores of all students under each category was input in AHP matrix to derive the average weightages of indicator for each road type. As expected none of the students selected a standalone cycling route and hence weightages have only been derived for arterial, collector and access road type using this method.

The derived weightages were analysed separately for both genders for each road category. In addition an aggregate weightages score, combining the scores from both genders was derived and used to define individual indicator weightages under each road category in the CyLOS tool. Weightages for standalone cycling paths were derived after internal discussion by the CyLOS development team.

7.4.1 Indicator Weight from Survey Response of School Children

Survey response from school children was categorised derived as per road category used by each student to come to school. The responses were analysed using AHP method described above and individual indicator weights within each category derived. These have been presented and discussed below

7.4.1.1 Survey Response: Arterial roads

1. *Response of the students concerning coherence indicators on Arterial Roads:*

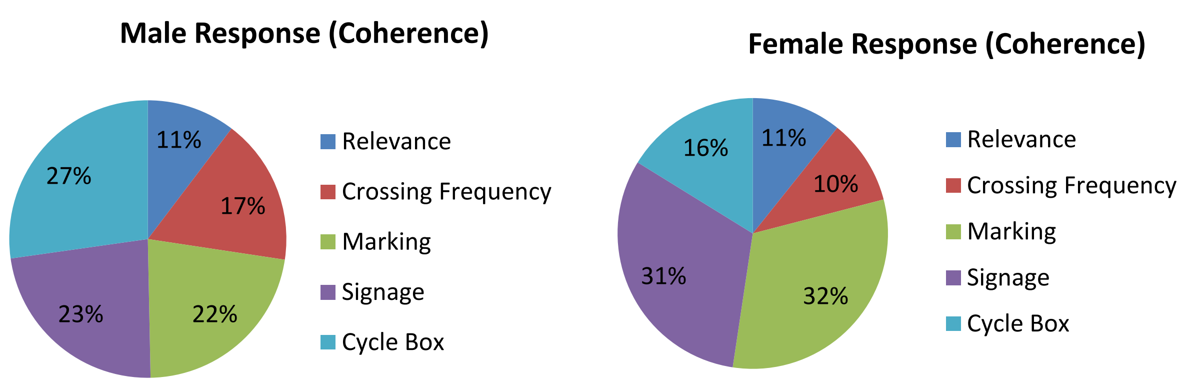


Figure 13: Gender wise Survey Response for Coherence at Arterial Roads

Among Five Individual indicators of Coherence category mentioned in the **Figure 13**, signage and marking were the most weighted among the males and females whereas cumulatively cycle box, signages and marking resulted out to be the most weighted indicators. The Gender wise consistency ratios (less than 0.1 is considered ideal) from the AHP analyses for arterial roads under coherence category are presented below:

Gender	Consistency Ratio
Male	0.019
Female	0.430

2. *Response of the students concerning safety indicators on Arterial Roads:*

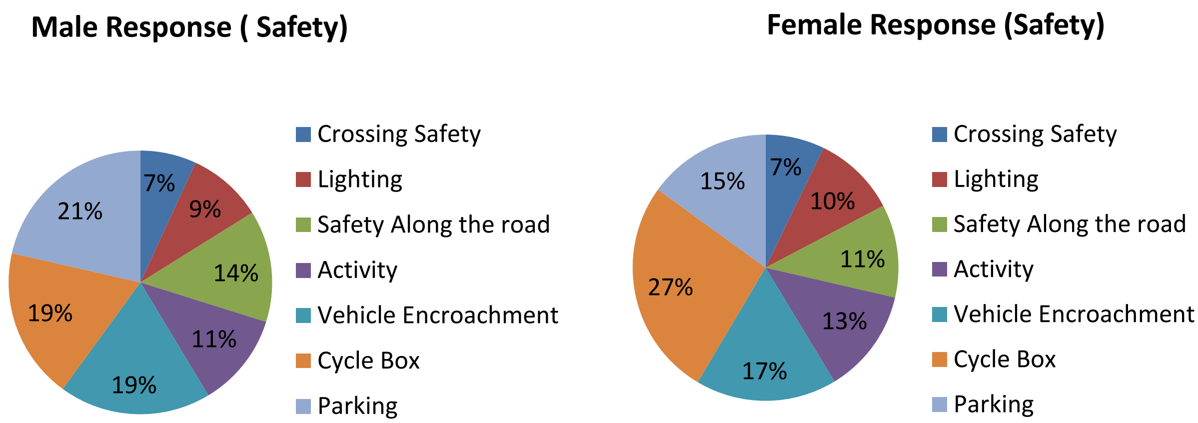


Figure 14: Gender wise Survey Response for Safety at Arterial Roads

Among seven Individual indicators of safety category mentioned in the **Figure 14**, crossing safety came out to be the most weighted among the males and cycle box resulted as most weighted according to the female response whereas cumulatively cycle box and crossing safety resulted out to be the most weighted indicators. The Gender wise consistency ratios the AHP analyses for arterial roads under safety category are presented below:

Gender	**Consistency Ratio**
Male	0.028
Female	0.269

3. *Response of the students concerning directness indicators on Arterial Roads:*

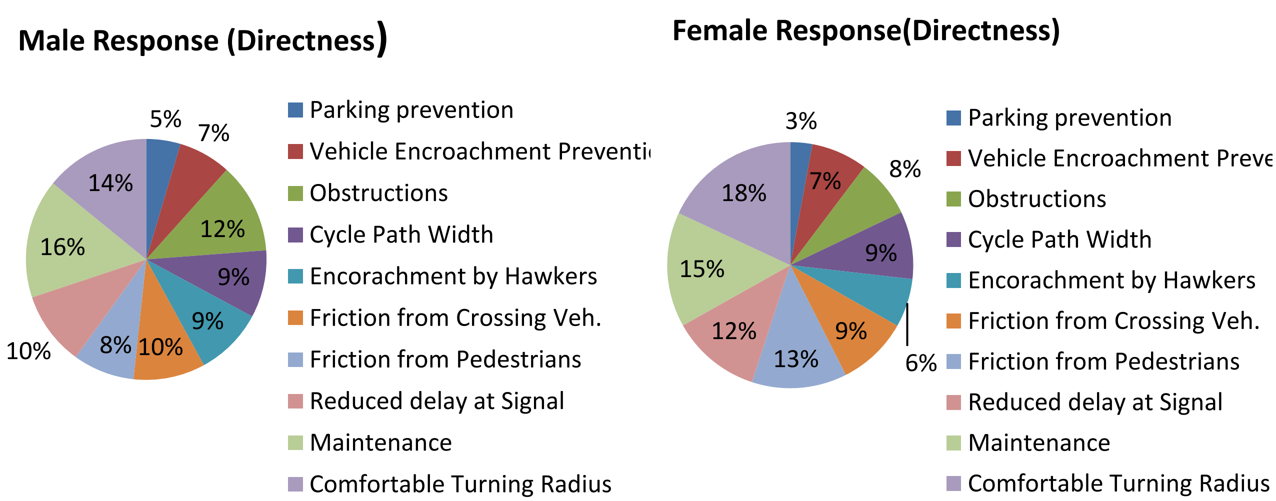


Figure 15: Gender wise Survey Response for Directness at Arterial Roads

Among ten Individual indicators of directness category mentioned in the **Figure 15**, maintenance came out to be the most weighted among the males and comfortable turning radius resulted as most weighted according to the female response and cumulatively both maintenance and comfortable turning radius resulted out to be the most weighted indicators.

The Gender wise consistency ratios the AHP analyses for arterial roads under directness category are presented below:

Gender	Consistency Ratio
Male	0.042
Female	0.378

4. *Response of the students concerning Comfort indicators on Arterial Roads:*

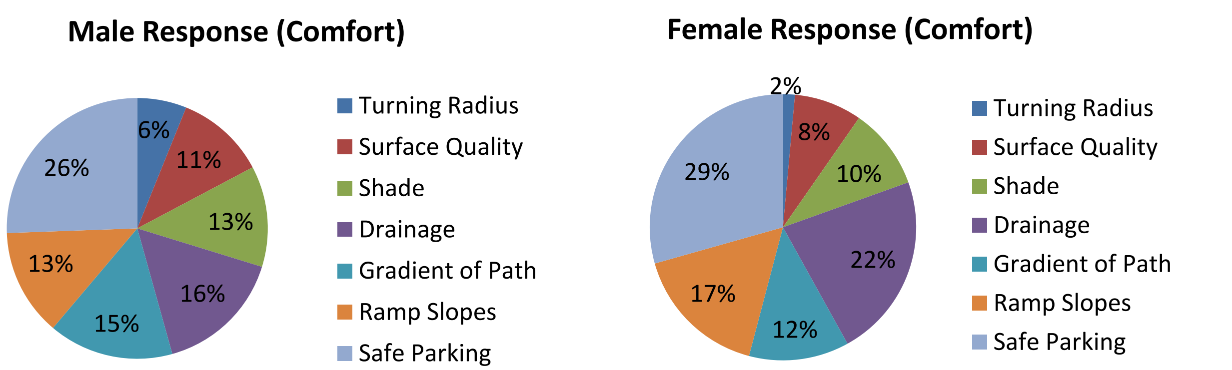


Figure 16: Gender wise Survey Response for Comfort at Arterial Roads

Among seven Individual indicators of comfort category mentioned in the **Figure 16**, students responded safe parking as the most weighted Indicator.

The Gender wise consistency ratios the AHP analyses for arterial roads under comfort category are presented below:

Gender	Consistency Ratio
Male	0.028
Female	0.396

5. *Response of the students concerning Attractiveness indicators on Arterial Roads:*

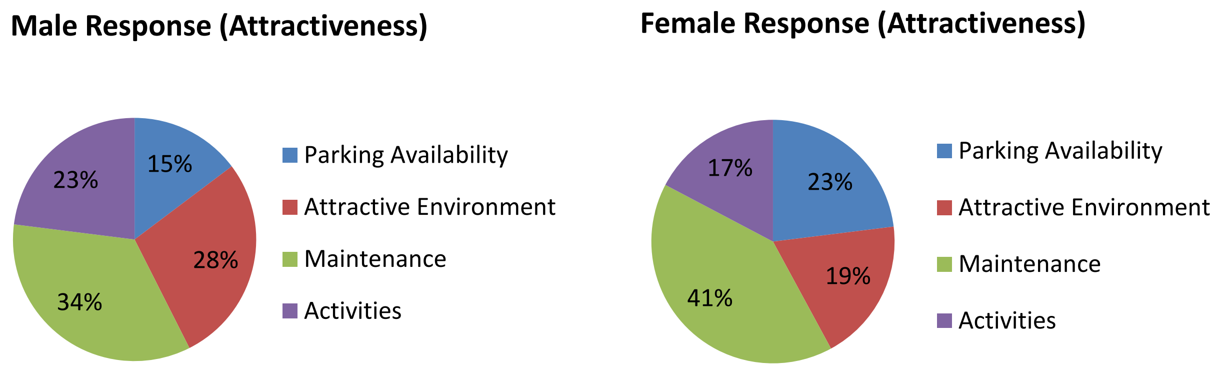


Figure 17: Gender wise Survey Response for Attractiveness at Arterial Roads

In response to the survey conducted, for attractiveness category students considered maintenance as the most weighted among the four individual indicators mentioned in the above **Figure 17**.The Gender wise consistency ratios the AHP analyses for arterial roads under attractiveness category are presented below:

Gender	Consistency Ratio
Male	- 0.179
Female	0.303

7.4.1.2 Survey Response: Access roads

The same set of questions where presented to the students for access roads, and the responses obtained are being presented in the following figures

1. *Response of the students concerning coherence indicators on Access Roads:*

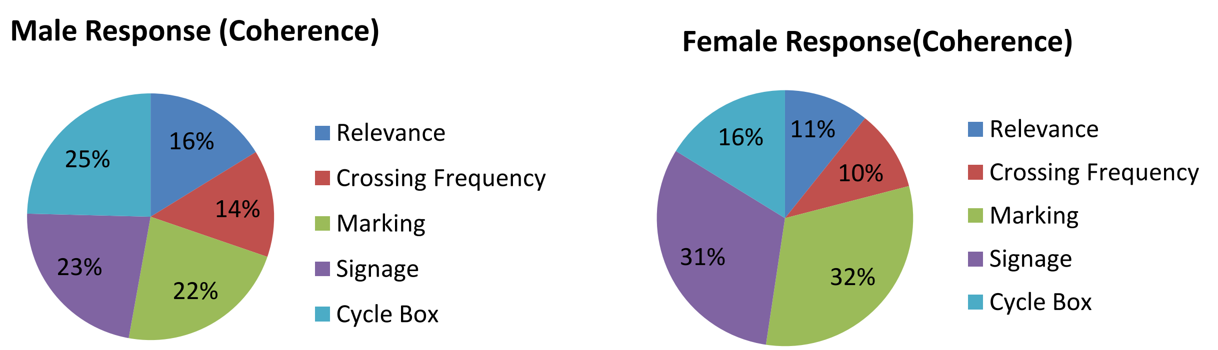


Figure 18: Gender wise Survey Response for Coherence at Access Roads

Among five Individual indicators of coherence category mentioned in the **Figure 18**, among the males, cycle box resulted to be the most weighted indicator followed by signage's and markings respectively while according to the female response predominantly marking resulted out to be the most weighted indicator followed by signage's. The Gender wise consistency ratios the AHP analyses for Access roads under coherence category are presented below:

Gender	Consistency Ratio
Male	0.418
Female	0.430

2. *Response of the students concerning safety indicators on Access Roads:*

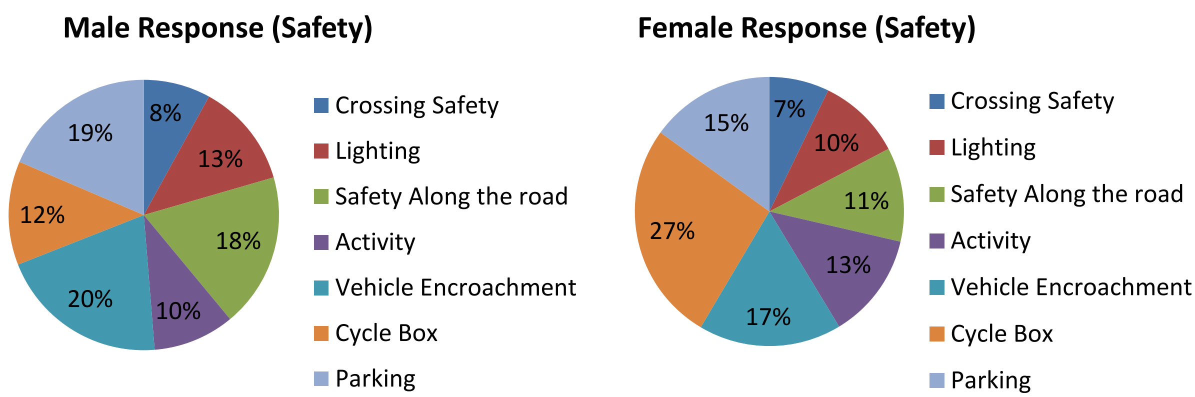


Figure 19: Gender wise Survey Response for safety at Access Roads

Among seven Individual indicators of Safety category mentioned in the **Figure 19**, among the males vehicle encroachment came out to be the most weighted followed by parking and safety along the road. Whereas according to the female response, cycle box resulted out to be the most weighted indicators. The Gender wise consistency ratios the AHP analyses for Access roads under safety category are presented below:

