

**ASSESSING VISUAL IMPACTS OF ROADScape  
INSTALLATIONS ON URBAN SAFETY AND  
COMFORT IN GALLE ROAD, COLOMBO**

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Dissertation submitted in partial fulfilment of the requirements for the Master of  
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## DECLARATION

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## **ABSTRACT**

Today, the world is moving towards Urbanization which adapts sustainable development. Currently in Sri Lanka, the challenging development position in terms of its urban development with the introduction of number of mega projects ranging from urban core intensification to introducing and improving infrastructure and alternative multimode transportation systems. With technology and other high intelligence base development are now making space for poor safe and secured cities resulting all types of pollutions such as air, water, soil, sound and visual which risking the inhabitants and exposing into the general public.

Though various urban development programs are being implemented in high dense urban areas of the country, how far such initiatives were able to create a positive impact to minimize visual issues in the city has not been clearly identified and clarified. Accordingly, views on redefining the urban environment in terms of visual atmosphere in order to prevent and control visual impacts of roadscape installations is a critical task facing today with rapidly increasing needs of commercialization. As the magnitude of its influences on urban users have not been identified, measured and analysed analytically, the results is increasing roadscape psychological and physical damages which runs as a long term process.

The proposed study is intended as an assortment of properly designed specific research constituents. In order to begin the study, it is expected to conduct first-hand observations and identify the key problematic situations in urban commercial roadways and roadsides in Colombo in terms of urban comfort and safety due to roadscape installations. A comprehensive literature survey will be carried out for in-depth studies of precise constituents of the research. Prior to the detail analysis, it is planned to conduct a pilot surveys to identify key factors to be measured with regards to the specific stockholders and area analysis through questionnaires, direct/indirect interviews etc. with random local and foreign city users. After that it is decided to conduct details field surveys, laboratory experiments on existing conditions using focus variables to understand the stockholder acceptance. Compiling the research findings giving high regards to user satisfaction and document accordingly.

In order to improve visual comfort and ensure user safety through visual impacts in roadways and roadsides due to roadscape installations, it is aimed to identify roadscape installations and its impact rating, to review build, designed and situational factors of identified installations, determine the correlation between roadway and roadside installations and safety, comfort and to investigate the effects of identified installations on pedestrian and driver attention and performance. As a result, this study will worth to design a method to assess visual impact due to roadscape installations in commercial activities based roads and to identify the visual influences and its magnitude on roadway and roadside users which opens a gateway to establish an assessment model in order to assess urban comfort, safety and security of public realm for sustainable urbanisation in Sri Lanka.

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# INTRODUCTION

## Background

In recent years, there has been a boom of urbanization with industrial development. As a result, development and improvement trends in road and highway network has become first priority in national level development in order to connect CBDs, with urban, sub-urban & remote areas.

Accordingly, roads and highways should be designed and constructed in a way that ensures and guarantees safe, effective, convenient and efficient transportation of people and different kinds of goods or materials.

Therefore, in one hand, it is always recommended and expected for drivers to travel at recommended speeds which are appropriate to the conditions of the roads in order to reach their final destination in a safe manner and for pedestrian, it is expected to aware and accountable on self-consciousness of safety on roads.

Along with the different magnitudes of development, the road accidents are noticeable social problem in Sri Lanka.

Further, there is an improvement in pedestrian fatality rate. (Kumarage, 2003) explains that, there are 815 pedestrian deaths in 2002 due to attempting to cross the road, lack of driver attention and distraction due to road elements.

Respectively, the Department of Sri Lanka Police reports in 2018 indicates that number of road accidents have been increasing resulting 3,097 deaths, 2,947 fatal accidents, 12,264 minor accidents, 8,475 critical accidents, 12,064 only damages and spending over 30,000 USD from Gross Domestic Product which is an additional cost for Sri Lanka as a developing country.

Even though the roads are marginally improved over time, gradually, road accidents are increasing. (Kumarage, 2003) elaborates that primary reasons for that are,

1. Due to increase of population, quality of the public transport has been decreasing which cause for road accidents, damages to people and considerable amount of harassments.
2. Increase extremely unsafe mode of transportation such as motor cycle within three to four years.
3. Poor road rules and insufficient monitoring of violation of road rules
4. Poor roadscape and roadway designs and elements, lack of safety & security precautions & interventions and poor maintenance.

Since there is lack of urban design concerns to mitigate road accidents due to poor road designs and unnecessary road elements and lack of road safety interventions in terms of visual impacts, this study aims to prepare a visual impact criterion in order to assess and improve road safety, security and comfort of public realm.

### **Research Position/ Question**

How to assess negative impacts of roadways and roadside elements on urban comfort, roadside safety and physical security of public realm.

### **Research Objectives**

1. To identify roadway and roadside installations and rate and rank in terms of its level of impact.
2. To review built, designed and situational factors of identified installations.
3. To determine the correlation between roadway and roadside installations and safety, comfort.
4. To investigate the effects of roadway and roadside installations on,
  - a) driver attention and performance.
  - b) pedestrian movements
5. To identify the possible safety and comfort implications of roadway and roadside installations in terms of installations.

## **Research Hypothesis**

1. Density of roadside installations along the roadway and roadside have a measurable impact on user such as pedestrian, cyclist and drivers.

## **Literature Study**

Relevant studies were found in the areas of,

1. Highway research
  - a) Hazard surveys
  - b) Roadside/roadway physical elements research
  - c) Driver behaviour studies
2. Environmental psychology
  - a) Attention/ Alertness
  - b) Vehicle speed
  - c) Focal/ Ambient vision
  - d) Arousal/ expectancy theory
  - e) Stress and emotional responses
  - f) Ability to navigate successfully
3. Simulation and computer technology
  - a) Real world, full scale mock up
  - b) Scale model of road system
  - c) Computer/ video simulation

### Hazard surveys

Hazard survey studies have indicated basically upon road characteristics (geometry, operations, environment and driver behaviour related to accidents)

The study basically focused on signage, line of trees, light poles run tangents to the road and then vees off, driver expectations may be violated. mostly, road geometry is confined to a description of paved roadways, but in some cases other aspects such as gradients, sight distance, the presence of roadside obstacles, edge makings, curbs, footpaths and roadside development are included as elements of 'geometry'.

Correlation of road geometry and accidents is a familiar method of measuring hazards along the roadway (Michigan, November, 1985) and similar methods could be used for roadside landscape elements.

Typical aspects of a geometry correlation study translated to roadway and road side elements survey could be as follow,

- a) Describe the road geometry (the shape and form of roadway and road side elements) at a sample of known accident sites/ areas.
- b) Identify geometry elements common to all sites/ areas.
- c) Identify the locations of these elements in entire road system.
- d) Classify the locations of these geometric elements as hazardous.
- e) Develop roadside designs or criteria to reduce the hazard.

#### Physical Elements Research

This area has focused on the visibility of individual physical factors, the hierarchy of perceived elements or the visual complexity of what is seen. The (Michigan, November, 1985) study examined the relationship between color in signs and detectability is typical of research on individual factors.

(Michigan, Evaluation of validity of two research method for studying perception of road signs , March, 1991 ) focused on color in landscape, although only road sign color is in earth tone.

(Research, 1985) helps to understand what is more important visually, the perception, the preview, the characteristic objects or the circumstances of vision.