Gender	Consistency Ratio
Male	0.268
Female	0.269

3. *Response of the students concerning Directness indicators on Access Roads:*

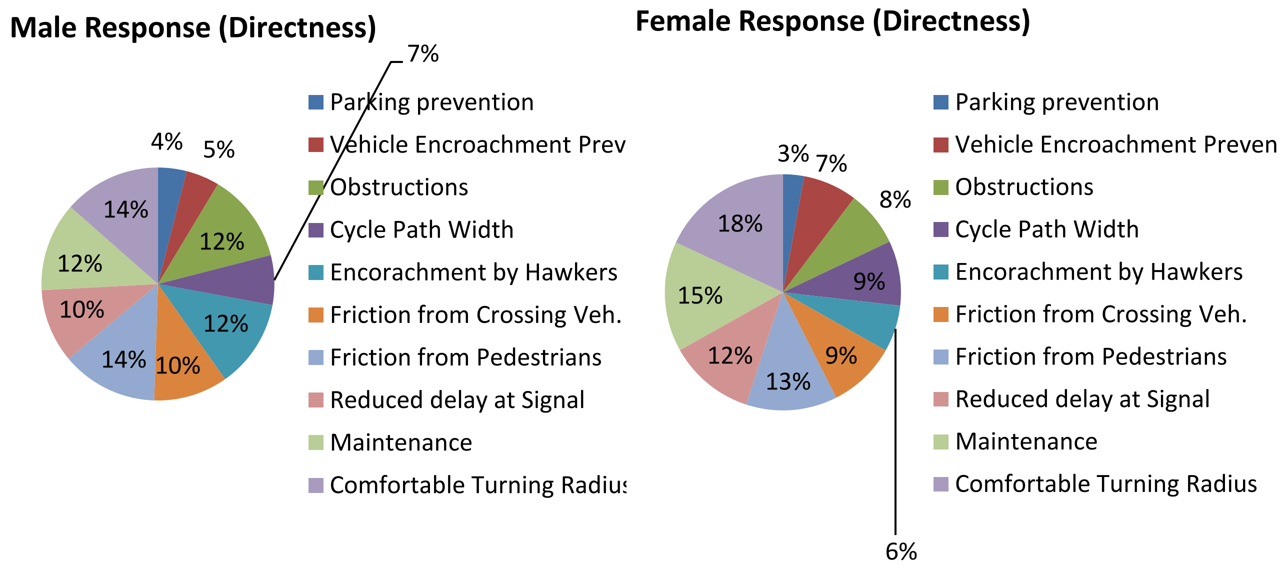


Figure 20: Gender wise Survey Response for Directness at Access Roads

Among ten Individual indicators of Directness category mentioned in the **Figure 20**, comfortable turning radius and friction from the pedestrians equally resulted to be the most weighted among the males and according to the female response again comfortable turning radius resulted out to be the most weighted indicator. The Gender wise consistency ratios of the AHP analysis for Access roads under directness category are presented below:

Gender	Consistency Ratio
Male	0.167
Female	0.378

4. *Response of the students concerning Comfort indicators on Access Roads:*

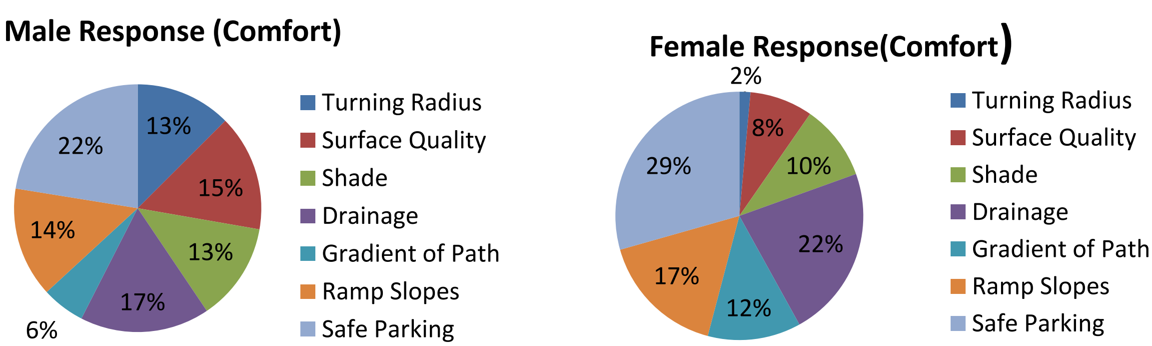


Figure 21: Gender wise Survey Response for Comfort at Access Roads

Among seven Individual indicators of comfort category mentioned in the **Figure 21**, gradient of the path equally resulted to be the most weighted among the males and females response. The survey output also reflected drainage as the most weighted indicator after gradient of the path, especially according to female response.

The Gender wise consistency ratios of the AHP analysis for Access roads under comfort category are presented below:

Gender	Consistency Ratio
Male	0.246
Female	0.396

5. *Response of the students concerning Attractiveness indicators on Access Roads*:

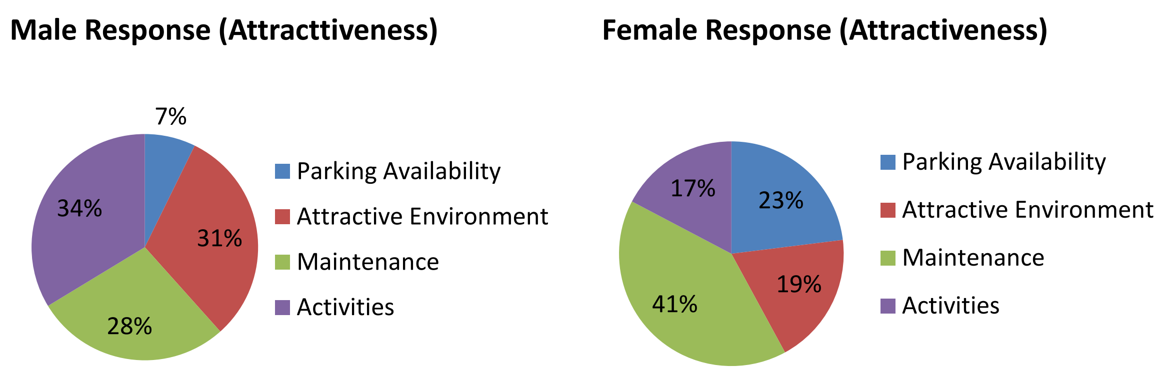


Figure 22: Gender wise Survey Response for Attractiveness at Access Roads

Among four Individual indicators of attractiveness category mentioned in the **Figure 22**, among the males, activities resulted to be the most weighted indicator followed by attractive environment and maintenance respectively while according to the female response predominantly maintenance resulted out to be the most weighted indicator.The Gender wise consistency ratios of the AHP analysis for Access roads under attractiveness category are presented below:

Gender	Consistency Ratio
Male	-0.196
Female	0.303

7.4.1.3 Survey Response: Collector roads

The same set of questions where presented to the students for collector roads, and the responses obtained are being presented in the following figures

1. *Response of the students concerning coherence indicators on Collector Roads:*

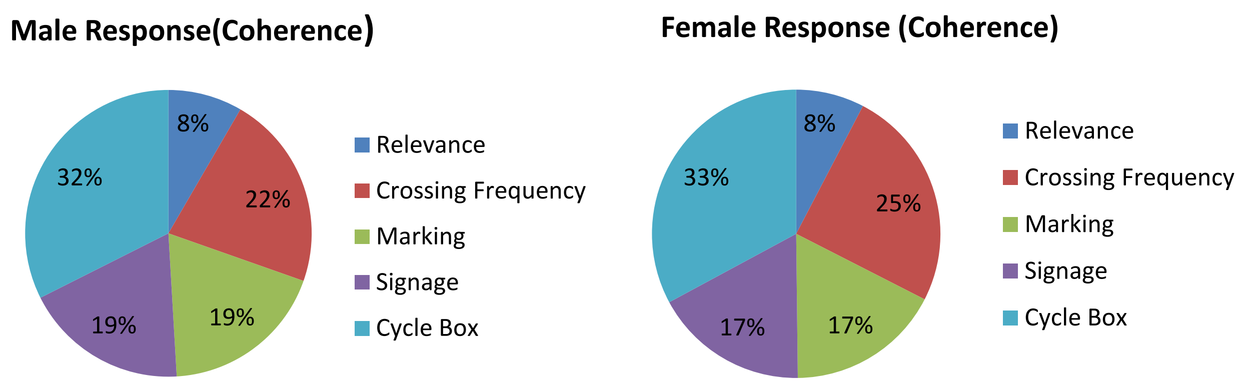


Figure 23: Gender wise Survey Response for Coherence at Collector Roads

Among five Individual indicators of coherence category mentioned in the **Figure 23**, among both the genders, cycle box resulted to be the most weighted indicator followed by crossing frequency and markings respectively. The Gender wise consistency ratios of the AHP analysis for Collector roads under coherence category are presented below:

Gender	**Consistency Ratio**
Male	0.043
Female	0.046

2. *Response of the students concerning safety indicators on Collector Roads:*

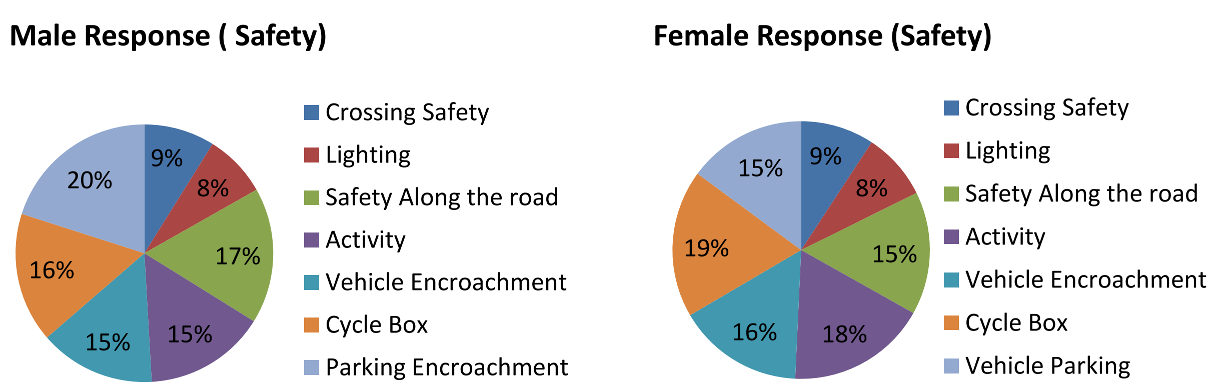


Figure 24: Gender wise Survey Response for Safety at Collector Roads

Among seven Individual indicators of Safety category mentioned in the **Figure 24**, among the males parking encroachment came out to be the most weighted followed by safety along the road and cycle box. Whereas according to the female response, cycle box followed by activity resulted out to be the most weighted indicators.

The Gender wise consistency ratios of the AHP analysis for Collector roads under safety category are presented in the table below:

Gender	**Consistency Ratio**
Male	0.029
Female	0.088

3. *Response of the students concerning Directness indicators on Collector Roads:*

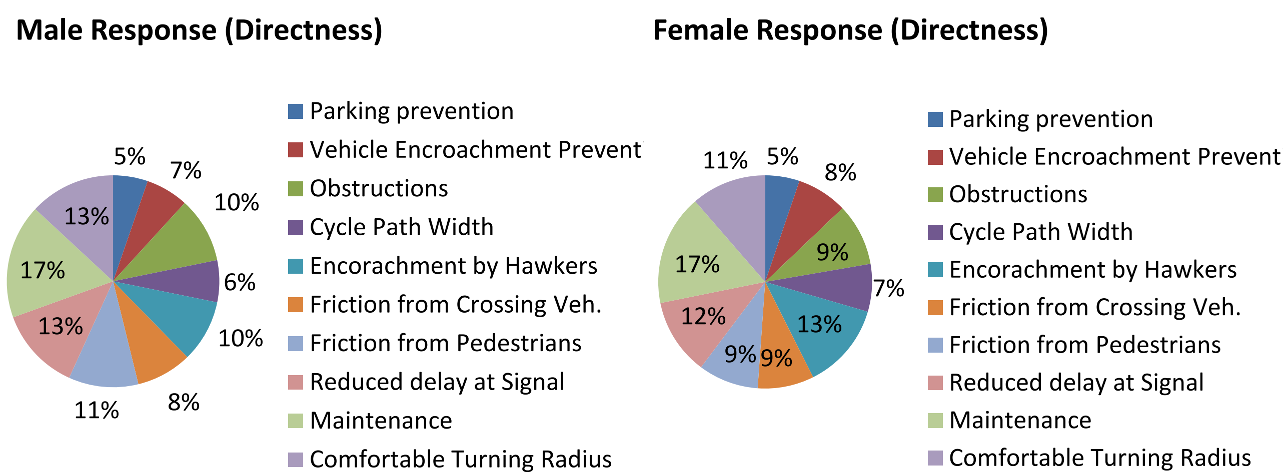


Figure 25: Gender wise Survey Response for Directness at Collector Roads

It can be observed from above **Figure 25**, among the mentioned ten Individual indicators of Directness category , Maintenance followed by reduced delay at signal and comfortable turning radius resulted to be the most weighted among the males. The survey response resulted the same in the case of females.The Gender wise consistency ratios of the AHP analysis for Collector roads under directness category are presented below:

Gender	**Consistency Ratio**
Male	0.030
Female	0.065

4. *Response of the students concerning Comfort indicators on collector Roads:*

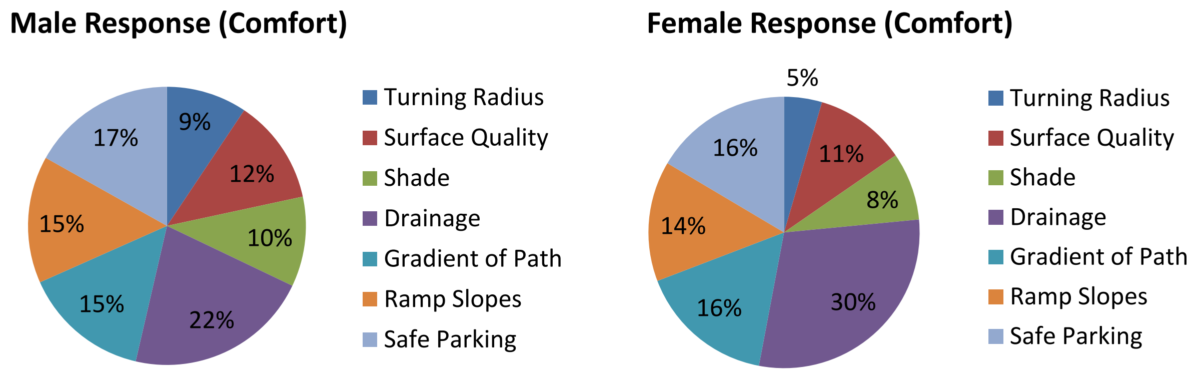


Figure 26: Gender wise Survey Response for Comfort at Collector Roads

Among seven Individual indicators of comfort category mentioned in the **Figure 26**, the survey outputs resulted drainage predominantly to be the most weighted among both males and females. The Gender wise consistency ratios of the AHP analysis for Collector roads under comfort category are presented below:

Gender	**Consistency Ratio**
Male	0.010
Female	0.010

5. *Response of the students concerning Attractiveness indicators on collector Roads:*

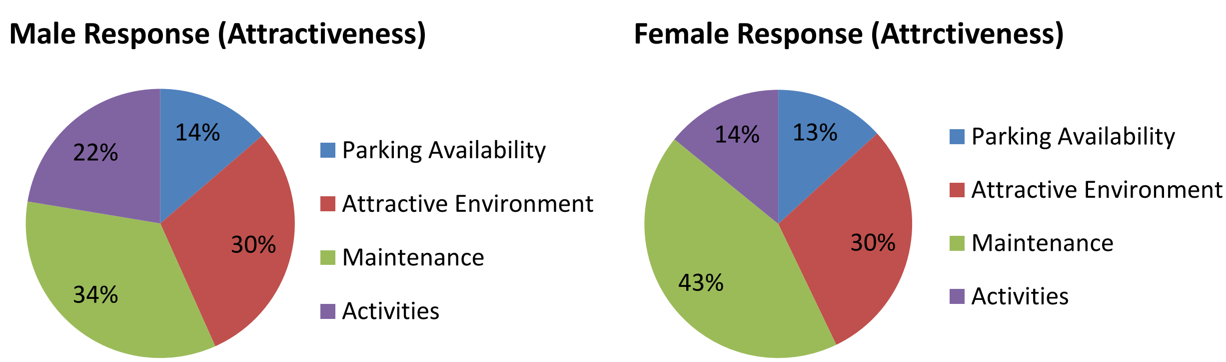


Figure 27: Gender wise Survey Response for Attractiveness at Collector Roads

Among four Individual indicators of attractiveness category mentioned in the **Figure 27**, Maintenance resulted to be the most weighted indicator followed by attractive environment considering both males and females. The Gender wise consistency ratios of the AHP analysis for Collector roads under attractiveness category are presented below:

Gender	Consistency Ratio
Male	-0.178
Female	-0.138

7.4.1.4 Cumulative Survey Response

After gender based analysis the data obtained from the surveys, was further analysed cumulatively under different road type for each category to derive a comparative inference for the five categories under different road type. These output obtained are being presented in the following figures.