According to (Gallagher, November, 1983) work, he produced a model of scene instability as an objective measure of scene complexity. he assumed that sequential processing is possible, that all information is sampled from narrow cone along the line-of-sight and included roadway objects and roadside foliage, utility poles, build lines and other elements.



## Driver Behaviour Studies

(Hanscom, April, 1973) elaborates a simple use of the ‘comparative erratic maneuver’ technique which uses stop-action, overhead photography to count waves, partial waves, hesitation and stopping/ backing drivers performed at some location of interests in reaction to new diagrammatic signs. Eye movement studies are a significant type of driver behaviour study that uses apparatus to follow and record where drivers look and eye movement pattern during the driving experience. Also, how they respond to particular colors, lights and figures.

### **Analytical Position**

This study aims to discuss how and to what extent the commercial roadscapes influence on the comfort and safety of roadscape users. Where a binary relationship between roadscape installations and the particular factors that related to the user comfort and safety are important to develop the argument. Hence, as the pre-identified roadscape installations have various parameters such as colors, texture, patterns, objects, illuminance etc. which influence on their tolerance, visibility, attentions, different type of perceptual issues etc. may have impact on the comfort and safety in the commercial realm. Accordingly, the analytical study will be developed how and to measure the magnitude of impact levels of these considerations influence on users in the commercial roadscapes in Colombo.

### **Research methods**

- a) Photography walk
- b) Questionnaire survey
- c) Personal interviews
- d) Participant Observations
- e) Direct observations

f) Secondary sources of information<sup>1</sup>

### **Research methodology**

a) Qualitative analysis

Contrast with the quantitative analysis, non-quantifiable information specially the most of the situational factors will be judged using qualitative method. Accordingly, this method aims to deals with intangibles, inexact concerns that belong to the social and experiential realm in selected commercial roadscape. Therefore, out of 3 stages of the research, stage 3 (assessment of the visual impact) are carried out using qualitative method.

Through questioners, formal and informal interviews and other related methods, qualitative measurements will be gathered.

b) Quantitative analysis<sup>2</sup>

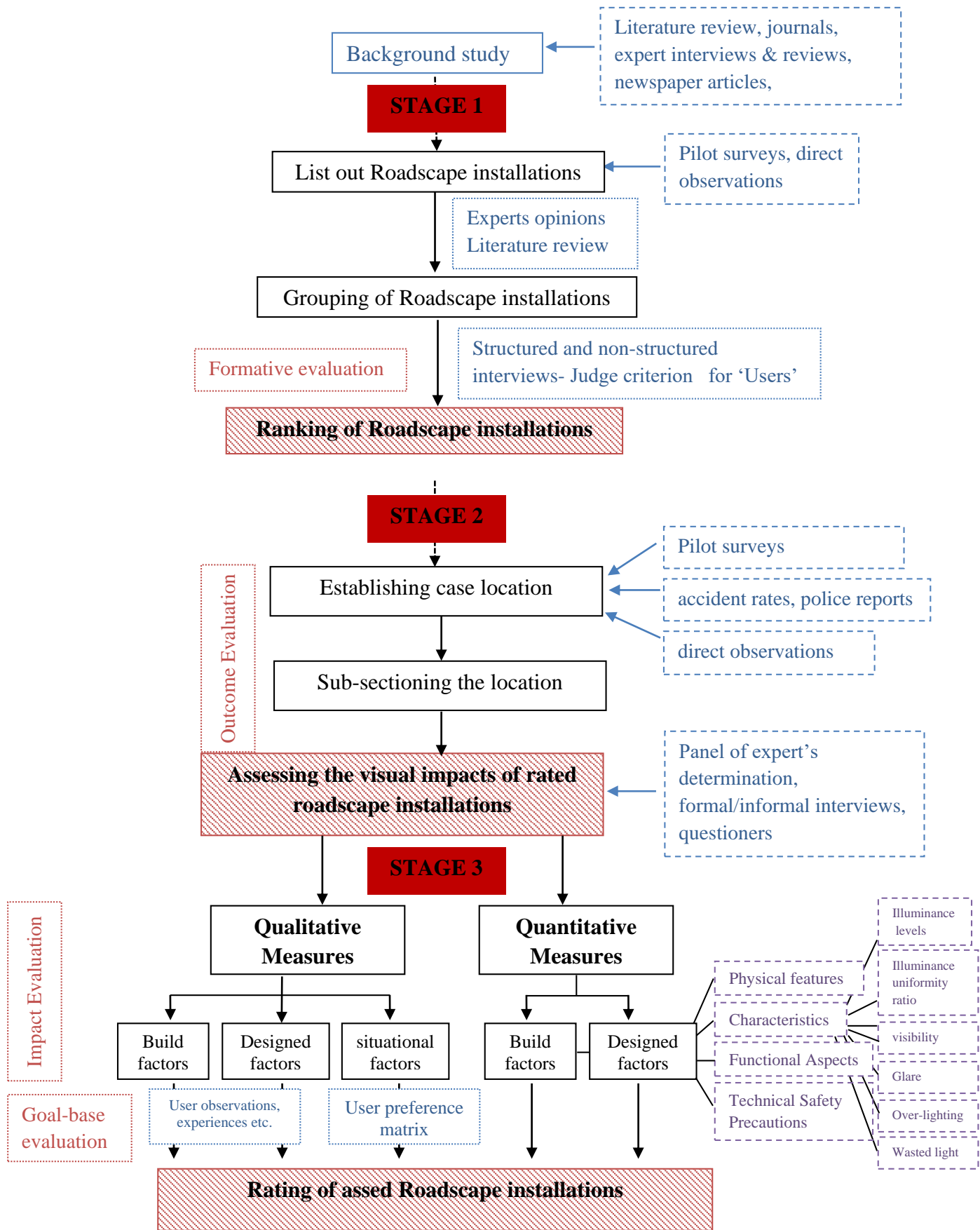
This technique aims to understand the behaviour by using mathematical methods and, measurement, and research. Also, this method represents a given reality in terms of a numerical values.

First couple of stages of the project are based on the quantitative method in order to review and rate roadscape installations which has direct and indirect influence on users.

---

<sup>1</sup> Data and information will be collected from unpublished research, case studies and certified literature. Also, qualitative and quantitative information from Colombo Municipal council

<sup>2</sup>Quantitative analysis does not include Visual Impact Assessment. But, it considers graphic contents such as color, size, shape, material property and location), visual experiments and figure ground ratio.



**Figure 1: Flow of research**

Source: Author

**Scope and limitations**

There are many factors will have influential impacts on roadside safety, security and urban comfort, the scope of this study based upon roadway and roadside installations.

Irrespective to the traffic volumes, road conditions and weather conditions, the study aims to consider related variables.

Causations for road accidents are not been considered and studied in this research.

Also, it can be expected low survey return rate. Typically, a 20% to 25% return is expected for mail surveys of city residents and communities selected.

In order to conduct formal & informal interviews, and questioners author avoids people with any visual difficulties or defects and select only age between 23 to 45.

**Research outcomes**

1. Design a method to assess visual impact due to roadscape installations in commercial activities based roads.
2. Identify the visual influences and its magnitude on roadway and roadside users due to roadscape installations.
3. Establish a baseline study to prepare an assessment model in order to assess urban comfort, safety and security of public realm for sustainable urbanisation in Sri Lanka.
4. Provide a rating for current status of roadscape installations in commercial activities based roads/streets.

# 1. CHAPTER 1: DESIGN CONSIDERATIONS OF ROADScape VISUAL INSTALLATIONS

This chapter aiming to introduce and briefly explain the elements generally found between adjacent buildings and the curb, including sidewalks, landscaped or other buffers, lighting, street furniture, street trees, transit stops and similar amenities which can be seen in good practice. Proper design of these features helps to ensure a safe and inviting space for pedestrians with adequate separation from nearby vehicles.

## 1.1 Pedestrian space

Pedestrian space of roadscape generally found between adjacent building and the curb of the roadway which includes sidewalks, landscape buffer or trees, illumination, roadside furniture, bus stops and other similar transport or related public amenities. This space is allocated along the either sides of the roadways in order to facilitate safe and secured walking lane for pedestrian. But, the real situation is, pedestrian tend to be considered as fairly neglected road shareholders in the conventional road designs. Accordingly, it has given a space to increase fatal rate, injuries etc. by 2019 in Sri Lanka.

### 1.1.1 Side walk presence and width



**Figure 2: Sidewalk**

Source: Author

Side walk is a separate strip for pedestrians to walk safely which minimizes the clash between vehicles and pedestrian movements. Presence of sidewalk and the its condition are going hand in hand, because the condition of sidewalk impacts on the choice of using.

Most important aspect of designing sidewalk is that it accomplishes 100% of its purpose rather providing linear strip for people to walk. Therefore, particular designs should meet the standards to facilitate physical as well as psychological safety & comfort. Not only the designing and construction but also the maintenance is crucial.

People's choice to use sidewalk also depends on the capacity of accommodating pedestrians: sidewalk width which can maintain flow of movements is an influential factor of sidewalks designing and planning. According to the (U A G Perera, 2018), in Sri Lanka, most of the city centres are generally congested during peak hours and there are uncontrollable pedestrian movements due to inadequate sidewalks width and possession of sidewalks for vending purposes.

Use of sidewalk is varying from land use zones. Not like commercial zone sidewalks, sidewalks in neighbourhood areas are associated with physical activities. children's activities, extend live hood activities to the sidewalks etc.

### **1.1.2 Buffer**

Buffer is known as the space between the side walk and the road curb. Mostly, the buffer consists of narrow but linear catchment which is planed with attractive plants and trees. Purpose of the buffer is to provide an additional physical safety to the pedestrian as well as control the rainwater and storm water drain to the catchment basins without running-off. In addition to the safe walking, it encourages activeness of walking.



**Figure 3: Tree buffer**  
Source: Author

In Sri Lankan urban contexts, it is hard to identify a strong layer of tree buffer which performs as a pedestrian safety strategy in roadscapes.

### **1.1.3 Illumination**

In terms of street illumination, it can be defined as control factor that restricts the movement of pedestrian and cyclists. According to (Foster S., 2008), presence of illumination can improve the perception of safety and deter the criminal activities.

Also, the distance between two illuminances and the intensity level of illumination as perceived by the pedestrian is also an important factor when designing pedestrian space.

### **1.1.4 Furnishing**

Public seating is the only urban design element that can be identified either in a street, roadside, urban public area, public park or urbanized neighbourhood. That is because, most of the streets fasten with transportation and vendor activities rather than pedestrian friendly recreational related amenities.

But it is interesting to spot that streets with public seating create more active environment and streets with moveable seating has super power to attract people and create socially integrated space.

### **1.1.5 Trees and vegetation**

In an urban public place, trees are essential element in the urban system. It acts as a natural sun cut device which influence on outdoor thermal comfort level. And trees have effective tolerance in order to break wind flow and reduce the wind speed.

Further, trees have strong resistance to urban heat island effect and vulnerability to the extreme heat conditions. (Rinner C, 2011), (Harlan SL, 2006) and (Yuan F, 2007) elaborates that commercial and industrial land uses which have high impervious surfaces and low vegetation coverage for high surface temperature. Most of the microclimate related researches elaborate that street trees have strong relation in order to mitigate heat island effect in urban environments.

Not only the functional aspects of trees, but also aesthetic aspects also impact on people's psychological comfort. Therefore, roadsides adopt tree planting either in the buffer area as discussed under 'buffer' mostly gives sense of safety, sense of liveliness and create a live and natural barrier or the filter to the vehicles.

In addition to the aesthetic and climatic considerations of trees, (Naderi JR, 2008 ) indicates that lined trees in the street section helps to reduce collision rate that street sections without trees. That is because, trees along the roadside provide a visual constraint that signals to the driver to slow down, whereas a wide open viewshed may encourage a driver to speed up. Another possibility is that the presence of trees conveys a calming effect to as well as adding interest for the driver, encouraging slower speeds. (Health, 2014)

In contrast to the positive of tree, lack of maintenance of trees, it has direct impact to distract pedestrians as well as drivers specially during high precipitations. Pedestrians tend to avoid sidewalks and it has been a reason for road accidents.



**Figure 4: Roadscape vegetation**

Source: Active design shaping the side walk, NYC, 2013

### **1.1.6 Public transit facilities and amenities**

In terms of usage, transit activities are highly functional and active than other pedestrian or cyclist activities in countries like Sri Lanka. Priority has been given to the vehicles related activities. it is interesting to observe that there is a correlation



between commercial activities and the transit facilities. Therefore, merging activities such as commercial and transit facilities have become a strong character in commercial street.



**Figure 5: Availability of mix of disordered public infrastructure**  
Source: 'UoM Urban Lab'- 'Centre for Cities', University of Moratuwa

Since this section focuses on the transit stop/station design and accessibility, most of the transit stops have merged with pedestrian space of sidewalk. For an example, in Sri Lanka, bus bays and sidewalks have been designed as element which create collision during peak hours between pedestrian and people who use buses. There is no buffer between sidewalk and the bus bay. As a result of that pedestrian space of the roadscape tend to become an unfriendly space for people and secondary impact is pedestrian spaces have been encroaching by the vendors. Vending spaces are addressed under the 'Café/vending space' section.

## **1.2 Cycling and lane facilities**

In Sri Lanka, vehicle lane facilities have not given the priority in the current practice in contrast to the Colombo metropolitan area in specific time schedules. (Tilahun NY, 2007) noted that most of the cyclists prefer bike lanes or other designated bicycle facilities which may have positive trend for higher rate of cycling.

In addition to the motorized bicycles, (Niranjala D., 2018) elaborates that the Road Development Authority (RDA) of Sri Lanka has taken an action to promote bicycles by establishing 'bicycle lanes' in Malambe and Piliyandala areas, under the long-term vision of introducing bicycle lanes for each road in other cities. The main purpose of the effort is to reduce traffic congestion mainly.

In order to measure bikeability index is used defined as an assessment of an entire bikeway network for perceived comfort and convenience and access to important destinations.

### **1.2.1 Bike lanes**

Lane facilities as basic bicycle infrastructure, in Sri Lanka there are competitive amount of bicyclist their impact on road is higher rather than the other vehicles. In order to maintain the road rules who breaks which is being increasing day by day. Therefore, establishing strong set of rules along with the facilitating bicycle lane is most suitable option in urban areas.