<u>Cumulative Response (Coherence)</u> – The cumulative response obtained for Coherence category for all the road types are presented in the **Figure 28**

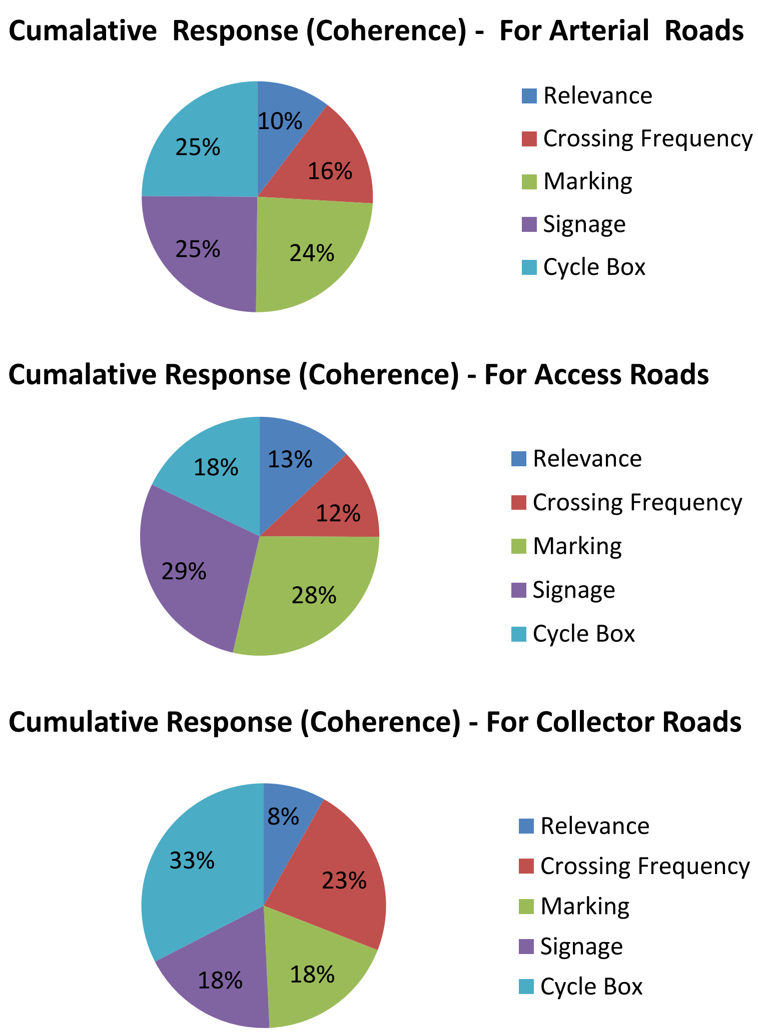


Figure 28: Coherence Cumulative Response for all roads

The consistency ratios of the cumulative AHP analysis conducted for the different road typology under coherence category are presented below:

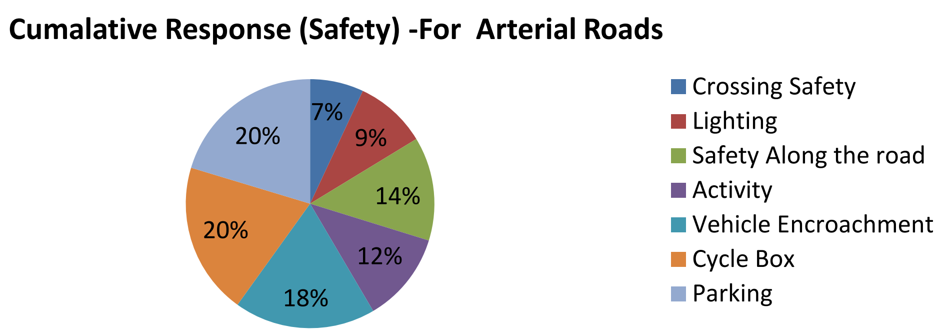
Cumulative Response	Consistency Ratio
Arterial Road	0.019
Access Road	0.218
Collector Road	0.043

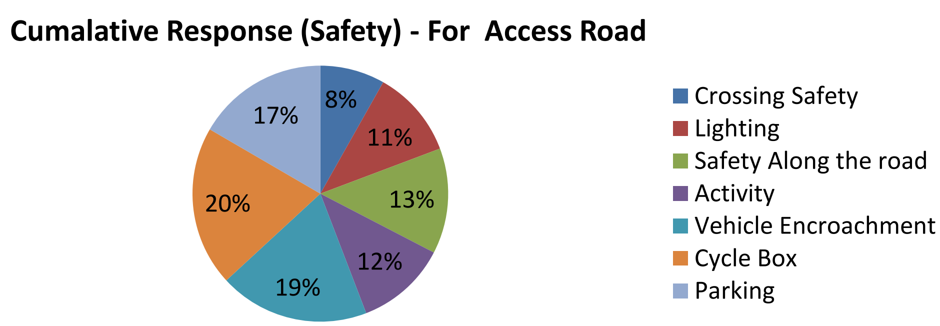
Comparative Inferences

Among Five Individual indicators of Coherence category mentioned in the above figures:

1. Cycle box, signage and marking resulted out to be the most weighted indicators in case of arterial roads.
2. In case of access roads signage and marking resulted out to be the most weighted indicators.
3. Whereas cycle box followed by crossing frequency resulted out to be the most weighted indicators in case of collector roads.

Cumulative Response (safety) – The cumulative response obtained for Safety category for all the road types are presented in the **Figure 29**





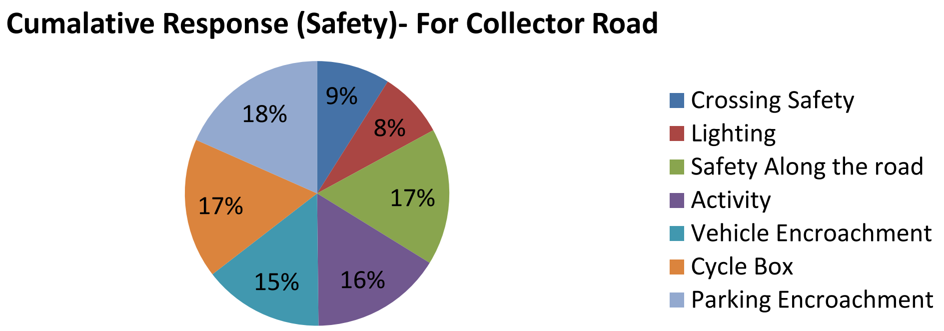


Figure 29: Safety Cumulative Response for all roads

The consistency ratios of the cumulative AHP analysis conducted for the different road typology under safety category are presented below:

Cumulative Response	Consistency Ratio
Arterial Road	0.026
Access Road	0.117
Collector Road	0.029

Comparative Inferences

Among Seven Individual indicators of safety category mentioned in the above figures:

1. It can be observed that Cycle box and parking resulted out to be the most weighted indicators in case of arterial roads.
2. In case of access roads vehicle encroachment and Cycle box resulted out to be the most weighted indicators.
3. Whereas parking encroachment followed by cycle box resulted out to be the most weighted indicators in case of collector roads.

Cumulative Response (Directness) – The cumulative response obtained for Directness category for all the road types is presented in the **Figure 30** below:

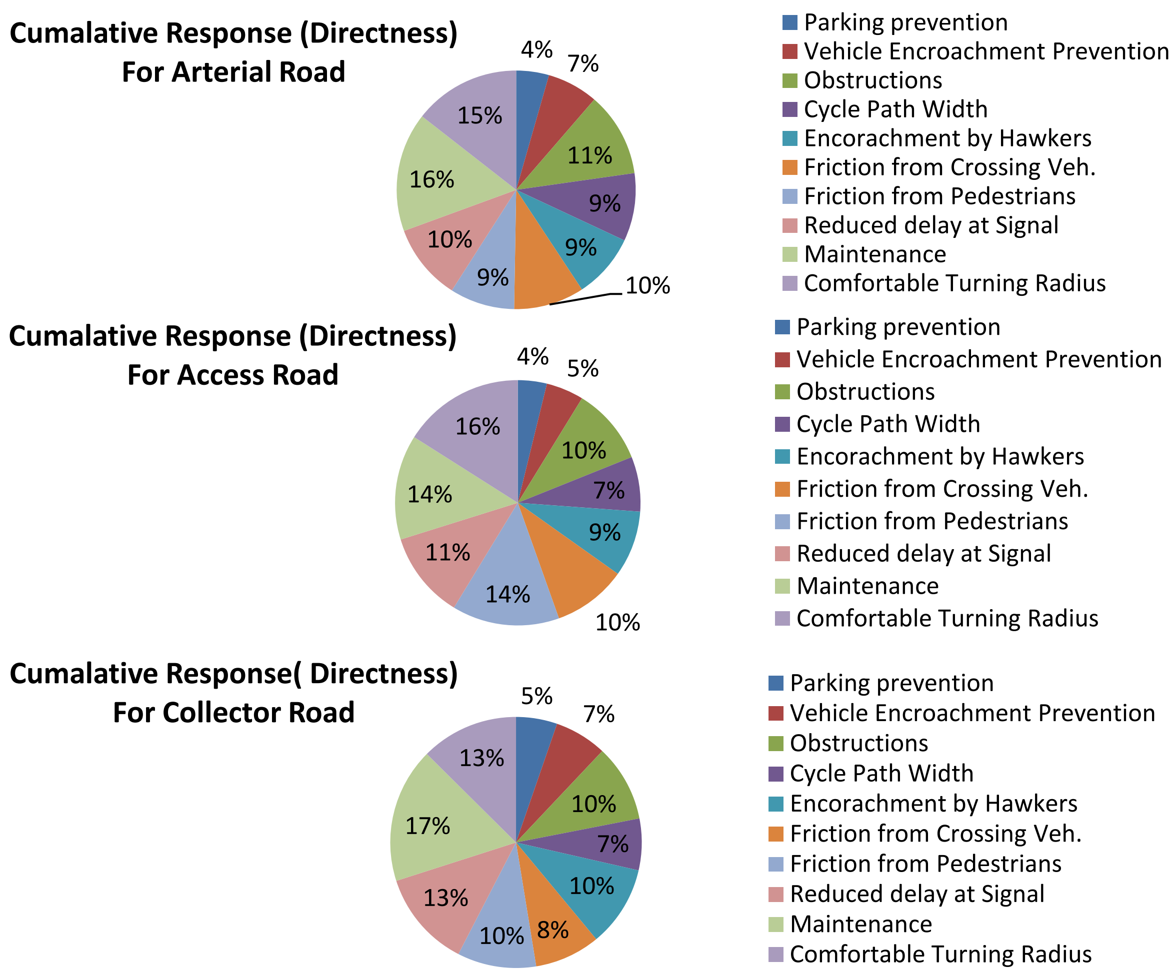


Figure 30: Directness Cumulative Response for all roads

The consistency ratios of the cumulative AHP analysis conducted for the different road typology under directness category are presented below:

Cumulative Response	Consistency Ratio
Arterial Road	0.043
Access Road	0.101
Collector Road	0.029

Comparative Inferences

Among ten Individual indicators of Directness category, the following can be observed:

1. Arterial Road - Maintenance followed by comfortable turning radius have been weighted the highest.
2. Access roads - Comfortable turning radius and maintenance is weighted the highest.

3. Collector Road - Maintenance followed by comfortable turning radius and reduced delay at signal are highest weighted indicators.

Cumulative Response (Comfort) – The cumulative response obtained for Directness category for all the road types is presented in the **Figure 31**

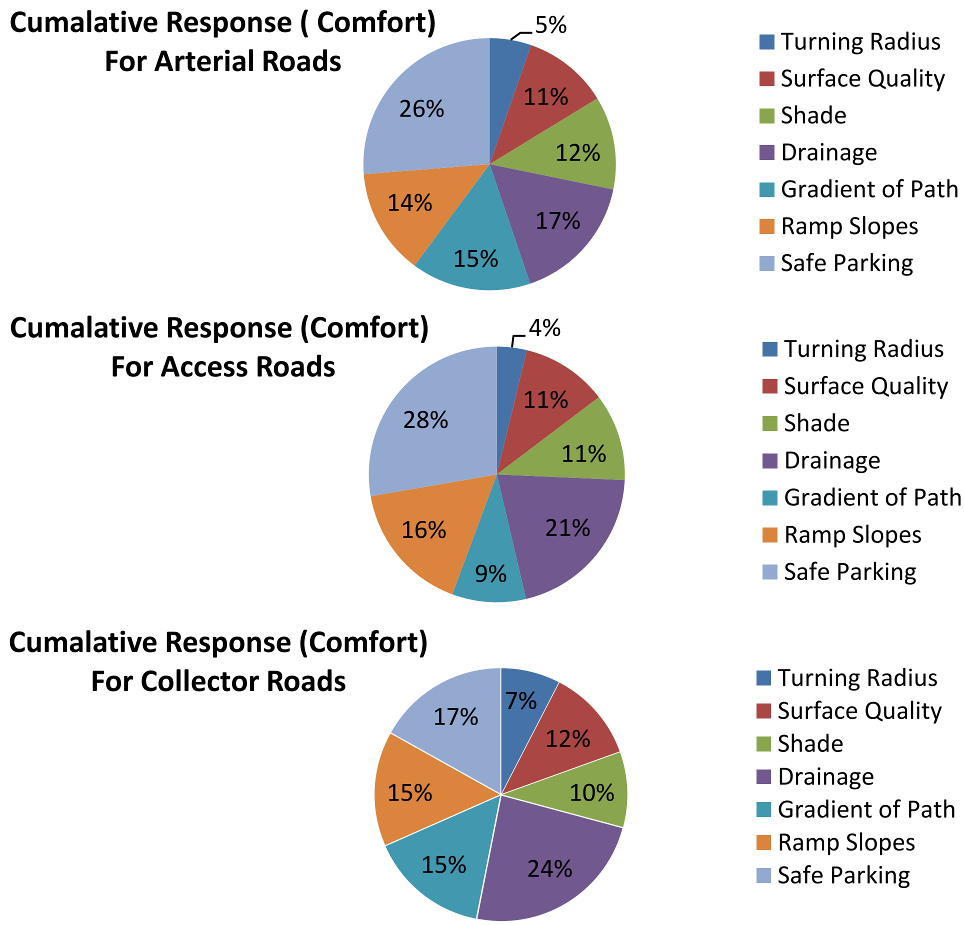


Figure 31: Comfort Cumulative Response for all roads

The consistency ratios of the cumulative AHP analysis conducted for the different road typology under comfort category are presented below:

Cumulative Response	Consistency Ratio
Arterial Road	0.034
Access Road	0.191
Collector Road	0.006

Comparative Inferences

Among seven Individual indicators of Comfort category mentioned in the above figures:

1. It can be observed that Safe parking resulted out to be the most weighted indicator in case of arterial roads.
2. In case of access roads Safe parking resulted out to be the most weighted indicator.
3. Whereas Drainage resulted out to be the most weighted indicators in case of collector roads.

Cumulative Response (Attractiveness) – The cumulative response obtained for Directness category for all the road types is presented in the **Figure 32**

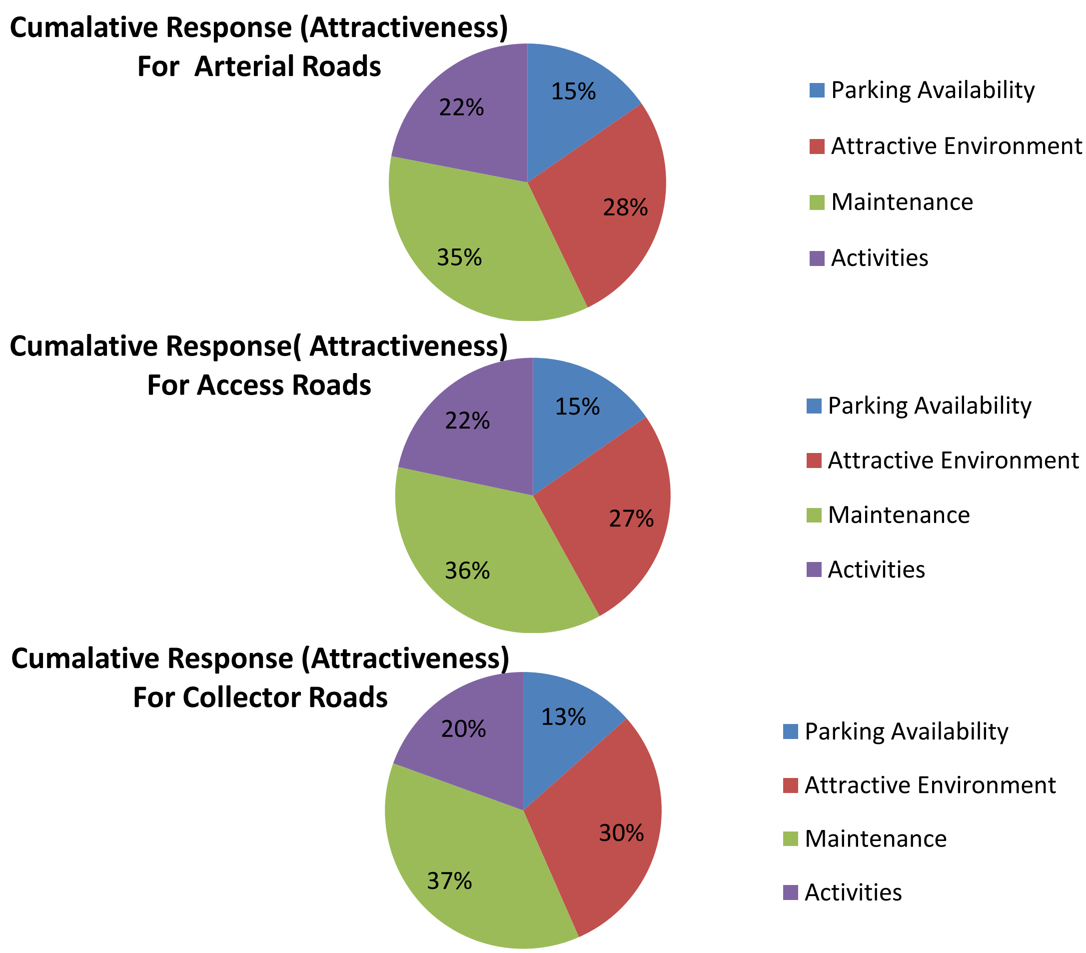


Figure 32: Attractiveness Cumulative Response for all roads

The consistency ratios of the cumulative AHP analysis conducted for the different road typology under attractiveness category are presented below:

Cumulative Response	Consistency Ratio
Arterial Road	-0.168
Access Road	-0.057
Collector Road	0.006

Comparative Inferences:

Among four Individual indicators of Attractiveness category mentioned in the above figures:

1. It can be observed that Maintenance followed by attractive environment and parking availability resulted out to be the most weighted indicator in case of arterial roads.
2. In case of access roads Maintenance followed by attractive environment and parking availability resulted out to be the most weighted indicator.
3. In case of collector roads also again Maintenance followed by attractive environment and parking availability resulted out to be the most weighted indicators.

7.4.2 Rationalised Indicator Weights for CyLOS Tool

Before conducting a student survey to determine indicator weights, the CyLOS development team in discussion with TRIPP, IIT Delhi determined through a discussion and deliberation process. The individual indicator weights in each category were multiplied with expert survey based category weights to determine the overall indicator weight for each of the 33 indicators (totalling 100%). We refer to these individual overall indicators weights as expert weightages. **Table 4** presents a overall expert weights for route/corridor for each road type.

Table 4: Overall expert weights for each road typology (Route/Corridor)

Category	Category Weight				Indicators	Description	Overall Indicator Weight%			
	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Indicators	Description	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent
Coherence	17%	22%	14%	14%	Infrastructure Relevance	How relevant is planned/constructed infrastructure to its context	5.95%	9.90%	9.10%	7.00%
					Frequency of cycle crossings	How frquent are available opportunities for cyclists to cross the road	5.95%	5.50%	0.70%	0.70%
					Cycle Specific Marking	Availability of adequate pavement marking to guide, warn and regulate cyclists	1.70%	2.20%	1.40%	2.80%
					Cycle Specific signage	Availability of adequate sign boards to guide, warn and regulate cyclists	1.70%	2.20%	1.40%	2.80%

					Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	1.70%	2.20%	1.40%	0.70%
Safety	44%	36%	32%	41%	Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	2.20%	1.80%	1.60%	2.05%
					Crossing Safety Index	What is the level of safety in terms of crash risk and severity, at cyclist crossing facilities	8.80%	7.20%	1.60%	2.05%
					Lighting quality index	What is the quality of lighting in terms of level and uniformity	6.60%	3.60%	6.40%	8.20%
					Mid block accident safety	Assesment of accident risk for cyclist along the carriageway	11.00%	7.20%	4.80%	2.05%
					Eyes on street	Assesment of level of activity along segment, to ensure security	8.80%	7.20%	8.00%	20.50%
					Enforcement	Assessment of level of enforcement to ensure safety on carriageway.	2.20%	3.60%	1.60%	4.10%
					Parking Friction Index	Assessment of risk posed by street parking to commuting cyclists	4.40%	5.40%	8.00%	2.05%
Directness	16%	20%	28%	12%	Enforcement	Assessment of level of enforcement to ensure minimal loss of directness to cyclists.	0.80%	2.00%	1.40%	0.60%
					Parking Friction Index	Assessment of loss of directness from friction by street parking to commuting cyclists	1.28%	5.00%	5.60%	0.60%
					Obstruction Index	Assessment of loss of directness casued by presence of abstruction in cycling path	3.36%	4.00%	5.60%	2.40%
					Width Sufficiency Index	Assesment of sufficiency of cycling path width with respect to vehicle size and cycle volume	3.36%	3.00%	1.40%	3.00%

					Hawker Friction Index	Assesment of loss of directness due to friction from hawkers on cycling path	1.60%	1.00%	2.24%	0.96%
					Frequency of punctures	How often is cycling lane/path crossed by vehicular path to access service lane/property entrance, etc.	1.28%	1.00%	0.56%	0.24%
					Pedestrian Friction Index	Assessment of loss of directness due to friction from pedestrians on cycle path	2.40%	2.00%	5.60%	1.80%
					Cyclist Delay at Intersection	Assesment of loss of directness due to delay to cyclists at intersections	0.64%	0.80%	1.68%	0.72%
					Maintenance	Assesment of loss of directness due to friction cause by poor maintenance/ cleaning cycle infrastructure	0.64%	0.80%	2.80%	1.20%
					Turning Radius	Assessment of loss of directness due to tight turning radiuses on cycling path	0.64%	0.40%	1.12%	0.48%
Comfort	18%	15%	18%	20%	Turning Radius	Assessment of loss of comfort due to tight turning radii on cycling path	1.44%	0.75%	0.90%	3.00%
					Riding Comfort Index	Assement of riding comfort with reference to surface type	6.30%	5.25%	6.30%	7.00%
					Shaded Length	Assessment of protection from wether in terms of shade/shelter over cycling path	3.60%	3.00%	4.50%	5.00%
					Cross Slope Index	Assessment of water runoff capability and comfortable riding cross slope	1.26%	0.75%	0.54%	0.60%
					Longitudenal Slope Index	Assessment of comfortable riding longitudenal slope	3.60%	3.75%	4.50%	3.00%
					Ramp Slope Index	Assessment of comfort of ramps provide to access egress from cycle path.	0.90%	0.75%	0.36%	0.40%
					Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	0.90%	0.75%	0.90%	1.00%

Attractiveness	5%	7%	8%	13%	Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	1.25%	1.40%	0.80%	0.65%
					Eyes on Street	Attraction of cycling infrastructure in terms of life/ activity along cycling path	1.00%	1.40%	2.00%	5.20%
					Maintenance	Attractiveness of cycling infrastructure in terms of how well it is maintained	2.00%	2.80%	3.20%	3.90%
					Landscaping	Attractiveness of cycling infrastructure in terms of alongside landscaping/ plantation	0.75%	1.40%	2.00%	3.25%
Total	100%	100%	100%	100%			100%	100%	100%	100%

The individual indicator weights in each category derived from the student survey, were also multiplied with expert survey derived category weights to arrive at overall indicator weights for all 33 indicators (totalling 100%). We refer these weights as student weightages. **Table 5** presents final overall student weights for route/corridor for each road type.

Table 5: Overall student weights for each road typology (Route/Corridor)

Category	Category Weight				Indicators	Description	Overall Indicator Weight%			
	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Indicators	Description	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent
Coherence	17%	22%	14%	14%	Infrastructure Relevance	How relevant is planned/constructed infrastructure to its context	1.76%	1.80%	1.81%	7.00%
					Frequency of cycle crossings	How frquent are available opportunities for cyclists to cross the road	2.65%	5.00%	1.70%	0.70%
					Cycle Specific Marking	Availability of adequate pavement marking to guide, warn and regulate cyclists	4.13%	4.03%	3.99%	2.80%
					Cycle Specific signage	Availability of adequate sign boards to guide, warn and regulate cyclists	4.24%	4.00%	3.99%	2.80%
					Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	4.23%	7.16%	2.50%	0.70%
Safety	44%	36%	32%	41%	Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	8.68%	6.15%	6.48%	2.05%

					Crossing Safety Index	What is the level of safety in terms of crash risk and severity, at cyclist crossing facilities	3.07%	3.23%	2.62%	2.05%
					Lighting quality index	What is the quality of lighting in terms of level and uniformity	4.11%	2.92%	3.55%	8.20%
					Mid block accident safety	Assesment of accident risk for cyclist along the carriageway	5.93%	6.02%	4.27%	2.05%
					Eyes on street	Assesment of level of activity along segment, to ensure security	5.17%	5.77%	3.70%	20.50%
					Enforcement	Assessment of level of enforcement to ensure safety on carriageway.	8.10%	5.29%	6.07%	4.10%
					Parking Friction Index	Assessment of risk posed by street parking to commuting cyclists	8.95%	6.62%	5.32%	2.05%
Directness	16%	20%	28%	12%	Enforcement	Assessment of level of enforcement to ensure minimal loss of directness to cyclists.	0.71%	1.06%	1.07%	0.60%
					Parking Friction Index	Assessment of loss of directness from friction by street parking to commuting cyclists	1.11%	1.35%	1.39%	0.60%
					Obstruction Index	Assessment of loss of directness casued by presence of abstruction in cycling path	1.83%	1.98%	2.84%	2.40%
					Width Sufficiency Index	Assesment of sufficiency of cycling path width with respect to vehicle size and cycle volume	1.47%	1.33%	2.02%	3.00%
					Hawker Friction Index	Assesment of loss of directness due to friction from hawkers on cycling path	1.40%	2.08%	2.43%	0.96%

					Frequency of punctures	How often is cycling lane/path crossed by vehicular path to access service lane/property entrance, etc.	1.53%	1.69%	2.72%	0.24%
					Pedestrian Friction Index	Assessment of loss of directness due to friction from pedestrians on cycle path	1.40%	2.03%	3.96%	1.80%
					Cyclist Delay at Intersection	Assesment of loss of directness due to delay to cyclists at intersections	1.66%	2.49%	3.21%	0.72%
					Maintenance	Assesment of loss of directness due to friction cause by poor maintenance/ cleaning cycle infrastructure	2.58%	3.48%	3.87%	1.20%
					Turning Radius	Assessment of loss of directness due to tight turning radiuses on cycling path	2.31%	2.51%	4.48%	0.48%
Comfort	18%	15%	18%	20%	Turning Radius	Assessment of loss of comfort due to tight turning radii on cycling path	0.96%	1.14%	0.68%	3.00%
					Riding Comfort Index	Assement of riding comfort with reference to surface type	1.97%	1.79%	1.96%	7.00%
					Shaded Length	Assessment of protection from wether in terms of shade/shelter over cycling path	2.15%	1.45%	1.98%	5.00%
					Cross Slope Index	Assessment of water runoff capability and comfortable riding cross slope	2.99%	3.59%	3.71%	0.60%
					Longitudenal Slope Index	Assessment of comfortable riding longitudenal slope	2.76%	2.29%	1.68%	3.00%
					Ramp Slope Index	Assessment of comfort of ramps provide to access egress from cycle path.	2.45%	2.21%	2.99%	0.40%
					Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	4.73%	2.53%	4.99%	1.00%

Attractiveness	5%	7%	8%	13%	Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	0.77%	0.96%	1.23%	0.65%
					Eyes on Street	Attraction of cycling infrastructure in terms of life/ activity along cycling path	1.10%	1.57%	1.73%	5.20%
					Maintenance	Attractiveness of cycling infrastructure in terms of how well it is maintained	1.76%	2.40%	2.91%	3.90%
					Landscaping	Attractiveness of cycling infrastructure in terms of alongside landscaping/ plantation	1.37%	2.07%	2.13%	3.25%
Total	100%	100%	100%	100%			100%	100%	100%	100%

Student weights were compared with expert weights to analyse any inconsistencies. For simplicity sake it was decided that student weights will be given preference for use in the CyLOS tools however top 7 (top 25%) weights shall be compared with top 7 expert weights to resolve any major inconsistencies. In this comparison it was assessed that between three to five, of the top seven indicators were not common between the two sets. Even within the indicators that were common. When these uncommon indicators were compared for their overall weightages, a significant difference in their individual weights was observed. It was determined that rationalising some of these indicator weights may be necessitated, because of the following reasons:

- Questionnaire may have failed to explain the features of some complex indicators involving more than one feature. For example the relevance indicator had been weighted very low by students but very high by experts. It is assumed that students failed to capture its importance because they may have been unaware of the fact that this indicator captures not only the relevance of an infrastructure design in a context but also the consistency and continuity of the infrastructure.
- Students may have been unaware of importance of features attached to some indicators as they have not experienced a cycling infrastructure.
- Students were biased towards basic features (such as maintenance and enforcement) that they currently find missing on the streets that they use.
- Though the last point is justified in determining the weightages the first two necessitated some correction. The said corrections were conducted through the following process in discussion with TRIPP, IIT Delhi:
- Based on the above reasons top 7 compared indicators were provided with a rationalized weightages. The rationalization involved using either the weightages from the student weights or from the expert weights. Two balance the sum of total student weights one indicator was to be adjusted to a value which may not be from student or expert weights.

The rationalized overall indicators were fed back in the student weights, and were converted to individual category weights for each road after dividing by category weights for the said road. These weights replaced the individual weights in each category as determined from the student survey. The rationalized student indicator weights in each category since modified based on overall total of 100% (were modified as overall weights) disturbed the sum of category weights which was now either less than or more than 100%. These were corrected by scaling up or down each weight in each category for each road type in the ratio of their current contribution in each category.

Finally multiplying each rationalised weight in each category with individual category weight provided overall rationalised weightages for each indicator for each road type.

Table 6 presents final overall rationalised weights for route/corridor for each road type.

Table 6: Overall rationalized weightages for each road typology (Route/Corridor)

Category	Category Weight				Indicators	Description	Overall Indicator Weight%			
	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Indicators	Description	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent
Coherence	17%	22%	14%	14%	Infrastructure Relevance	How relevant is planned/constructed infrastructure to its context	5.10%	8.58%	6.58%	7.00%
					Frequency of cycle crossings	How frquent are available opportunities for cyclists to cross the road	2.21%	4.40%	1.26%	0.70%
					Cycle Specific Marking	Availability of adequate pavement marking to guide, warn and regulate cyclists	3.40%	3.52%	2.80%	2.80%
					Cycle Specific signage	Availability of adequate sign boards to guide, warn and regulate cyclists	3.57%	3.52%	2.80%	2.80%
					Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	2.72%	1.98%	0.56%	0.70%

Safety	44%	36%	32%	41%	Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	7.48%	1.80%	2.24%	2.05%
					Crossing Safety Index	What is the level of safety in terms of crash risk and severity, at cyclist crossing facilities	3.52%	7.56%	2.56%	2.05%
					Lighting quality index	What is the quality of lighting in terms of level and uniformity	4.84%	2.88%	6.40%	8.20%
					Mid block accident safety	Assesment of accident risk for cyclist along the carriageway	12.76%	6.12%	4.16%	2.05%
					Eyes on street	Assesment of level of activity along segment, to ensure security	6.16%	5.76%	3.52%	20.50%
					Enforcement	Assessment of level of enforcement to ensure safety on carriageway.	3.08%	5.40%	2.56%	4.10%
					Parking Friction Index	Assessment of risk posed by street parking to commuting cyclists	6.16%	6.48%	10.56%	2.05%
Directness	16%	20%	28%	12%	Enforcement	Assessment of level of enforcement to ensure minimal loss of directness to cyclists.	0.32%	1.20%	0.56%	0.60%
					Parking Friction Index	Assessment of loss of directness from friction by street parking to commuting cyclists	0.64%	1.40%	2.80%	0.60%
					Obstruction Index	Assessment of loss of directness casued by presence of abstruction in cycling path	1.92%	2.20%	3.08%	2.40%
					Width Sufficiency Index	Assesment of sufficiency of cycling path width with respect to vehicle size and cycle volume	1.60%	1.40%	2.24%	3.00%
					Hawker Friction Index	Assesment of loss of directness due to friction from hawkers on cycling path	1.44%	2.20%	2.52%	0.96%

					Frequency of punctures	How often is cycling lane/path crossed by vehicular path to access service lane/property entrance, etc.	1.60%	1.80%	2.80%	0.24%
					Pedestrian Friction Index	Assessment of loss of directness due to friction from pedestrians on cycle path	1.44%	2.20%	4.76%	1.80%
					Cyclist Delay at Intersection	Assesment of loss of directness due to delay to cyclists at intersections	1.76%	2.60%	3.36%	0.72%
					Maintenance	Assesment of loss of directness due to friction cause by poor maintenance/ cleaning cycle infrastructure	2.72%	2.20%	3.92%	1.20%
					Turning Radius	Assessment of loss of directness due to tight turning radiuses on cycling path	2.56%	2.80%	1.96%	0.48%
Comfort	18%	15%	18%	20%	Turning Radius	Assessment of loss of comfort due to tight turning radii on cycling path	0.72%	1.14%	0.36%	3.00%
					Riding Comfort Index	Assement of riding comfort with reference to surface type	5.04%	1.79%	2.52%	7.00%
					Shaded Length	Assessment of protection from wether in terms of shade/shelter over cycling path	1.80%	1.45%	2.52%	5.00%
					Cross Slope Index	Assessment of water runoff capability and comfortable riding cross slope	2.34%	3.59%	4.86%	0.60%
					Longitudenal Slope Index	Assessment of comfortable riding longitudenal slope	2.34%	2.29%	2.16%	3.00%
					Ramp Slope Index	Assessment of comfort of ramps provide to access egress from cycle path.	1.98%	2.21%	3.78%	0.40%
					Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	3.78%	2.53%	1.80%	1.00%

Attractiveness	5%	7%	8%	13%	Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	0.77%	1.12%	0.40%	0.65%
					Eyes on Street	Attraction of cycling infrastructure in terms of life/ activity along cycling path	1.10%	1.82%	1.92%	5.20%
					Maintenance	Attractiveness of cycling infrastructure in terms of how well it is maintained	1.76%	1.68%	3.28%	3.90%
					Landscaping	Attractiveness of cycling infrastructure in terms of along side landscaping/ plantation	1.37%	2.38%	2.40%	3.25%
Total	100%	100%	100%	100%			100%	100%	100%	100%

Table 7 presents a comparison of final overall expert weights, student weights, and rationalised weights for route/corridor; for each road type.