Bikeability index is used to find the level of bikeability of bicycle lanes. But the limitation of this index is that it does not consider the environment around the bicycle lanes. bikeability index safety, topography, environment condition, mixed land use rate, residential density, bicycle infrastructure, road network density, importance of destination, destination density, generalized cost and impedance function for the travel time are taken in to consideration in the bikeability index.

### **1.2.2 Cycle tracks**

This sub topic focuses on on-road cycle tracks. Currently, cycling is not much popular in urban Colombo but, still cycling is popular in Jaffna, Trincomalee and Ampara areas. Due to introduction and feasibility of purchasing the automobiles, there can be noticeable decline.

Most of the studies identify that separate cycle tracks are traffic safer. but in some of the studies highlighted that separate cycle tracks increase the vehicle accidents (Health, 2014). even though there is a safer option for the cyclists as cycle tracks, there are some accidents have been reported at the intersections.

In foreign countries, there are two-way cycle tracks but, (Health, 2014) indicates that two-way cycle tracks increase cycling collision than one-way tracks.

Current practice in Sri Lanka, acceptable and adequate width is allocated for one-way cycle track from road. But, it is important to identify that whether there is a relationship between track width and the rate of cycling collision.

### **1.2.3 Bicycle parking**

As per the local authority and the UDA (Urban Development Authority) planning regulations in Sri Lanka, number of vehicle parking has been decided according to the type of development. But, space allocation in roadside for each type of vehicles specially bicycle has not been clearly noted anywhere even though there are over 2 million of two- wheeled vehicles. Because, it is important to manage limited space in highly urbanized areas due to rapidly increasing vehicles since we do not regulate number of vehicles registration in order to maintain bearable vehicles on roads.

### **1.2.4 Emissions exposure**

According to Gas inventory,2008 estimated that 40% of greenhouse gases emitted by the motorized vehicles. High impact of these emissions cause for cyclist on road. Therefore, exposure to these toxic gases such as CO<sub>2</sub>, CO and dust particles has high health risk for cyclist compared to other vehicles.

## **1.3 Roadway**

Main section of the roadscape is roadway where all. Even in Sri Lanka roadways categorize into different classes such as A class, AB class, B class and C class roads according to their condition and width. According to road width, number of lanes are decided. but in other countries, overall travel way width, number of vehicular lanes, and vehicular lane width, and often also incorporate medians, traffic calming features, and mid-block crossings have been taken in to considerations for roadway fictional classification. (Health, 2014) elaborates that These features have an influence on traffic volume and speed, which in turn influence the likelihood of walking and cycling, pedestrian/cyclist collision risk with vehicles, air and noise pollution, and the potential for social interaction. Even if the roadways have same characteristics roadsides differ from place to place, town to town, city to city.

### 1.3.1 Street width/ total number of lanes

In Sri Lanka, there are maximum 4-lane sections roads in urbanized cities such as Colombo and Hambantota etc. Comparing to other roads due to the width of roads it can bears high vehicle capacity. but Sri Lanka police reports indicate that accident rate has direct relationship with road width.

### 1.3.2 Narrow lane width

Narrower lane widths carry smaller number of vehicle compared to wider road widths which cause for low vehicle travel speed. Also, it has been identified that divided, multi-lane arterial roadways have higher accidents rates.

### 1.3.3 On street parking



**Figure 6: On street Parking, Bagatale road**

Source: 'UoM Urban Lab' – Centre for Cities', University of Moratuwa

In Sri Lankan context either it is urban or sub-urban or remote areas, on- street parking is famous and in common practice. in some cases, half or one lane of roadway reserve for on-street parking which reduces the travel width of roadway. But, most of the urban and sub-urban areas found that there is no proper and organized way of bike parking in order to facilitate maximum number of vehicles in limited urban space.

Interesting side of on-street parking is it creates separation/ buffer between pedestrian way and the roadway which give extra safety and comfort for pedestrian. But, some studies identified that there are impacts of on-street parking on collisions. Traffic calming features

Speed humps, speed tables, and traffic circles, traffic lights and road signs are mostly can be identified as traffic calming features use in order to reduce vehicle speed, accident frequency and traffic volume on roadways.

Volume and the condition of traffic in particular context decide the selection and impact of traffic calming features. (T., 1999) elaborates that treatments appropriate for commercial streets may include but are not limited to speed limit reductions, warning signs and lighting, narrowed lanes, speed tables, rumble strips, pavement markings, and various forms of curb extensions that either narrow the lane. Author has identified that wide range of traffic calming features associate with transport activities but not much with other activities such as pedestrian, recreational etc.

Since traffic signs are part of the roadway, in Sri Lankan context mostly the roadscape designs create loose correlation between roadways and the pedestrian space which ultimately have negative influence on pedestrians. That is because, most of the traffic signs are fixed in the pedestrian space which disturbs the movement patterns and eventually it increases the collision rate.

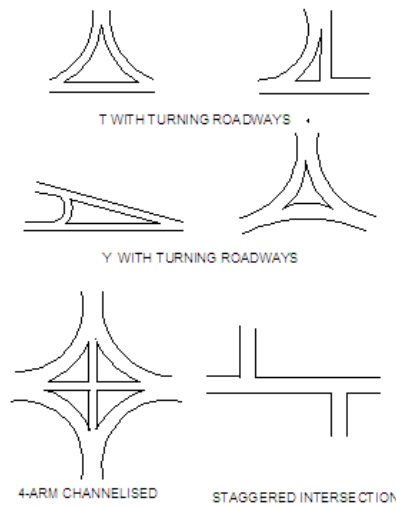
#### **1.4 Intersections and crossings**

Since road safety and comfort is the main focus of this study, traffic control, warning and other road safety features which can be identified in the intersections and crossing are taken in to consideration in this sub-section of the chapter. Also it is important to study the connection between road safety/comfort and the intersections/crossings.

##### **1.4.1 Intersection control**

Intersections are considered as where two or more roads meet and or are the points of potential vehicle conflict. They are critical element of a road section. (Planning Tank: Happy, Healthy & Sustainable human settlements , 2019)

In terms of geometry, intersections can be divided into 7 categories such as T, Y, Scissor, cross, staggered, staggered and skewed and multiway.



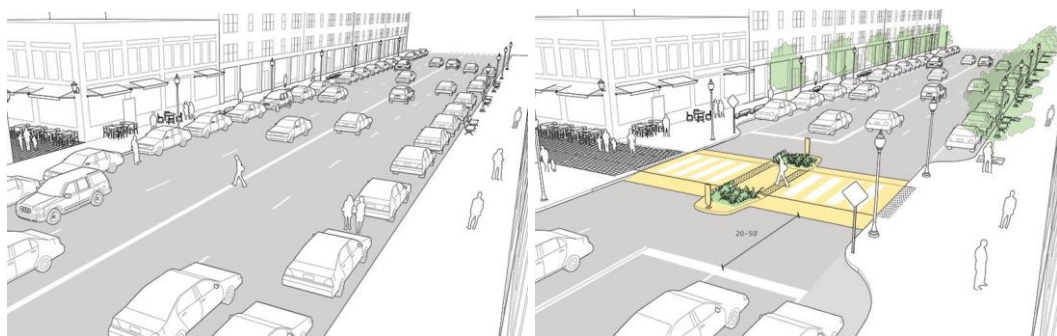
**Figure 7: Types of intersection controls**

Source: (Planning Tank: Happy, Healthy & Sustainable human settlements , 2019)

### 1.4.2 Midblock Control

Midblock crosswalk is a safety solution for pedestrian that controls the vehicular speed instead of pedestrian activities. That is because, crossing in the midblock creates negative situation for both pedestrian and drivers who cannot predict each party's co-actions at the moment of crossing and moving the vehicle.