Table 7: Comparative Overall weightages chart for each road typology (Route/Corridor)

Category	Category Weight				Indicators	Overall Indicator Weight%(Experts)				Overall Indicator Weight%(Students)				Overall Indicator Weight%(Rationalized)			
	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Indicators	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent
Coherence	17%	22%	14%	14%	Infrastructure Relevance	5.95%	9.90%	9.10%	7.00%	1.76%	1.80%	1.81%	7.00%	5.10%	8.58%	6.58%	7.00%
					Frequency of cycle crossings	5.95%	5.50%	0.70%	0.70%	2.65%	5.00%	1.70%	0.70%	2.21%	4.40%	1.26%	0.70%
					Cycle Specific Marking	1.70%	2.20%	1.40%	2.80%	4.13%	4.03%	3.99%	2.80%	3.40%	3.52%	2.80%	2.80%
					Cycle Specific signage	1.70%	2.20%	1.40%	2.80%	4.24%	4.00%	3.99%	2.80%	3.57%	3.52%	2.80%	2.80%
					Cycle Box at Intersection	1.70%	2.20%	1.40%	0.70%	4.23%	7.16%	2.50%	0.70%	2.72%	1.98%	0.56%	0.70%
Safety	44%	36%	32%	41%	Cycle Box at Intersection	2.20%	1.80%	1.60%	2.05%	8.68%	6.15%	6.48%	2.05%	7.48%	1.80%	2.24%	2.05%
					Crossing Safety Index	8.80%	7.20%	1.60%	2.05%	3.07%	3.23%	2.62%	2.05%	3.52%	7.56%	2.56%	2.05%
					Lighting quality index	6.60%	3.60%	6.40%	8.20%	4.11%	2.92%	3.55%	8.20%	4.84%	2.88%	6.40%	8.20%
					Mid block accident safety	11.00%	7.20%	4.80%	2.05%	5.93%	6.02%	4.27%	2.05%	12.76%	6.12%	4.16%	2.05%
					Eyes on street	8.80%	7.20%	8.00%	20.50%	5.17%	5.77%	3.70%	20.50%	6.16%	5.76%	3.52%	20.50%
					Enforcement	2.20%	3.60%	1.60%	4.10%	8.10%	5.29%	6.07%	4.10%	3.08%	5.40%	2.56%	4.10%
					Parking Friction Index	4.40%	5.40%	8.00%	2.05%	8.95%	6.62%	5.32%	2.05%	6.16%	6.48%	10.56%	2.05%
Directness	16%	20%	28%	12%	Enforcement	0.80%	2.00%	1.40%	0.60%	0.71%	1.06%	1.07%	0.60%	0.32%	1.20%	0.56%	0.60%
					Parking Friction Index	1.28%	5.00%	5.60%	0.60%	1.11%	1.35%	1.39%	0.60%	0.64%	1.40%	2.80%	0.60%
					Obstruction Index	3.36%	4.00%	5.60%	2.40%	1.83%	1.98%	2.84%	2.40%	1.92%	2.20%	3.08%	2.40%
					Width Sufficiency Index	3.36%	3.00%	1.40%	3.00%	1.47%	1.33%	2.02%	3.00%	1.60%	1.40%	2.24%	3.00%
					Hawker Friction Index	1.60%	1.00%	2.24%	0.96%	1.40%	2.08%	2.43%	0.96%	1.44%	2.20%	2.52%	0.96%
					Frequency of punctures	1.28%	1.00%	0.56%	0.24%	1.53%	1.69%	2.72%	0.24%	1.60%	1.80%	2.80%	0.24%
					Pedestrian Friction Index	2.40%	2.00%	5.60%	1.80%	1.40%	2.03%	3.96%	1.80%	1.44%	2.20%	4.76%	1.80%
					Cyclist Delay at Intersection	0.64%	0.80%	1.68%	0.72%	1.66%	2.49%	3.21%	0.72%	1.76%	2.60%	3.36%	0.72%
					Maintenance	0.64%	0.80%	2.80%	1.20%	2.58%	3.48%	3.87%	1.20%	2.72%	2.20%	3.92%	1.20%
					Turning Radius	0.64%	0.40%	1.12%	0.48%	2.31%	2.51%	4.48%	0.48%	2.56%	2.80%	1.96%	0.48%

Comfort	18%	15%	18%	20%	Turning Radius	1.44%	0.75%	0.90%	3.00%	0.96%	1.14%	0.68%	3.00%	0.72%	1.14%	0.36%	3.00%
					Riding Comfort Index	6.30%	5.25%	6.30%	7.00%	1.97%	1.79%	1.96%	7.00%	5.04%	1.79%	2.52%	7.00%
					Shaded Length	3.60%	3.00%	4.50%	5.00%	2.15%	1.45%	1.98%	5.00%	1.80%	1.45%	2.52%	5.00%
					Cross Slope Index	1.26%	0.75%	0.54%	0.60%	2.99%	3.59%	3.71%	0.60%	2.34%	3.59%	4.86%	0.60%
					Longitudenal Slope Index	3.60%	3.75%	4.50%	3.00%	2.76%	2.29%	1.68%	3.00%	2.34%	2.29%	2.16%	3.00%
					Ramp Slope Index	0.90%	0.75%	0.36%	0.40%	2.45%	2.21%	2.99%	0.40%	1.98%	2.21%	3.78%	0.40%
					Parking Availability Index	0.90%	0.75%	0.90%	1.00%	4.73%	2.53%	4.99%	1.00%	3.78%	2.53%	1.80%	1.00%
Attractiveness	5%	7%	8%	13%	Parking Availability Index	1.25%	1.40%	0.80%	0.65%	0.77%	0.96%	1.23%	0.65%	0.77%	1.12%	0.40%	0.65%
					Eyes on Street	1.00%	1.40%	2.00%	5.20%	1.10%	1.57%	1.73%	5.20%	1.10%	1.82%	1.92%	5.20%
					Maintenance	2.00%	2.80%	3.20%	3.90%	1.76%	2.40%	2.91%	3.90%	1.76%	1.68%	3.28%	3.90%
					Landscaping	0.75%	1.40%	2.00%	3.25%	1.37%	2.07%	2.13%	3.25%	1.37%	2.38%	2.40%	3.25%
Total	100%	100%	100%	100%		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Of these the three sets of rationalised weights have been fed as default weightages in the CyLOS tool.

The same is being done for the transit evaluation also; however, two indicator types were decided to be doubled in their weight contribution in each of these categories. This is because of the additional importance of these indicators in assessing transit influence area (and not just the route to transit station). These indicators were link density indicator (in coherence category) and parking availability indicator in comfort and attractiveness category. Once again all indicators in these categories were adjusted to accommodate this doubling of weights.

Table 8 presents final overall rationalised weights for Transit access area; for each road type.

Table 8: Overall rationalized weightages for each road typology (Transit area)

Category	Category Weight				Indicators	Description	Overall Indicator Weight%			
	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent	Indicators	Description	Highway, Arterial or Sub arterial	Collector/ Distributory	Access	Standalone/ Independent
Coherence	17%	22%	14%	14%	Infrastructure Relevance	How relevant is planned/constructed infrastructure to its context	4.42%	7.26%	6.02%	6.72%
					Accessibility Index	How much accesssible are the transit stations	3.91%	7.26%	2.38%	1.26%
					Cycle Specific Marking	Availability of adequate pavement marking to guide, warn and regulate cyclists	3.06%	2.86%	2.52%	2.66%
					Cycle Specific signage	Availability of adequate sign boards to guide, warn and regulate cyclists	3.23%	2.86%	2.52%	2.66%

					Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	2.38%	1.76%	0.56%	0.70%
Safety	44%	36%	32%	41%	Cycle Box at Intersection	Availability of cycle box marking at intersection to hold crossing cyclists	7.48%	1.80%	2.24%	2.05%
					Crossing Safety Index	What is the level of safety in terms of crash risk and severity, at cyclist crossing facilities	3.52%	7.56%	2.56%	2.05%
					Lighting quality index	What is the quality of lighting in terms of level and uniformity	4.84%	2.88%	6.40%	8.20%
					Mid block accident safety	Assesment of accident risk for cyclist along the carriageway	12.76%	6.12%	4.16%	2.05%
					Eyes on street	Assesment of level of activity along segment, to ensure security	6.16%	5.76%	3.52%	20.50%
					Enforcement	Assessment of level of enforcement to ensure safety on carriageway.	3.08%	5.40%	2.56%	4.10%
					Parking Friction Index	Assessment of risk posed by street parking to commuting cyclists	6.16%	6.48%	10.56%	2.05%
Directness	16%	20%	28%	12%	Enforcement	Assessment of level of enforcement to ensure minimal loss of directness to cyclists.	0.32%	1.20%	0.56%	0.60%
					Parking Friction Index	Assessment of loss of directness from friction by street parking to commuting cyclists	0.64%	1.40%	2.80%	0.60%
					Obstruction Index	Assessment of loss of directness casued by presence of abstruction in cycling path	1.92%	2.20%	3.08%	2.40%
					Width Sufficiency Index	Assesment of sufficiency of cycling path width with respect to vehicle size and cycle volume	1.60%	1.40%	2.24%	3.00%

					Hawker Friction Index	Assesment of loss of directness due to friction from hawkers on cycling path	1.44%	2.20%	2.52%	0.96%
					Frequency of punctures	How often is cycling lane/path crossed by vehicular path to access service lane/property entrance, etc.	1.60%	1.80%	2.80%	0.24%
					Pedestrian Friction Index	Assessment of loss of directness due to friction from pedestrians on cycle path	1.44%	2.20%	4.76%	1.80%
					Cyclist Delay at Intersection	Assesment of loss of directness due to delay to cyclists at intersections	1.76%	2.60%	3.36%	0.72%
					Maintenance	Assesment of loss of directness due to friction cause by poor maintenance/ cleaning cycle infrastructure	2.72%	2.20%	3.92%	1.20%
					Turning Radius	Assessment of loss of directness due to tight turning radiuses on cycling path	2.56%	2.80%	1.96%	0.48%
Comfort	18%	15%	18%	20%	Turning Radius	Assessment of loss of comfort due to tight turning radii on cycling path	0.54%	1.05%	0.36%	2.80%
					Riding Comfort Index	Assement of riding comfort with reference to surface type	4.14%	1.50%	2.34%	6.60%
					Shaded Length	Assessment of protection from wether in terms of shade/shelter over cycling path	1.44%	1.20%	2.34%	4.80%
					Cross Slope Index	Assessment of water runoff capability and comfortable riding cross slope	1.98%	3.00%	4.32%	0.60%
					Longitudenal Slope Index	Assessment of comfortable riding longitudenal slope	1.98%	1.95%	1.98%	2.80%
					Ramp Slope Index	Assessment of comfort of ramps provide to access egress from cycle path.	1.62%	1.95%	3.42%	0.40%
					Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	6.30%	4.35%	3.24%	2.00%

Attractiveness	5%	7%	8%	13%	Parking Availability Index	Assesment of cycling comfort in terms of availability of safe and secure cycle parking	1.30%	1.96%	0.72%	1.17%
					Eyes on Street	Attraction of cycling infrastructure in terms of life/ activity along cycling path	0.95%	1.54%	1.84%	4.94%
					Maintenance	Attractiveness of cycling infrastructure in terms of how well it is maintained	1.55%	1.47%	3.12%	3.77%
					Landscaping	Attractiveness of cycling infrastructure in terms of along side landscaping/ plantation	1.20%	2.03%	2.32%	3.12%
Total	100%	100%	100%	100%			100%	100%	100%	100%

8 Workshop Consultation

To ensure access by critical users to the tool, it was inevitable to expose CyLOS to various stakeholders through feedback and consultation workshops in four cities. The cities chosen were Bhopal, Hyderabad, Chandigarh and Guwahati. The feedback session on CYLOS was included as part of a full day workshop which focused on Sustainable Transport – NMT Policy Planning and Design.

It was since inception intended that a collaboration with a local or a central CSO/NGO as a third party assessor shall be taken up in the final feedback/consultation stage. This CSO/NGO should be equipped with adequate background knowledge of the project as well issues concerning NMT infrastructure planning and implementation.

While the local/central CSO shall provide and impartial third party review of the process and the tool, the workshops will include gathering comprehensive stakeholder, based review of the tool. Such information shall also be useful to validate, calibrate and if required upgrade the tool. The CSO/NGO shall also have access to city officials and city level decision makers to facilitate better co-ordination of city level workshops.

SGArchitects collaborated with the Institute of Democracy and Sustainability headed by Rajendra Ravi, for all four city workshops. Rajendra Ravi and his organisation has credible acknowledgement as a national level CSO. Their work has been synonymous with social action and training in India. He is also a member of Sustainable Mobility Network (SUM-Net), India. Each city had representatives on behalf of IDS or sister organisation to delve into discussion and raise relevant issues not only contributing to the CyLOS session but also the other sessions in the workshop

8.1 Program

The program included four sessions which were presented under Sustainable Urban Transport – NMT Policy, Planning and Design. The workshop was closely crafted by starting with the national policy – National Urban Transport Policy 2014 prepared by Institute of Urban Transport, Delhi. This was followed by the Non Motorised Transport Policy and Planning and Design Guideline for Cycle Infrastructure prepared by TRIPP-IIT Delhi. These sessions provided critical foundation of the cycling environment in India through policies and planning and design interventions. CYLOS was introduced to the audience as the final session where the tool focused the evaluation of the cycle infrastructure. Eminent Speakers presented relevant sessions followed by discussion with the audience.

Megha Aggarwal IUT, Delhi	Dr. Anvita Arora iTrans Pvt Ltd	Prof. Geetam Tiwari TRIPP, IIT-Delhi	Ruchi Varma SGArchitects	Sandeep Gandhi SGArchitects

Figure 33: Workshop Speakers

8.2 Target Audience

The workshop comprised of participants ranging from municipal officials, government sector, private organisations, consultants - architects, planners, engineers, academicians, students, non government organisations and civil society working on cycling.

Figure 34: Workshop and Discussions

8.3 Findings and Comments

The presentation of the CYLOS tool included the introduction and use of tool on the web format. Mr. Sandeep Gandhi also included some case examples which illustrated how the output/results can be compared. This gave the audience an insight into use of tool to analyze context and design in their city and use it as an empirical evidence to assist in decision making.

Since the CyLOS tool is based on Planning and Design Guideline for Cycle Infrastructure, the forms also took a feedback of if the guideline provided adequate information for the user to understand the planning, design and implementation aspects of cycle infrastructure, which further assists the use of the tool.

In all the workshops, the following were the findings:

1. **Quality of visual and audio material**: The presentation was well accepted with an average rating of good. 22% - 53% of the participants rated it as excellent. None rated it as bad.

2. **Legibility and quality of communication**: 60% - 70% of the participants rated the quality of the communication as good. Summarizing the complexity of cycle infrastructure and the tool into a brief presentation was appreciated.

3. **Quality and quantity of the content:** More than 50% of the participants found the quality and content of the presentation satisfactory. 78% of participants in Guwahati rated it as good.

4. **Understanding of CYLOS tool & the know how to use it after the presentation**: The initial understanding was satisfactory. Almost 70% of the participants at Hyderabad and Chandigarh understood the knowhow of the tool through the presentation.

5. **Understanding of NMT Guideline & its usability for cycle infrastructure planning**: Above 60% of all participants rated their understanding and usability of guideline for cycle infrastructure planning as good.

6. **Understanding of NMT Guideline & its usability for cycle infrastructure design:** 22 % – 53 % of all participants rated their understanding and usability of guideline for cycle infrastructure design as excellent. In cities like Guwahati, the highest rating was 67% for good.

7. **Understanding of NMT Guideline & its usability for cycle infrastructure implementation:** The understanding and usability for cycle infrastructure implementation was rated between good and fair. No participant rated it as poor.