Need of the midblock control is important when there are wider roadways which has higher distance between intersections. Therefore, it is necessary to have control device in order to control pedestrian movement speed and vehicular speed as well. Hence, midblock crosswalk or medians and refuge island gives adequate safety for pedestrians.



### **Figure 8: Midblock Control**

Source: (National Association of City Transportation Officials: Urban Street Design Guide , 2019)

According to (Chen L, 2013) and (Ewing R, 2009), in order to improve visibility and driver compliance, effective strategies include advance stop lines that help keep drivers from encroaching on the crosswalk, flashing warning lights to help reduce vehicular speed and reduce conflicts with pedestrians, and the use of high-visibility crosswalk treatments. As a design strategy, road design guidelines it is better to have separate paving pattern or material for crosswalk because, drivers can easily notice the crosswalk even specially during night time. Therefore, Adequate lighting helps to warn oncoming drivers of pedestrians crossing the street at midblock locations and also helps guide pedestrians across the street at night. In pavement lights, overhead lighting, LED warning system and High-intensity activated crosswalk play a vital role in this regard.

#### **1.4.3 Small corner radius and other curb treatments**

Most of the studies elaborate that higher right turn speeds are associated with large corner radii and shorter turn lane length, while collision rates were highest at intersections with median islands separating thru-traffic from turning traffic.

Road curb is a physical safety measure in order to prevent conflicts between pedestrians and vehicles. Installing curb extensions increase driver yielding at uncontrolled crossings, reduce pedestrian delay before crossing and increase the distance between the crosswalk and the point where cars yielded to pedestrians.

### **1.5 Adjacent Activities and Building facades**

This section aims to review adjacent buildings and Land uses which influences on safety and comfort of roadscapes activities.

#### **1.5.1 Retail uses**

Specially in commercial streets, most of the retail functions such as shops, restaurants etc. extend either to pedestrian space or up to roadway. Also, it encourages transportation related activities in commercial streets. The classic

example in Sri Lankan context is Pettah. Streets are shared by commercial activities, pedestrians as well as vehicles.

Author has identified in earlier research that people are great interested in moving to the open shop frontages, under-umbrella retails, outdoor retails etc. due to two reasons. One is most of the outdoor retail has low price ranges and another reason is to magnet to those outdoor shopping because, transparency is key aspect which directly impact on physical safety and psychological comfort in public spaces.

But the issue of these retail uses in street is all activities clashes same time. In one hand, one can define it as a multifunctional and diversity of activities but, in terms of safety and comfort of parties who share the roadscape, it increases collision between vehicles, pedestrians and cyclists too. Even though the streets need diverse activities in order to make it functional, active and energetic safety should be the first priority. Therefore, when designing roadscape, it is important to design co-activities of roadsides properly which has driving force to create active, live and ordered space which maintains safety and comfort of roadscape shareholders.

### **1.5.2 Building scale and façade design**

From the nature of commercial activities, they have linear development along the roadways. Therefore, the correlation between commercial activities and pedestrian activities encourage or discouraged by the scale, massing, height/right-of-way ratio of street facades.

Since the height of building facades do not directly impact on pedestrian or vehicle activities, but shadows will be created according to building heights. Therefore, activity patterns especially pedestrian movements depend on the shadows throughout the day.

In addition to height, building massing such as shape and size can also contribute to activity patterns due to blocking the sun. Another crucial factor is wind direction and speed which affects the pedestrian, cyclist and vehicle safety and comfort in the roadscape. Wind and sun direction can be controlled by understanding orientation and height of the buildings when planning and designing roadscape.



### **1.5.3 Café/vending space**

In Sri Lankan context, bazaar activities are famous and sidewalk café, dining, and vending spaces extend to pedestrian space mostly as a strategy to attract customers basically. Though pedestrians are interested in such kinetic outdoor activities with public seating etc. pedestrian traffic and collision between pedestrian and vehicles are the ultimate result of that. Therefore, designing of commercial roadscapes should have strong sense of public activities and social relationships.

### **1.6 Roadside Installations**

After the roadway and pedestrian space, roadside installation plays a vital role in different ways. Therefore, mainly review Outdoor Advertisements, Roadside barriers and road signage, wall chalking and paintings, Poles, Transformers, generators and Hanging wires and exposed sewer/drains which are directly influence on visual safety and comfort in roadscapes.

Due to the contrasting colors, shapes and forms of roadside installations in different levels of roadsides may have negative influence of pedestrians, drivers and cyclist throughout the day in different frequencies. These intangible factors will contribute to increase of collision specially in commercial roadscapes that has agglomeration of activities happen.

Since the main focus of this study is to assess the visual impact of roadside elements following chapter aims to discuss roadside installations in detail.

### **1.7 Chapter Conclusion**

People's decision to be physically activity through walking and cycling and driving can be influenced by providing streets and other facilities which allow for convenient access to destinations in a safe and enjoyable way. This chapter summarized the available roadscape elements of how complete streets design elements are associated with more active lifestyles and better health. Many health associations have been found, including physical activity, traffic safety, body weight, physical health, and mental and social health.

In between these road elements, other types of roadscape installations play major role which has different impacts on users. Considering all the factors and information, following chapter, 'Chapter Two' aims elaborate roadscape installations in commercial roads under identified classifications.

## **2. CHAPTER 2: INSTALLATIONS IN COMMERCIAL ROADSCAPES**

The urban system has been composed with agglomeration of living and non-living beings in order to perform different activities for different purposes. In addition, in each situation living and non-living components function and incorporate each other in order to complete activities successfully every day. The roads and roadsides, roadscape installations primarily referred to objects that fixed for multiple purposes such as traffic calming installations, outdoor advertisements etc.

Accordingly, this chapter focuses on the commercial roadscape installations or the devices which has capability of creating visual influence on urban comfort and safety. to road different users in commercial roadscape and

### **2.1 Commercial roadscape Installations and its classification**

Some road safety related studies note that both road environment and within the vehicles, there are sources which distract drivers as well as pedestrians and other users of roadscape. According to SL Police department reports, in recent years, substantially increased the impacts of aforementioned road environment elements.

Roadscapes mainly consist of pedestrian space and the roadway which shares by the bicyclists and other vehicles. In Addition, there are secondary elements and the devices which have direct or indirect influence on users such as visual elements, landscape elements, building elements etc.

In this sub section, visual elements compact with roadways which have been classified considering similarity of objects. Set of object directly cannot categorize as visual elements but included as influences on users who may get affected on roadsapces.

Following broad complete streetscapes and roadscape element categories will be discusses in detail.