8. **Usefulness of CYLOS tool in the evaluation and audit of NMT infrastructure:** The tool was well accepted by the participants. More than 60% of participants in all workshops gave it thumbs up and considered it useful for their area of work.

9. **Would you recommend the use of CYLOS tool in your organization**?: Considering the utility of the tool, the participants were most likely to use the tool in their organisations. 56% of the participants in Bhopal were extremely likely to use the tool for their future works in cycling.

Additional Comments received are as follows:

1. The presentation was explanatory and rich in content.
2. The legibility and quality of communication in the presentation was coherent and simplified the complexity of cycle infrastructure into one tool.
3. Inclusion of more visual content was recommended.
4. Inputs/ parameters used are very good and measurable with least difficulty.
5. The tool is very useful and it gives a direct insight into how design and planning can be evaluated by non technical people through simple data collection and understanding of output scores.
6. Output results are informative.
7. The tool can help in auditing designs and save costs/ budget.
8. Web based platform assists in maximum outreach.
9. Strong recommendations were suggested to popularize the tool through workshops and awareness through training programs in academic institutions, municipal organizations.
10. As a measure to increase outreach, translation of tool into multiple languages was suggested so that the state agencies and municipalities can use them easily.
11. The tool could be enhanced if there was an output that reflects financial implications with change in design.
12. The score format can be changed to a scale of 1 to 10.
13. The output indicators currently are design based. One could enhance the tool by including more social and economical heads.
14. Knowledge dissemination of the guideline document should be taken up so that authorities can use CYLOS with a technical know-how.
15. Implication of certain aspects such as participatory planning approach or land distribution should be included in the guideline / tool. Currently, it is totally design based.
16. The guideline document is comprehensive and good and needs to be used effectively to get results on ground.
17. Implementation agencies, stakeholders involved should be identified in the guideline document.
18. Also, budget allocation should also be well defined.

9 Annexure

9.1 Annexure 1 – Components used in derived indicators – Corridor/ route evaluation type.

Codes	Indicator	Components used in the formulas
A	Total Number of Crossings	Safe/Traffic calmed crossing no., number of unsignalized/unsafe crossing ,number of major crossing, additional grade separated cycle crossings in the segment- foot over bridges and subways, % of Cycle crossing to be considered at grade separated- indicators contributing to the estimated total number of crossings
B	Total Frequency of Crossing	length of segment, total number of crossings- indicators contributing to the estimated Total Frequency of Crossing
C	Number of Unsignalized /Unsafe Crossing	% length divided, length of segment, Major Junction width, Number of major crossings, safe/Traffic calmed crossing no., Minor Crossing width- indicators contributing to the estimated Number of Unsignalized/Unsafe Crossing
D	Total number of Safe Crossings	Number of major safe crossings, safe/Traffic calmed crossing no- indicators contributing to the estimated Total number of Safe Crossings
E	Total Frequency of Safe Crossings	length of segment, total number of safe crossings- indicators contributing to the estimated Total Frequency of Safe Crossings
F	Total Frequency of unsignalized Crossings	length of segment, number of unsignalised/unsafe crossings- indicators contributing to the estimated Total Frequency of unsignalized Crossings
G	Crossing Intensity	PHPDT Crossing Attraction, Weighted Average of Land use
I	Effective Width	Min.width, total shy away width, number of lanes, lane width of carriage way- indicators contributing to the estimated Effective Width
J	Safety Index of Crossing	crossing exposure index, crossing intensity, total number of safe crossing, total number of crossing, total traffic calming index- intersections and crossings- indicators contributing to the estimated Safety Index of Crossing
K	Number of Major Crossings	no provision for crossing/ physically prevented from crossing, number of major junctions- indicators contributing to the estimated number of major crossings
L1	Shy away Width Left Side	peak hour traffic data in PHPD- bicycle, passenger rickshaw, goods rickshaw, primary adjacent vertical heights(left), shy away width- wall, vertical structures- indicators contributing to the estimated Shy away Width Left Side
L2	Shy away Width Right Side	peak hour traffic data in PHPD- bicycle, passenger rickshaw, goods rickshaw, primary adjacent vertical heights(right), shy away width- wall, vertical structures- indicators contributing to the estimated Shy away Width Right Side

L3	Total Shy away Width	shy away width left side, shy away width right side- indicators contributing to the estimated Total Shy away Width
M	Number of Major Safe Crossings	number of major junctions, traffic calming used at intersection, unsignalized junction, % of Cycle crossing to be considered at grade separated, primary cyclist crossing type across the road(overpass or underpass)- indicators contributing to the estimated Number of Major Safe Crossings
N	Crossing Exposure Index	vehicular speed safety index, exposure to MV lanes index, Weighted avg. exposure to MV lane- indicators contributing to the estimated Crossing Exposure Index
O	Shaded Length	Shading length Index, % length shaded- indicators contributing to the estimated Shaded Length
P	Vehicular Speed	posted speed limits, observed peak speeds- indicators contributing to the estimated Vehicular Speed
Q	Total PBU	peak hour traffic data- bicycle, passenger rickshaw, goods rickshaw, Passenger Bicycle unit- bicycle, bicycle with goods, passenger rickshaw, goods rickshaw, breakup of captive bicycle user share(as % of total captive users)- indicators contributing to the estimated Total PBU
R	Frequency of Puncture Index	Frequency of Punctures, length of midblock, number of cycle lane puncture- indicators contributing to the estimated Frequency of Puncture Index
S	Number of Cycle Lane Puncture	service lane %, number of minor junctions, number of property entrances, length of midblock, Frequency of punctures on service lane- indicators contributing to the estimated Number of Cycle Lane Puncture
T	Friction from Pedestrian Index	infrastructure design at mid block- segregated track, painted lanes, unsegregated, common with footpath- indicators contributing to the estimated Friction from Pedestrian Index
U	Pedestrian Density Index	Space allocation per pedestrian, availability as percentage of total segment length- footpath %, length of segment, Footpath width, pedestrian speed- indicators contributing to the estimated Pedestrian Density Index
V	Parking Friction Index	infrastructure design at mid block- segregated track, painted lanes, unsegregated, common with footpath, infrastructure location-cycle track or segregated, Between street parking and carriage way and angled parking, primary location of track/lane on cross section- between on street parking and carriage way, private vehicles on street parking numbers along the segment, parallel parking, Parking length- indicators contributing to the estimated Parking Friction Index
X	Relivence Index	XA, XB, XC, XD, Cycle track height index, Intersection relevence, Intersection boundry, Primary cyclist crossing type across free left turns or segregated left turn lanes, Cycle track height index, Cyclist approach / access to intersection- - indicators contributing to the estimated relivence index

XA		Primary segregation type from carriageway-raised median, green belt, open drain, location of bus stop- no bus station on curbside, bus stop in between cycle track and carriageway, street category and speeds- highway, arterial, sub-arterial, primary location of track/lane on cross section-along carriageway, segregated tracks, segregation width- indicators contributing to the estimated XA
XB		street category and speeds- collector/distributory, location of bus stop- no bus station on curbside, bus stop in between cycle track and carriageway, carriageway traffic(along segment)-LHS and R.H.S, one way, primary segregation type from carriageway- not segregated, paint marking, raised median, green belt, open drain, segregation width, primary location of lane/track on cross section-along carriageway, segregated tracks, parallel parking, independent parking, no parking, carriageway traffic- one way- indicators contributing to the estimated XB
XC		street category and speeds- access, painted lanes, primary location of track/lane on cross section- along carriageway, unsegregated- indicators contributing to the estimated XC
XD		street category and speeds- independent track/facility, primary segregation type from carriageway- not along carriageway, primary location of track/lane on cross section-independent or standalone, common with footpath- indicators contributing to the estimated XD
Z	Riding Comfort Index	riding comfort index, primary surface type- asphalt, concrete, smooth tiled, rough finish paver blocks, conc. Slabs- indicators contributing to the estimated Riding Comfort Index
A1	Service Lane %	street category and speeds- highway, arterial, sub arterial, service lane, service quality index- indicators contributing to the estimated Service Lane %
B1	Footpath % Index	% of footpath- indicators contributing to the estimated Footpath % Index
C1	Parking Length	angled parking, parallel parking, independent path, private vehicle on street parking numbers along segment(PCU), parallel parking length- indicators contributing to the estimated Parking Length
C2	Parking Length(IPT parking)	IPT parking bays provided, IPT parking bays number, IPT standard width- indicators contributing to the estimated Parking Length(IPT parking)
C3	Percentage of parking over the segment	parking length(private vehicles), parking length(IPT), length of midblock- indicators contributing to the estimated Percentage of parking over the segment
D1	Hawking Friction Index	Hawking Friction Index, frequency of hawkers- indicators contributing to the estimated Hawking Friction Index
E1	Frequency of Hawkers	length of midblock, hawking zones provided, number of hawkers, Friction caused by hawkers- hawking zones provided,

		hawking zones not provided- indicators contributing to the estimated Frequency of Hawkers
F1	Vehicular Speed Safety Index	Vehicular speed safety Index- indicators contributing to the estimated Vehicular Speed Safety Index
G1	Exposure to MV Lanes Index	Exposure to MV lane Index, primary cyclist crossing type across intersecting roads- crossing with or without marking, raised crossing, signalized with or without raised crossing, grade separated(overpass or underpass), no provision for crossing/physically prevented from crossing, carriageway traffic along segment- number of lanes per direction- indicators contributing to the estimated Exposure to MV Lanes Index
H1	PHPDT Crossing Attraction Index	total number of cyclist, total number of cyclist PHPD- indicators contributing to the estimated PHPDT Crossing Attraction Index
J1	Turning Radius Index (MIDBLOCK)	Turning Radius, minimum turning radius for cyclist- indicators contributing to the estimated Turning Radius Index (MIDBLOCK)
K1	Obstruction Index (MIDBLOCK)	Infrastructure type- Painted lanes, unsegregated, right angled parking, parallel parking, street parking, Frequency of Obstruction, Parallel parking over cycle lane/ unsegregated/bus stop on the cycle track, Angled parking over cycle lane/ unsegregated indicators contributing to the estimated Obstruction Index (MIDBLOCK)
LL1	Cross Slope Gradient Index (MIDBLOCK)	cross slope gradient index(Intersections / midblocks), slopes and gradients- minimum cross slope gradient- indicators contributing to the estimated Cross Slope Gradient Index (MIDBLOCK)
M1	Longitudinal Slope Index(MIDBLOCK)	Long. slope gradient index(Intersections / midblock), slopes and gradients- max. gradient or longitudinal slopes(>3m length)- indicators contributing to the estimated Longitudinal Slope Index(MIDBLOCK)
N1	Ramp Slope Gradient(MIDBLOCK)	average ramp slopes used for level changes, Ramp. slope gradient index(Intersections / midblock)- indicators contributing to the estimated Ramp Slope Gradient(MIDBLOCK)
O1	Lighting Levels	lighting levels measured on cyclist path-designed/observed average lighting levels, street category and speeds- independent track/facility, highway, arterial, sub arterial collector/distribuitory, access, Light levels at intersections and midblock- indicators contributing to the estimated Lighting Levels
P1	Lighting Uniformity	lighting levels measured on cyclist path-designed/observed average lighting uniformity, street category and speeds- independent track/facility, highway, arterial, sub arterial collector/distribuitory, access, Light Uniformity at Intersections and midblock- indicators contributing to the estimated Lighting Uniformity
Q1	Cycle Specific Marking- Major junctions	presence of cycle specific signage and markings- indicators contributing to the estimated Cycle Specific Marking- Major junctions

R1	Cycle Specific Signage- Major Junctions	presence of cycle specific signage and markings- indicators contributing to the estimated Cycle Specific Signage- Major Junctions
S1	Cyclist Delay At Intersection	Intersection delay, average cyclist delay, Cyclist delay at intersections, Infrastructure relevance and continuity index, Cycle infrastructure continuity, Cyclist approach / access to intersection - indicators contributing to the estimated Cyclist Delay At Intersection
T1	Traffic Calming at Intersection Index	traffic calming used at intersection- indicators contributing to the estimated Traffic Calming at Intersection Index
U1	Cycle Box at Intersection Index	demarcated cycle stacking spaces such as bike boxes provided- indicators contributing to the estimated Cycle Box at Intersection Index
V1	Traffic Calming other than intersection	primary cyclist crossing type across intersecting roads- traffic calmed- indicators contributing to the estimated Traffic Calming other than intersection
X1	Lighting Levels at Intersection	average lighting levels, street category and speeds- independent track/facility, highway, arterial, sub arterial, collector/distributory, access, Light levels at intersections and midblock- indicators contributing to the estimated Lighting Levels at Intersection
Y1	Lighting Uniformity at Intersection	average lighting uniformity, street category and speeds- independent track/facility, highway, arterial, sub arterial, collector/distributory, access, lighting levels measured on cyclist path-designed/observed average lighting uniformity, Light Uniformity at Intersections and midblock- indicators contributing to the estimated Lighting Uniformity at Intersection
A4	Lighting Quality Index Midblock	lighting levels(midblock) + lighting uniformity(midblock)- indicators contributing to the estimated Lighting Quality Index Midblock
B4	Lighting Quality Index Intersection	lighting levels(intersection) + lighting uniformity(intersection)- indicators contributing to the estimated Lighting Quality Index Intersection
C4	Overall Lighting Quality Index	lighting quality index(midblock), length of midblock, length of segment, lighting quality index(intersection)- indicators contributing to the estimated Overall Lighting Quality Index
Z1	Total No. of Cyclists	peak hour traffic data in PHPD- bicycle, passenger rickshaw, goods rickshaw- indicators contributing to the estimated Total No. of Cyclists
A2	Weigted Average of Landuse	Land use(both sides)- Com. Ret Facing Com.Ret, Com.Ret Facing Resi/ Office, Com.Ret facing others, Resi/ off facing Resi /off, Resi/ off facing Others, Others facing others- indicators contributing to the estimated Weighted Average of Landuse
G2	Trasit Station NMV PARKING	% of transit stations covered with parking(within 100 m), Parking at transit stations - indicators contributing to the estimated Trasit Station NMV PARKING

J2	Cycle Parking	% of commercial/inst. Landuse served by parking(within 100m), % of Cycle parking- indicators contributing to the estimated Cycle Parking
I2	Over all parking availability index	transit station NMV parking, % of transit stations covered with parking(within 100 m), % of commercial/inst. Land use served by parking(within 100m), parking land use, usability of cycle parking- indicators contributing to the estimated Over all parking availability index
M2	Maintenance	Maintenance- entirely clean, well maintained and free from debris, partly clean but mostly free from debris and/or with minor maintenance requirement, mostly covered with debris and/or in need of urgent repairs along majority length- indicators contributing to Maintenance
N2	Landscaping	landscaping- periphery/edges include designed green cover, street furniture and varied façade, periphery/edges partly or fully include green cover but lacks interesting façade and/or street furniture along majority length, lack of designed green cover and other landscaping elements and/or has long monotonous facades along majority length- indicators contributing to the estimated Landscaping
O2	Enforcement	Enforcement, well enforced-no encroachment by motorists and parking along the entire segment length, partly enforced-light motor vehicles encroach designated cycle infrastructure near intersections but no parking and no encroachment at mid block, lack enforcement- motor vehicles routinely encroach and park on designated infrastructure- indicators contributing to enforcement
P2	Usability of cycle track facility	evaluation type- evaluation of existing infrastructure or facility, additional information for existing segment/route- in case designated cycle track or lane indicate average % of cyclists using facility along segment- indicators contributing to the estimated Usability of cycle track facility
R2	Usability of cycle parking	evaluation type- evaluation of existing infrastructure or facility, in case of designated cycle or rickshaw parking indicate average % of cyclists using facility along segment- indicators contributing to the estimated Usability of cycle parking
S2	Cycle marking - midblock	marking and signage- presence of cycle specific marking (excluding lanes)- indicators contributing to the estimated Cycle marking - midblock
T2	Cycle signage - midblock	marking and signage- presence of cycle specific sign boards- indicators contributing to the estimated Cycle signage - midblock
U2	Overall cycle marking	cycle specific marking(major junctions), cycle marking(midblock)- indicators contributing to the estimated Overall cycle marking
V2	Overall cycle signage	cycle signage(midblock), cycle specific signage(major junctions)- indicators contributing to the estimated Overall cycle signage