### 2.1.1 Installations in Roadway

Since the roadway is considered as overall travel way width, number of vehicular lanes, vehicular lane width, and often also incorporate medians, traffic calming features, and mid-block crossings, following roadscape visual elements have been identified through observations, expertise interviews and literature surveys.

Identified visual features have coercion on traffic volume and speed, which in turn influence the likelihood of walking and cycling, pedestrian/cyclist collision risk with vehicles, visual impacts on road users.

1. Traffic calming features
  - a) Traffic lights
  - b) Traffic signage
2. Midblock crosswalk
3. road crossing
4. Roadway illumination



Figure 9: Traffic related roadway installations

Source: <https://images.search.yahoo.com>

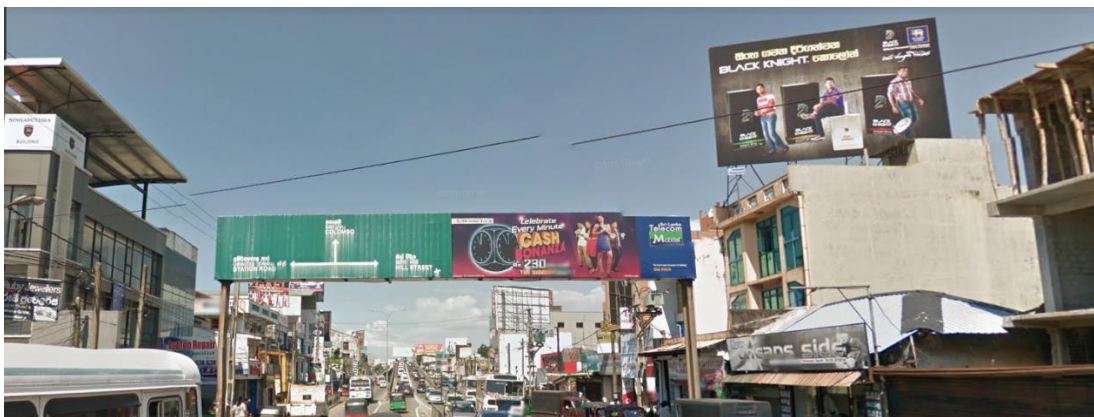
## 2.1.2 Installations in Roadside (including pedestrian space)

Roadsides are normally considered as pedestrian way, cyclist path, buffer area and building frontages including building facades. Most of the visual elements located in the either sides of the roadways than roadways and its impacts have affected for all types of road users. But, depends on the observer position in a particular location and the characteristics of the visual elements decide the intensity level of its impacts on users which will be analyzed in subsequent sections.

1. Outdoor advertisements
  - a) Over bright-lit digital signboards
  - b) Bill-boards
  - c) Political and commercial advertisement
  - d) Banners & Posters
  - e) Way guiding installations



**Figure 10: Billboard types**  
Source: <https://images.search.yahoo.com>



**Figure 11: Outdoor advertisements**  
Source: Author



1. Temporary retail installation



**Figure 12: Visually attractive retail installations**  
Source: <https://www.google.com>

2. Roadside infrastructure and service accessories

- a) Electricity and telephone poles
- b) Hanging and cluttered wires
- c) Roadside illumination



**Figure 13: Hanging wires**  
Source: <https://www.google.com>

Depending on the functionality of the location, different visual elements such as outdoor advertisements, road infrastructure and service accessories, temporary retail installations etc. have been given priority accordingly. Hence, the magnitude of impacts of listed visual installations in commercial roadscapes will be differ from place to place.

### 2.1.3 Installations in cyclist space

In Sri Lankan context, cyclist have not been given separate space in roadscapes. But, as a long-term vision of introducing bicycle lanes for each road in other towns and cities, GOSL has established 'bicycle lanes' in Malambe and Piliyandala areas. Referring to aforementioned examples, cyclist space cannot segregate from the roadway which has combine effects from roadway and roadside visual elements.



Figure 14: Cycling facilities and lane installations  
Source: <https://www.google.com>

## 2.2 Characteristics of roadscape installations in Commercial roads and roadsides

Either planned or unplanned urban positive spaces have been composed with agglomeration of activities which appreciates rhythm of movements of users, series of patterns, balance and most importantly, harmonic relationships. Outcome of these components is creating its own character to the place.

Hence, Character of the place depends on the spatial qualities of space such as coherence, legibility, complexity and mystery which contribute to the people's preference for a particular physical space. (Kaplan, 1982). Zoom in to the focused area of the research, character of an urban space derives not only from its spatial qualities but also from context specific characteristics of visual elements such as

physical appearance, adjacent land-use, functional hindrance, placement, display surface, size, color scheme, view hindrance.

Well- structuring and ordering of aforementioned visual element characteristics add quality and visual interest to the urban space that has potential to turn the space in to functionally and aesthetically active space.

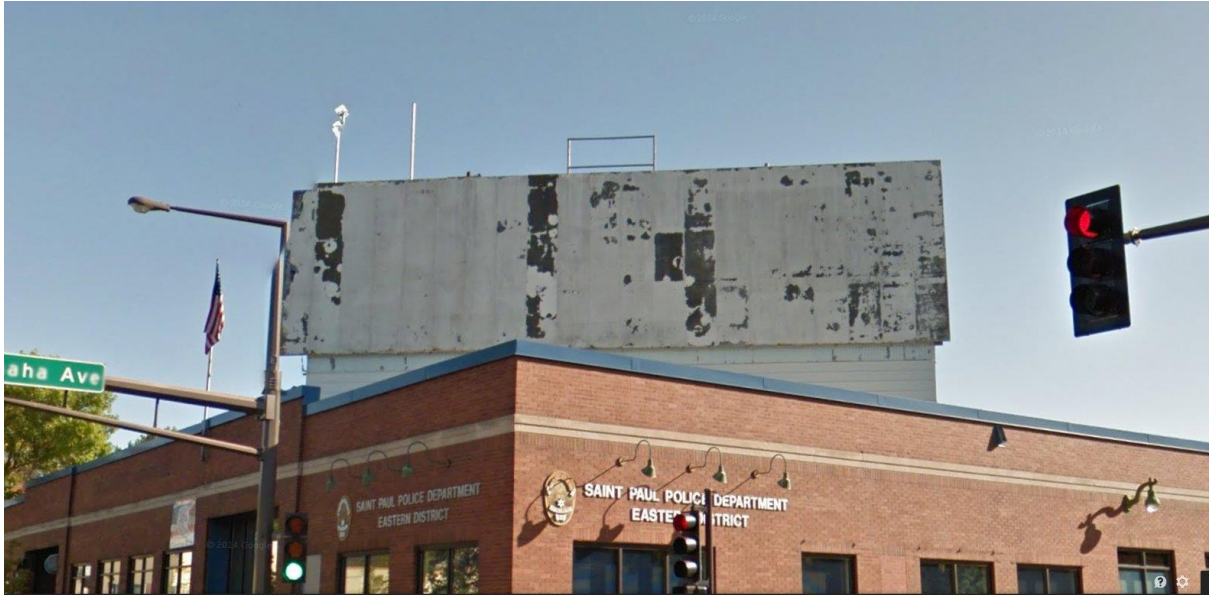
### **2.2.1 Physical appearance**

Physical appearance is considered as shape, location, placement height etc. of the visual installation in particular area. Physical appearance is most strategic factor in order to perform its particular purpose and achieving goals and aims. In addition to that, depends on the type of visual element, the appearance affects its purpose. for an instance, the purpose of outdoor advertisement and the appearance of hanging & cluttered wires give different experience for users in a same urban space.