W2	PBU per effective lane	cycle signage(midblock), cycle specific signage(major junctions)- indicators contributing to the estimated Overall cycle signage
X2	Width sufficiency Index	infrastructure type-segregated tracks, painted lanes, unsegregated, NMV width requirement, NMV width requirement(segregated tracks), NMV volume requirement per lane, NMV width requirement(painted lanes), NMV width requirement index(common), width requirement index for common cycle track and footpath(based on volume)- indicators contributing to the estimated Width sufficiency Index
E4	NMV width requirement (segregated tracks)	infrastructure design at midblock-minimum width, NMV track width segregated- indicators contributing to the estimated NMV width requirement (segregated tracks)
H4	NMV volume requirement	PBU per effective lane, NMV Volume/lane- indicators contributing to the estimated NMV volume requirement
I4	NMV width requirement (painted lane)	infrastructure design at mid block-minimum width, NMV lane width (painted)- indicators contributing to the estimated NMV width requirement (painted lane)
J4	Width requirement index for common cycle track footpath(based on measurement)	infrastructure design at mid block-minimum width, NMV track width requirement index(common)(based on measurement)- indicators contributing to the estimated Width requirement index for common cycle track footpath(based on measurement)
K4	Frequency of obstructions midblock	length of midblock, number of obstruction on bicycle path- indicators contributing to the estimated Frequency of obstructions midblock
L4	Length of Midblock	Infrastructure Type, length of segment, number of major intersections, Major Junction width- indicators contributing to the estimated Length of Midblock
M4	Midblock Accident safety Index	evaluation type- evaluation of existing infrastructure, midblock risk index, estimated midblock risk, Midblock accident safety index, Side edge drop index- indicators contributing to the estimated Midblock Accident safety Index
N4	Eyes on street (% of Segment which has activity(Hawkers))	frequency of hawkers, % of Segment which has activity(Hawkers)- indicators contributing to the estimated Eyes on street (% of Segment which has activity(Hawkers))
O4	Current Fatalities	indicate the average annual number of cyclist fatalities along the segment, Fatalities- indicators contributing to the estimated Current Fatalities
P4	Frequency of crossing index	street category and speeds-independent track/facility, highway, arterial, sub-arterial, collector/distributory, access, Crossing frequency- indicators contributing to the estimated Frequency of crossing index
Q4	Total traffic calming index - Intersections & Crossings	primary intersection type- unsignalized junction, signalized junction, one lane roundabout, two lane roundabout, rotary, grade separated(for vehicles), traffic calming at intersection index, traffic calming at midblock index, % of Cycle crossing to be considered at grade separated- indicators contributing to the estimated Total traffic calming index - Intersections &

		Crossings
S4	Midblock risk index	fatalities/segment length, Midblock Risk Index- indicators contributing to the estimated Midblock risk index
T4	Estimated midblock risk	vehicular speed, primary segregation type from carriageway-paint marking, reflector studs, Estimated Midblock Risk, Cycle infrastructure continuity- indicators contributing to the estimated midblock risk
U4	Fatalities/ segment length	current fatalities, length of segment- indicators contributing to the estimated Fatalities/ segment length
W4	Width requirement index for common cycle track and footpath(based on volume)	infrastructure type- minimum width, width requirement for common cycle track footpath- indicators contributing to the estimated Width requirement index for common cycle track and footpath(based on volume)
PLI	Parking Length Index	percentage of parking over the segment, parking length-indicators contributing to the estimated Parking Length Index
W4-1	Width requirement for common cycle track footpath	peak hour traffic data in PHPD- pedestrians, number of bicycle, pedestrian speed, Effective Lane width- indicators contributing to the estimated Width requirement for common cycle track footpath
W4-2	Width requirement for common cycle track footpath	peak hour traffic data in PHPD- pedestrians, number of bicycle, pedestrian speed, Effective Lane width- indicators contributing to the estimated Width requirement for common cycle track footpath
W4-3	Width requirement for common cycle track footpath	peak hour traffic data in PHPD- pedestrians, number of bicycle, pedestrian speed, Effective Lane width- indicators contributing to the estimated Width requirement for common cycle track footpath
W4-4	Width requirement for common cycle track footpath	peak hour traffic data in PHPD- pedestrians, number of bicycle, pedestrian speed, Effective Lane width- indicators contributing to the estimated Width requirement for common cycle track footpath
W4-5	Width requirement for common cycle track footpath	peak hour traffic data in PHPD- pedestrians, number of bicycle, pedestrian speed, Effective Lane width- indicators contributing to the estimated Width requirement for common cycle track footpath
SQI	service lane quality index	availability as percentage of total segment length- service lane %, quality in terms of percentage of service lane and footpath meeting different grades-Service lane- % of A, % of B- indicators contributing to the estimated service lane quality index
FQI	footpath quality index	availability as percentage of total segment length- footpath %, quality in terms of percentage of service lane and footpath meeting different grades-Service lane-footpath- % of A, % of B- indicators contributing to the estimated footpath quality index

CIC	Cycle infrastructure continuity index	Cycle infrastructure continuity at minor junctions, Cycle infrastructure continuity at property entrances
B5	Blinkers and signages at Minor junction	Provision of warning such as blinkers and signboards
SS1	Cycle path width reduction at intersection approach(more than 0.3 m)	Width of cycle track / lane reduction (by more than 0.3m) on approaching to the junction
SS2	Cyclist approach / access to intersection	Cyclist Approach/access at the Intersection- segregated, cycle lane, unsegregated, common, stand alone, Street Category and Speeds- collector road, access road, Infrastructure Type- segregated tracks, painted lanes, unsegregated ,common with footpath
XI	Intersection relevance	Street Category and Speeds- independent track, highway, arterial, sub arterial, collector, access, Primary intersection type- signalized junction, unsignalized junction, one lane round about, two lane round about, rotary, grade separated(for vehicles)
IBI	Intersection boundary	Street category and speeds- highway, arterial, sub-arterial, collector, primary cycle infrastructure along intersection boundary- painted marking on the periphery along circular road, no segregation/demarcation- common with carriageway
PCCT	Primary cyclist crossing type across free left turns or segregated left turn lanes	street categories and speeds- independent track, arterial, collector, distributory, Primary cyclist crossing type across free left turns or segregated left turn lanes- crossing marked across carriageway, raised crossing, grade separated(underpass or overpass), signalized crossing
PCI	Parking cost index	Parking cost rupees per day
CHI	Cycle track height index	street category and speeds- independent track, Average height above/below road surface (main carriageway)
SED	Side edge drop	Primary adjacent vertical edge heights
SEDI	Side edge drop index	Side edge drop
CICM	Cycle infrastructure continuity at minor junctions	Infrastructure Type-segregated tracks, painted lanes,unsegregated, common with footpath, Primary type of crossing for cyclists across vehicular path- at carriageway level,

		level of cycle track remains same(above carriageway), at footpath level
CICP	Cycle infrastructure continuity at property entrances	Infrastructure design at mid block- Segregated tracks, painted lanes, unsegregated, common with footpath, Primary type of crossing for cyclists across vehicular path- at carriageway level, level of cycle track remains same(above carriageway), at footpath level

9.2 Annexure 2 – Components used in derived indicators -Transit access area evaluation type.

Codes	Indicator	Components used in formula
P4	Accessibility index	Street category and speeds-independent track/facility, highway, arterial, sub-arterial, collector/distributory, access, Crossing frequency- indicators contributing to the estimated Frequency of crossing index
Y4	Link density	Number of links, Accessibility influence zone radius
Y3	Link density index	Link density

9.3 Annexure 3 – List of the participants (NMT workshop)

Participants Name	From
Dr. Geetam Tiwari	IIT - DELHI
Miss Aloke Parna	IIT - DELHI
Miss Leeza Malik	IIT - DELHI
Mr.Ravi Gadepalli	Shakti Foundation
Mr.Ranjit Gadgil	Parisar
Dr. Joseph Fazio	Fazio Engineerware
Prof.Girish aggarwal	IIT - DELHI
Miss Ruchi Varma	SGArchitects
Mr. Nilesh Bansal	SGArchitects
Mr. Parvesh sherawat	I-Trans
Mr.Sandeep Gandhi	SGArchitects

9.4 Annexure 4 – Feed Back forms (NMT workshop)

AHP forms for road infrastructure type are as follows:

S. No. 1	Surveyor: Sandeep Respondent: Leeza Malik	Date: 17/12/13
S. No.	Which one of the two is preferred? By how much?	Score
1	Coherence, or the degree to which the cycling infrastructure is legible to cyclist, is continuous, integrated and networked	
	Directness, or the measure impacting the the travel time and speed of cyclist	
2	Coherence, or the degree to which the cycling infrastructure is legible to cyclist, is continuous, integrated and networked	
	Safety, or the measure of infrastructures ability to protect the cyclist from crashes/accidents and crime	
3	Coherence, or the degree to which the cycling infrastructure is legible to cyclist, is continuous, integrated and networked	
	Comfort, or the ability of the infrastructure to ensure a comfortable ride for cyclists in terms of surface quality and protection from environment	
4	Coherence, or the degree to which the cycling infrastructure is legible to cyclist, is continuous, integrated and networked	
	Attractiveness, or the the property of the infrastructure to provide a visually and physically pleasing environment for cycling	
5	Directness, or the measure impacting the the travel time and speed of cyclist	
	Safety, or the measure of infrastructures ability to protect the cyclist from crashes/accidents and crime	
6	Directness, or the measure impacting the the travel time and speed of cyclist	
	Comfort, or the ability of the infrastructure to ensure a comfortable ride for cyclists in terms of surface quality and protection from environment	
7	Directness, or the measure impacting the the travel time and speed of cyclist	
	Attractiveness, or the the property of the infrastructure to provide a visually and physically pleasing environment for cycling	
8	Safety, or the measure of infrastructures ability to protect the cyclist from crashes/accidents and crime	
	Comfort, or the ability of the infrastructure to ensure a comfortable ride for cyclists in terms of surface quality and protection from environment	
9	Safety, or the measure of infrastructures ability to protect the cyclist from crashes/accidents and crime	
	Attractiveness, or the the property of the infrastructure to provide a visually and physically pleasing environment for cycling	
10	Comfort, or the ability of the infrastructure to ensure a comfortable ride for cyclists in terms of surface quality and protection from environment	
	Attractiveness, or the the property of the infrastructure to provide a visually and physically pleasing environment for cycling	

9.5 Annexure 5 – Survey Form for School Children – English Version

CyLOS, Cycling Level of Service Tool, 2014

CyLOS is a tool that helps planners and designers to plan and develop safe and convenient cycling paths and facilities. Such cycling infrastructure will be useful for short commutes within the city, including trips to school, to local shops, work places, etc. The following questionnaire shall assist in enhancing the performance of the tool. You are requested to fill in the basic details on this page, and select a road type which best resembles the road that you may be using to reach the school (tick against one image). In the subsequent forms, please select one of the two given features (in each row) that you prefer. To rate your preference level of one feature over the other, please input a score (1 to 9), where 1 means that both features are equally preferred and 9 means that the selected feature is extremely preferred over the other.

Name	AMIT SHARMA	Age	16	Gender (M/F)	M
Class	10			Section	A
School	Sarthak Senior Secondary School			City	Lucknow

How do you come to school? (TICK (√) ONE)

Walk	Cycle	Auto	Cycle Rickshaw	Bus	Van	Car	Scooter/Motor Cycle	Others (Specify)
		√						

What type of road is connecting your home to school?		TICK (√) ONE
MAJOR ROAD, WITH HIGH SPEED MOTOR VEHICLES		
NOT VERY WIDE, MAIN ROAD WITH FEW CARS AND TWO WHEELERS		√
NARROW ROAD WITH SHOPS OR HOUSES ON BOTH SIDES, LESS CARS, MORE PEOPLE		
NO ROAD - PATHS OR LANES GOING THROUGH PARK OR OTHER OPEN AREAS		

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CyLOS, Cycling Level of Service Tool, 2014

PREFERENCE SCORE	
Equally Preferred	1
Moderately Preferred	3
Strongly Preferred	5
Very Strongly Preferred	7
Extremely Preferred	9

EXAMPLE		
WHAT DO YOU PREFER? (CHOOSE ONE and TICK MARK IN THE BOX GIVEN)		SCORE - BY HOW MUCH do you prefer apple over orange?
APPLE	ORANGE	7

What features in a proposed cycling facility do you prefer for cycling to/from school?			
Tick mark the preference between features (each row) and add a preference score for the selected			
	SELECT ROAD TYPE	ARTERIAL / COLLECTOR / ACCESS / STANDALONE	SCORE
DIRECTNESS			
1	Prevention from car/scooter parking along your cycling path	Prevention from other vehicles using your cycling path	9
2	Prevention from car/scooter parking along your cycling path	Removal of obstruction like poles, potholes, broken surface, etc from your cycling path	5
3	Prevention from car/scooter parking along your cycling path	Adequate width of your cycling path	5
4	Prevention from car/scooter parking along your cycling path	Prevention of hawkers/street vendors standing in your cycling path	7
5	Prevention from car/scooter parking along your cycling path	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	3
6	Prevention from car/scooter parking along your cycling path	Preventing pedestrians walking on your cycling path?	3
7	Prevention from car/scooter parking along your cycling path	Less waiting time at red light	7
8	Prevention from car/scooter parking along your cycling path	Cycle path which is clean,well-maintained, free from	3
9	Prevention from car/scooter parking along your cycling path	Smooth turnings which does not reduce your speed	3
10	Prevention from other vehicles using your cycling path	Removal of obstruction like poles, potholes, broken surface, etc	7
11	Prevention from other vehicles using your cycling path	Adequate width of your cycling path	7
12	Prevention from other vehicles using your cycling path	Prevention of hawkers/street vendors standing in your cycling path?	3
13	Prevention from other vehicles using your cycling path	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	9
14	Prevention from other vehicles using your cycling path	Preventing pedestrians walking on your cycling path?	5
15	Prevention from other vehicles using your cycling path	Reduced waiting time at red light	5

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CyLOS, Cycling Level of Service Tool, 2014

What features in a proposed cycling facility do you prefer for cycling to/from school?

Tick mark the preference between features (each row) and add a preference score for the selected

	SELECT ROAD TYPE	ARTERIAL / COLLECTOR / ACCESS / STANDALONE	SCORE
16	Prevention from other vehicles using your cycling path	Cycle path which is clean,well-maintained, free from	7
17	Prevention from other vehicles using your cycling path	Smooth turnings which does not reduce your speed	3
18	Removal of obstruction like poles, broken surface, etc from cycling path	Adequate width of your cycling path	5
19	Removal of obstruction like poles, broken surface, etc from cycling path	Prevention of hawkers/street vendors standing in your cycling path?	7
20	Removal of obstruction like poles, broken surface, etc from cycling path	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	3
21	Removal of obstruction like poles, broken surface, etc from cycling path	Preventing pedestrians walking on your cycling path?	5
22	Removal of obstruction like poles, broken surface, etc from cycling path	Reduced waiting time at red light	5
23	Removal of obstruction like poles, broken surface, etc from cycling path	Cycle path which is clean,well-maintained, free from	7
24	Removal of obstruction like poles, broken surface, etc from cycling path	Smooth turnings which does not reduce your speed	3
25	Adequate clear width of your cycling path	Prevention of hawkers/street vendors standing in your cycling path?	5
26	Adequate clear width of your cycling path	Reducing number of vehicle crossings to enter property entrances, petrol pump, etc	7
27	Adequate clear width of your cycling path	Preventing pedestrians walking on your cycling path?	3
28	Adequate clear width of your cycling path	Less waiting time at red light	3
29	Adequate clear width of your cycling path	Cycle path which is clean,well-maintained, free from	5
30	Adequate clear width of your cycling path	Smooth turnings which does not reduce your	5
31	Prevention of hawkers/street vendors standing in your cycling path?	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	9
32	Prevention of hawkers/street vendors standing in your cycling path?	Preventing pedestrians walking on your cycling path?	5
33	Prevention of hawkers/street vendors standing in your cycling path?	Reduced waiting time at red light	5
34	Prevention of hawkers/street vendors standing in your cycling path?	Cycle path which is clean,well-maintained, free from garbage, etc	7
35	Prevention of hawkers/street vendors standing in your cycling path?	Smooth turnings which does not reduce your speed	3
36	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	Preventing pedestrians walking on your cycling path?	5
37	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	Reduced waiting time at red light	7
38	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	Cycle path which is clean,well-maintained, free from garbage, etc	3
39	Reducing number of vehicle crossings cycle path to enter road, gate, petrol pump, etc	Smooth turnings which does not reduce your speed	5

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CyLOS, Cycling Level of Service Tool, 2014

What features in a proposed cycling facility do you prefer for cycling to/from school?			
Tick mark the preference between features (each row) and add a preference score for the selected			
	SELECT ROAD TYPE	ARTERIAL / COLLECTOR / ACCESS / STANDALONE	SCORE
40	Preventing pedestrians walking on your cycling path?	Less waiting time at red light	7
41	Preventing pedestrians walking on your cycling path	Cycle path which is clean,well-maintained, free from garbage, etc	3
42	Preventing pedestrians walking on your cycling path?	Smooth turnings which does not reduce your speed	5
43	Less waiting time at red light	Cycle path which is clean,well-maintained, free from garbage, etc	7
44	Less waiting time at red light	Smooth turnings which does not reduce your speed	3
45	Cycle path which is clean,well-maintained, free from garbage, etc	Smooth turnings which does not reduce your speed	5