Major requirement of an outdoor advertisement is to depict its message effectively who can grab the idea at first glance. Therefore, design component establishes powerful and creative background to the advertisements with different design elements such as large text, contrasting colors, human scale figures etc.

Hence, one of the objectives of this study is to identify whether there is an impact on users and examine the impacts of aforementioned characteristics of roadscape visual elements on users.





**Figure 15: The dilapidated billboard at top of the St. Paul Police eastern district station building**  
 Source: Sarah Geving

### 2.2.2 Illumination

Illumination is a primary need in roadscape in order to establish safety, security and comfort of users. Further, it promotes the image of a visual appealing and uncluttered city. In terms of aesthetic, illumination specially the street lighting has approached beyond the primary function of illumination. (Engineers R. &.)

In terms of illumination, safety can be defined as any user reach to his/her destination without any physical damage and mental discomfort and dissatisfaction.



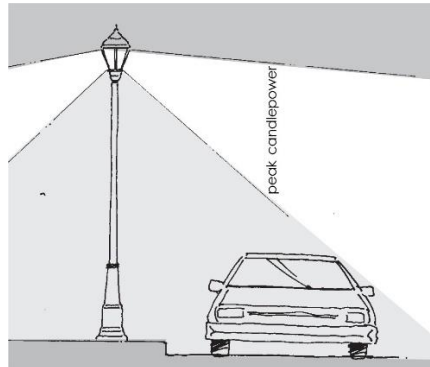
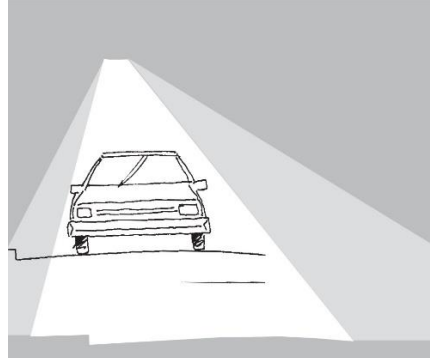
**Figure 16: Roadside Illumination**  
 Source: <https://www.tvilight.com>

Security can be defined as the freedom from deliberate harm or threat by other. Therefore, proper illumination has potential in creating a sense of security in roadscape.

In order to assess the illumination level of roadscapes, there are considerations to be studied such as wasted light, controlled light, glare, orientation, light trespass and clutter.

### 2.3 Illumination considerations

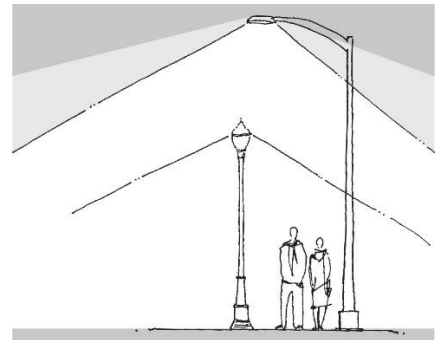
Table 1: Types of Illumination Considerations

Consideration	Description	Illustration
Wasted light	the peak candlepower of the light is not reaching the necessary area- the roadscape- and thus is wasted.	 <p>A diagram showing a street lamp on the left. A wide, shallow cone of light is cast from the lamp, but it does not reach the car on the right. A vertical line from the lamp's peak is labeled 'peak candlepower', indicating that the maximum light intensity is not directed towards the road surface where the car is.</p>
Controlled Light	light which directs toward the necessary area	 <p>A diagram showing a car on a road. A narrow, focused beam of light is directed from an unseen source (likely a headlight or a spotlight) directly onto the car, illustrating light that is precisely controlled to reach the intended target.</p>

Glare result from too much light which makes things harder to see, forming harsh shadows (and good hiding places) as well as blind spots for drivers - all causing safety concerns.



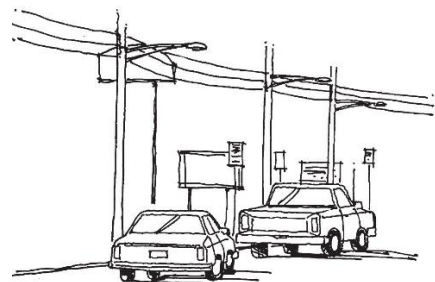
Over lighting avoided by not duplicating light fixtures



Light trespass results from light "spilling over" from poor quality fixtures or substandard installations



Clutter ("noise") refers to any factors that interfere with or distract the user's attention away from the desired visual signals (signs regarding entry or displaying information, etc.). Many other overhead utilities including



telephone, cable TV, and traffic signals, contribute to this "noise." Lighting should be designed to enhance the visual signals and reduce the visual "noise."

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(Engineers R. &.)

In addition to the illumination considerations, having clear understanding of the behavior of the illuminations.

Planning of Illumination specially in the roadscape designs, following aspects should be given the priority in first hand such as Quality of Lighting, Luminaire Spacing, Average Illuminance, Lighting Uniformity, Lighting Plan, Luminaire Mounting Heights and Uniformity Ratio (Average/Minimum).

Since this study focus on the safety and comfort on users in commercial roadscape, illumination should have to be assessed using specific and standard criterion. Accordingly, minimum and maximum levels of illuminance are measured based on the following illuminance standards.

a) Average required Illuminance level

**Table 2: Average illumination levels**

Average maintained illuminance values ( $E_{avg}$ ) in Lux †					
Road and area classification		R1	Pavement classification R2 and R3	R4	Illuminance uniformity ratio $E_{avg}$ to $E_{min}$
Freeway class A		6	9	8	3 to 1
Freeway Class B		4	6	5	
Expressway	Commercial	10	14	13	3 to 1
	Intermediate	8	12	10	
	Residential	6	9	8	
Major	Commercial	12	17	15	3 to 1
	Intermediate	9	13	11	
	Residential	6	9	8	
Collector	Commercial	8	12	10	4 to 1
	Intermediate	6	9	8	
	Residential	4	6	5	
Local	Commercial	6	9	8	6 to 1
	Intermediate	5	7	6	
	Residential	3	4	4	

**Table 3: Horizontal Illuminance levels**

Horizontal Illuminance ( $E_{avg}$ ) in Lux <sup>3</sup>	

<sup>3</sup> Recommended uniformity of Illumination is 3 to 1 or better. Average to minimum for all road classifications at the illuminance levels recommended above. these design values apply only to the travelled portions of the roadway. Interchange roadways are treated individually for the purposes of uniformity and illuminance level analysis. † for approximately values in foot-candles multiply by 0.1

Road and area classification	Commercial area	Intermediate area	Residential area
Freeway	6	6	6
Expressway	10	8	6
Major	12	9	6
Collector	8	6	6

**Table 4: Horizontal and vertical illuminance levels of walkway and bikeway**

Walkway and Bikeway classification <sup>4</sup>	Minimum average horizontal levels ( $E_{avg}$ )	Average verticle levels for special pedestrian security ( $E_{avg}$ ) †
Sidewalks (roadside) and type A bikeways		
Commercial areas	10	22
Intermediate	6	11
Residential	2	5
Walkways distant from roadways and type B bikeways		
Walkways, bikeways and stairways	5	5
Pedestrian tunnels	43	54