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CyLOS, Cycling Level of Service Tool, 2014

PREFERENCE SCORE	
Equally Preferred	1
Moderately Preferred	3
Strongly Preferred	5
Very Strongly Preferred	7
Extremely Preferred	9

EXAMPLE		
WHAT DO YOU PREFER? (CHOOSE ONE and TICK MARK IN THE BOX GIVEN)		SCORE - BY HOW MUCH do you prefer apple over orange?
APPLE	ORANGE ✓	7

What features in a proposed cycling facility do you prefer for cycling to/from school?			
Tick mark the preference between features (each row) and add a preference score for the selected option			
	SELECT ROAD TYPE	ARTERIAL / COLLECTOR ✓ / ACCESS / STANDALONE	SCORE
	ATTRACTIVENESS		
1	Safe Cycle parking available close to your destination ✓	Pleasing, nice and attractive environment including plants, benches, nice lighting, etc	5
2	Safe Cycle parking available close to your Destination	Cycle path which is clean,well-maintained, free from garbage, etc ✓	7
3	Safe Cycle parking available close to your destination ✓	Presence of activities such as shops and hawkers/vendors along the cycling path	3
4	Pleasing, nice and attractive environment including plants, benches, nice lighting, etc	Cycle path which is clean,well-maintained, free from garbage, etc ✓	7
5	Pleasing, nice and attractive environment including plants, benches, nice lighting, etc	Presence of activities such as shops and hawkers/vendors along the cycling path ✓	3
6	Cycle path which is clean,well-maintained, free from garbage, etc ✓	Presence of activities such as shops and hawkers/vendors along the cycling path	5

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9.6 Annexure 6 – Survey Form For School Children – Hindi Version

The same form was being translated in Hindi version for better understanding. The sample of Hindi version survey form is as follows:

CyLOS, *साइकिलिंग की सेवा का स्तर माप उपकरण*, 2014

CyLOS सॉफ्टवेयर उपकरण का एक प्रकार है जो योजनाकारों और डिजाइनरों को सुरक्षित और सुविधाजनक साइकिल पथ और सुविधाओं की योजना विकसित करने में मदद करता है. इस तरह साइकिल चालन के बुनियादी ढांचे, शहर भीतर यात्रा जैसे की स्थानीय दुकानों के लिए यात्राएं, स्कूल के लिए यात्राएं, काम के स्थानों तक की यात्राएं, के लिए सुरक्षित और उपयोगी होंगे. निम्नलिखित प्रश्नावली उपकरण के प्रदर्शन को बढ़ाने में सहायता करेगा. आप से अनुरोध है की कृपया इस पेज पर बुनियादी विवरण भरें फिर एक सड़क प्रकार का चयन करें जो तुम्हारे स्कूल तक पहुंचने की सड़क जैसा दिखता है. बाद के रूपों में, हर अंक पर दी दो सुविधाओं के बीच आप के लिए, आपके सड़क पर, अधिक महत्वपूर्ण, एक पर टिक करना, और यह आपके लिए कितना महत्वपूर्ण, है महत्व स्कोर से दर्शाना. दूसरे के ऊपर एक सुविधा की अपनी पसंद स्तर रेट करने के लिए, महत्व स्कोर इनपुट करना (1-9), जहां 1 का मतलब है कि दोनों सुविधाओं उतना ही पसंद कर रहे हैं, और 9 का मतलब है कि चयनित सुविधा बहुत अधिक पसंद किया जाता है.

नाम	अमित शर्मा				**उम्र**	16	**लिंग (नर/ महिला)**		नर
कक्षा	10							**अनुभाग**	क
स्कूल का नाम	सार्थक वरिष्ठ माध्यमिक विद्यालय							**शहर का नाम**	लखनऊ
कैसे आप स्कूल के लिए आए हो? (एक पर टिक (√) करना)									
पैदल	**साइकिल**	**ऑटो रिक्शा** ✓	**साइकिल रिक्शा**	**बस**	**वैन**	**कार**	**स्कूटर / मोटर साइकिल**	**अन्य (बताएं)**	
किस प्रकार की सड़क आपके घर से स्कूल को जोड़? (एक पर टिक (√) करना)									
1. उच्च गति मोटर वाहनों के साथ प्रमुख सड़क,									
2. कुछ कारों और दुपहिया वाहनों के साथ मुख्य सड़क, बहुत व्यापक नहीं									✓
3. दोनों पक्षों ने कम कारें, अधिक लोगों को दुकानों या घरों के साथ संकरी सड़क									
4. कोई सड़क - रास्ते या पार्क या अन्य खुले क्षेत्रों के माध्यम से जाती सड़क									

9.7 Annexure 7 – Survey Audit Form.

The form below should be used by the surveyor to collect data from site and fill the forms. The data collection form for Corridor/Route and Transit access influence area is same.

DATA COLLECTION FORM

Name of road: ____________________________ Date: _____________

Name of surveyor: _________________________ Time: ____________

Total number of segments: _________________

Segment Number: __________________________

Instructions to fill the forms:

1. There are six sections in the entire form which includes:
   a) Common form for the entire segment
   b) Observation sheet (Day time) – LHS
   c) Observation sheet (Day time) – RHS
   d) Observation sheet (Night time) – LHS & RHS
   e) Description sheet (Day and Night time)

2. * - This symbol indicates to refer description sheet. The category to be filled is explained in the description sheet for the respective item.
3. For proper information data should be collected in peak hour time. Also complete form should be filled in one time slot.
4. Each segment should be divided in a range of 200 m up to 800 m. If the segment is more than 800m long a separate form can be used.

a. Common Survey for Entire Segment

S.No.		
1	**Type of Road (Tick any one)**	
	Highway	
	Arterial/ Sub Arterial (30 - 80 m)	
	Collector/Distributor (12-30 m)	

	Local - (6 -15 m)	
	Independent track/facility -(upto 6m)	
2	**Carriageway traffic along segment (Tick any one)**	
	LHS & RHS (2 way)	
	One Way (LHS)	
	One Way (RHS)	
	Independent path	
3	**Right of way (ROW)**	
4	**No. of lane**	
5	**Segment Length (km)**	
6	**Posted speed limit**	
7	**Peak hour Traffic data**	
	No. of motor vehicles (PCU)	
	No. of Bicycle	
	No. of auto rickshaw	
	No. of goods rickshaw	
	No. of Pedestrians	
8	**Bicycle user share**	
	Passenger only (no.)	
	Passenger with goods (no.)	
9	**Type of Cycle track/lane (Tick any one)**	
	Segregated track	
	Painted track	
	Unsegregated (common with carriageway)	
	Common with footpath	
10	**Location of cycle track/lane (Tick any one)**	
	Along carriage way	
	Along footpath	
	Along property edge	
	On the median	
	Between on street parking & carriageway	
	Between service lane & property edge	
	Independent Standalone	
11	**Surface Type (Tick any one)**	
	Asphalt	
	Concrete	
	Smooth tiled	
	Paver blocks	
	Concrete slabs	
	Others	
12	**Cycle parking cost (rupees per day)**	

13	**Primary Intersection type (Tick any one)**	
	Signalized junction	
	Unsignalized junction	
	One lane roundabout	
	Two lane roundabout	
	Rotary	
	Grade separated	
	Not applicable	
	If Intersection type is not applicable then 11 - 23 are not to be filled.	
14	No. of major junctions	
15	Observed wait time at the junction	
16	Traffic calming at intersections (Yes/No)	
17	Demarcated cycle stacking spaces at intersection (Yes/No)	
18	**Primary cyclist crossing type across intersecting roads (Tick any one)**	
	Crossing with or without marking	
	Raised crossing	
	Grade separated (underpass or overpass)	
	Signalized with or without raised crossing	
	No provision for crossing/ physically prevented from crossing	
19	**Primary cyclist crossing type across free left turns or segregated left turn lanes (Tick any one)**	
	Crossing marked across carriageway	
	Raised crossing	
	Grade separated (underpass or overpass)	
	Segregated left turning lanes exists	
20	**Primary cycle infrastructure along intersection boundary (Tick any one)**	
	Segregated from carriageway and footpath	
	Common with footpath but segregated from carriage way	
	Painted marking on the periphery along circular roadway	
	No Segregation/demarcation - common with carriage way	
21	**Width of cycle track/lane at the junction (m)**	
22	**Cyclist approach to the Intersection (Tick any one)**	
	Segregated track	
	Cycle lane (painted)	
	Unsegregated	
	Common cycle track and footpath	
	As part of or along service lane	
	Stand alone	
23	**Additional grade separated cycle crossings in the segment**	
	Foot over bridges (no.)	
	Subways (no.)	
24	**Primary speed/conflict control measure used at mid block cyclist or pedestrian crossing (Tick one)**	

	Traffic calmed	
	Pedestrian signal with or without traffic signal	

b. Observation Sheet (Day) - LHS

S.No.	Chainage		0-200 m	201-400 m	401-600 m	601-800 m	Average/Min.
1	Shaded length % on Cycle track/lane						Average
2	% length of divided carriageway in the segment						Average
3	Observed peak speed						Average
4	Land use*						Average
5	Length with service lane						Total
6	Quality of service lane(Good, Bad, poor)*						Average
7	Length of Footpath						Total
8	Quality of footpath (Good, Bad, Poor)*						Average
9	No. of hawkers present						Total
10	No. of parked IPT						Total
11	No. of parked private vehicles on carriageway						Total
12	Height of cycle track/lane w.r.t. to carriageway						Average
13	Minimum width of cycle track/lane						Min.
14	Segregation width between cycle track/lane/path & carriageway						Average
15	Edge height	Left Side					Average
		Right Side					Average
16	Minimum Turning Radius						Min.
17	No. of obstructions						Total
18	Slope of Ramp*						Average
19	Presence of cycle specific signage & marking						Total
20	Location of bus stop*						
21	No. of property entrances						Total
22	No. of secondary lane entrances / minor junctions						Total
23	No. of signalised or traffic calm pedestrian/cycling crossings at carriageway						Total
24	Level of cycle track/lane crossing at minor junction/collector road entrance*						Average
25	Level of cycle track/lane crossing at property entrance*						Average
26	No. of cycle/NMV parking						Total
27	Quality & maintenance of Cycle track/ lane						Average

28	Quality of landscaping & environment					Average
29	Encroachment on cycle track/lane by private vehicles*(refer description sheet)					Average
30	Approx. % of total cyclist using bicycle infrastructure					Average
31	Approx. % of total NMV parking using designated parking NMV bays					Average

c. Observation Sheet (Day) - RHS

S.No.	Chainage		0-200 m	201-400 m	401-600 m	601-800 m	Average/Min.
1	Shaded length % on Cycle track/lane						Average
2	% length of divided carriageway in the segment						Average
3	Observed peak speed						Average
4	Land use*						Average
5	Length with service lane						Total
6	Quality of service lane(Good, Bad, poor)*						Average
7	Length of Footpath						Total
8	Quality of footpath (Good, Bad, Poor)*						Average
9	No. of hawkers present						Total
10	No. of parked IPT						Total
11	No. of parked private vehicles on carriageway						Total
12	Height of cycle track/lane w.r.t to carriageway						Average
13	Minimum width of cycle track/lane						Min.
14	Segregation width between cycle track/lane/path & carriageway						Average
15	Edge height	Left Side					Average
		Right Side					Average
16	Minimum Turning Radius						Min.
17	No. of obstructions						Total
18	Slope of Ramp*						Average
19	Presence of cycle specific signage & marking						Total
20	Location of bus stop*						
21	No. of property entrances						Total
22	No. of secondary lane entrances / minor junctions						Total
23	No. of signalised or traffic calm pedestrian/cycling crossings at carriageway						Total
24	Level of cycle track/lane crossing at minor junction/collector road entrance*						Average

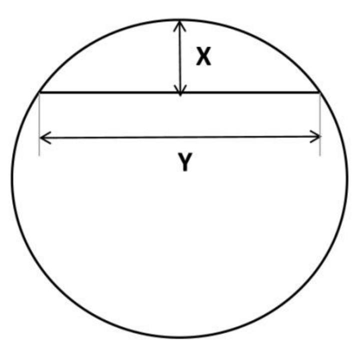
25	Level of cycle track/lane crossing at property entrance*					Average
26	No. of cycle/NMV parking					Total
27	Quality & maintenance of Cycle track/ lane					Average
28	Quality of landscaping & environment					Average
29	Encroachment on cycle track/lane by private vehicles*(refer description sheet)					Average
30	Approx. % of total cyclist using bicycle infrastructure					Average
31	Approx. % of total NMV parking using designated parking NMV bays					Average

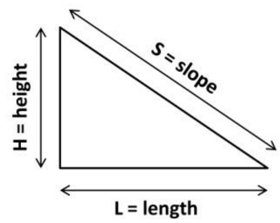
d. Observation Sheet (Night) - LHS and RHS

OBSERVATION SHEET (NIGHT) -LHS						
S.No.	**Chainage**	**0-200 m**	**201-400 m**	**401-600 m**	**601-800 m**	**Average/Min.**
1	Lighting on cycle track - lux level (40 lux, 20 lux, >10 lux)*					
2	Lighting uniformity on cycle track/lane/path (Good, Bad, Poor)*					
3	No of hawkers					

OBSERVATION SHEET (NIGHT) -RHS						
S.No.	**Chainage**	**0-200 m**	**201-400 m**	**401-600 m**	**601-800 m**	**Average/Min.**
1	Lighting on cycle track - lux level (40 lux, 20 lux, >10 lux)*					
2	Lighting uniformity on cycle track/lane/path (Good, Bad, Poor)*					
3	No of hawkers					

e. Description Sheet (Day and Night) – LHS & RHS

DESCRIPTION SHEET (DAY)		
S.NO.	**SURVEY FORM - LHS & RHS**	
4	**Land Use**	
A	Commercial /Retail	
B	Residential	
C	Others - Institutional, Recreational, Green, etc.	
D	Commercial + Residential	
E	Residential + Others	
F	Commercial + Others	
6	**Quality of service lane**	
	Good (Grade A)	Width >= 6m, Lighting level=18 lux, Uniformity =40 %, No Obstructions, Footpath - 1.8m, segregated
	Bad (Grade B)	Width 4.5m to 6m, Lighting level=15 lux, Uniformity =33 %, No Obstructions, Footpath - 1.2 to 1.8m, segregated
	Poor (Grade C)	Width >=4.5m, Lighting level>15 lux, Uniformity =33 %, Obstructions present, Footpath - 1.2, unsegregated
8	**Quality of footpath**	
	Good (Grade A)	Width 1.8m, Height-18 cm, No Obstruction, Excellent surface quality, Proper cross slope, barrier free
	Bad (Grade B)	Width 1.8 to 1.5m , Height-20 cm, Obstructions present but clear width 1.2m achieved, Excellent surface quality, Proper cross slope, barrier free, Pavement may not include tactile
	Poor (Grade C)	Width = 1.5m , Height-20 cm, Obstructions present but clear width 1.2m achieved, Poor surface quality, Improper cross slope, Not disabled friendly, Poor surface quality of pavement.
16	**Calculate turning radius** **$R = Y/2 + X^2/8 \times Y$**	

18	**Calculate slope** $S^2 = H^2 + L^2$	
19	**Location of Bus stop**	
A	No bus shelter on kerbside	
B	Cycle track between bus shelter & carriageway	
C	Bus stop between cycle track and carriageway	
D	Bus stop on cycle track	
24	**Level of cycle track/lane crossing at minor junction/collector road entrance**	
A	At carriageway level	
B	Level of cycle track remains same (above carriageway)	
C	At footpath level	
25	**Level of cycle track/lane crossing at property entrance**	
A	At carriageway level	
B	Level of cycle track remains same (above carriageway)	
C	At footpath level	
29	**Encroachment on cycle track/lane by private vehicles*(refer description sheet)**	
	Well enforced	No encroachment by motorist & no parking
	Partly enforced	Encroachment by motorist near intersections & no parking
	Lack enforcement	Motor vehicles routinely encroach & park on cycle track

DESCRIPTION SHEET (NIGHT)		
S.NO.	**SURVEY FORM - AT NIGHT**	
1	**Lighting on cycle track - lux level**	
	40 lux	Distinguishable till 200 m
	20 lux	Distinguishable till 100 m
	> 10 lux	Distinguishable till 50 m
2	**Lighting uniformity level**	
	Good	No dark patches throughout the track/lane
	Bad	Clearly visible dark areas between light poles
	Poor	No lighting at all in the entire track/lane

References

2009, *Work zone Safety Manual*, Transportation Reserch and Injury Prevention Programme.

2013a, *Non Motorized Transport Planning and Guideline*, Transportation Reserch and Injury Prevention Programme.

2013b, *Public Transport Accessibility Toolkit*, Transportation Reserch and Injury Prevention Programme (TRIPP).

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