<sup>4</sup> Crosswalk traversing roadways in the middle of long blocks and at street intersections should be provided with additional Illumination. † for approximately values in foot-candles multiply by 0.1. †for pedestrian identification at a distance. Values at 1.8m (6 feet) above walkway.

b) Maximum required Illuminance level

**Table 5: Maximum Illuminance levels**

Functional classification	Average maintained illumination at pavement by pedestrian area classification			$E_{avg}/E_{min}$
	High	Medium	Low	
Major/Major	34.0/3.4	26.0/2.6	18.0/1.8	3.0
Major/ Collector	29.0/2.9	22.0/2.2	15.0/1.5	3.0
Major/Local	26.0/2.6	20.0/2.0	13.0/1.3	3.0
Collector/collector	24.0/2.4	18.0/1.8	12.0/1.2	4.0
Collector/ Local	21.0/2.1	16.0/1.6	10.0/1.0	4.0
Local/Local	18.0/1.8	14.0/1.4	8.0/0.8	6.0

Uniformity of roadscape illumination is directly influence on user perception in safety and comfort in a particular place in urban context. The user perceives the light as safer when the uniformity is higher (3: 1) and this numerical factor remains positive when the illuminance is increased. In addition, 15:1 and 10:1 uniformity ratios do not produce light that most users do not recognize as uniform light. above ratios can be identified in both bright and dark areas in the roadsapes. Accordingly, 15: 1 and 10:1 ratio would feel insecurity which encourages illicit behaviors.

### 2.3.1 Size

The size of any visual element in roadsapedominate the space around itself. Also, it matters to the adjacent functions or the activities surrounded by.

Outdoor advertisements as a major visual element in urban public spaces, size is crucial factor which has negative impacts most of the time on diverse urban activities. In addition to that, in terms of maintenance, size is a critical factor which should be taken in to consideration over period of its life time. Due to the climatic conditions and other external forces, those large instalments would collide negatively. Therefore, size of any visual element in an urban space will have negative or positive influence on users and their activity patterns.

### **2.3.2 Color scheme**

Selection of color scheme for majority of the visual elements will be decided in order to achieve its aims and to influence and impress the targeted group/s. In urban setup, most of the outdoor advertisements benefit from bright and contrast color themes which can catch the eyes easily. In addition, rest of the visual elements which were categorized has specific color schemes in order to establish its objectives in function. But, over use of color schemes either have direct or indirect influence on all types of users who shares the roadscapes. some literature elaborates that bright colors tend to distract the attention of drivers on roads etc. Therefore, this research aims to investigate negative and positive influences of above stated roadscapes elements critically.

### **2.3.3 View Hindrance**

Visual elements in roadscapes are different in function and purpose and its functionality in terms of visual aspects are comparatively diverse. Hence, visual functions tend to collide each that produces chaotic effects to the immediate environment and it affects the psychological state of receptor.

Therefore, agglomeration of visual activities should control and monitor in a sensitive manner without harming the diversity of different installations and other effective visual elements that has magnetic field to attract people in a city.

### **2.3.4 Tolerance**

Since the noise is one of the 5 senses that can be easily measured and examine the optimum subjective tolerance level of a person in a particular environment. But, zoom in to the visual atmosphere, it is much complex to identify the visual sensibility level of a person.

Visual threshold is an important term merge with sensitivity level of receptor who directly affected to the visual collision. Since the sensibility level differ from person to person, it has a complicated process to decide the optimum level of visual sensitivity of each visual element. Also, visual elements as a whole specific in an



urban environment will give a totally different value compared to single visual element.

Therefore, it is important to understand the sensibility level of a receptor who receives effects of visual elements in a particular environment.

### **2.3.5 Visibility**

visibility can be defined as level of visual effects that can be perceived by a receptor in a particular place and time. Most of the visual elements which were categorized in early pages, have high level of visibility. Among other types of visual elements, outdoor advertisements are attractive in colors, size of text, eye catching designs have high visibility level in order to attract the reader. But, the result of high visibility level thickens the effects on perceivers.

### **2.3.6 Effectiveness to the environment**

After all considerations of visual elements in roadscaapes, effectiveness of visual element which is to be placed in a particular environment should be assessed before placing visual element in order to get the maximum advantage of it. In addition to the getting advantage, visual elements supposed to respect the nature of place where underlying positive activities should be energized and conserved.

In terms of aesthetic value, most of the outdoor advertisements hang or place on either sides of roads or junctions or public spaces where most people get together. And, Traffic calming features usually can be seen where there is high level of traffic situations. also, lots of encroachments are concentrated either in or close to a junction or public spaces. unethical dumping has been noticed at the end of a street or neglected spaces where there are lack of human activities.

Hence, the effectiveness of visual elements will be establishing when it considers the suitability to a particular space rather just place some elements in urban public spaces which will give negative influences on receptors because, public space must be a place where people can hangout without any external disturbances or agitation.



**Figure 17: Relevance of roadscape installations to user and immediate environment**  
Source: Author

## **2.4 User factor considerations**

In addition to the characteristics of visual elements identified in commercial roadscape, Human/ user factors are hand to hand important when considers the safety and comfort of road and roadside users. pedestrian's activity patters and movement patterns, drivers and cyclist's vehicle speed, lane changes, traffic navigation, intersections, read and interpret various traffic signage and all types of activities related to roadscape have been influenced by user factors.

This section is focused on positive and negative effects of external visual sources such as driver distractions, abnormal pedestrian movements and circulations etc. In order to contribute to the current evaluation of whether visual elements might have an impact on pedestrian, cyclists and driving safety, the following section review the nature of attention and some perceptual issues that are likely to be important to the activities happening in urban public spaces in commercial roadways.

### **2.4.1 Nature of attention**

specially in the roadways, there can be identified couple of attention types that will be automatically capture of attention and the other is the limited capacity of human attention.(Paul R., 2013)

### 2.4.1.1 Automatic capture of attention

The attention of drivers, cyclists and pedestrians deliberately distracted by visual elements in roadscaes. Hence, the activity or the task that the receptor has been engaging will be purely or partially affected due by visual elements.

(Dingus, 1989) elaborates that drivers typically modulate their off-road glances, not looking away from the forward roadway for more than 1.5 seconds at a time. They deliberately attend to look at the roadway and roadside elements which are displayed randomly. In addition, the receptor's attention pays on visual element of roadscaes will be voluntarily and goal- directed.

Based on the theoretical considerations, voluntary attention on visual elements in roadscaes have been investigated by researchers. Because of either by voluntary or goal- directed, being distracted from roadway or pedestrian way, have been investigated and there are clear findings on distraction potentials of roadscape installations.

**Table 6: Research findings on distraction potentials of roadscape installations**

No.	Reference	Research title	Findings
01	(Yantis, 1994)	Stimulus-driven attentional capture: evidence from equiluminant visual objects	the appearance of new objects in the visual field was the key to predicting attentional capture
02	(Theeuwes, 1995)	Abrupt luminance change pops out; abrupt color changes does not	luminance changes were necessary to capture attention
03	(Hollingworth, 2010)	New objects do not capture attention without a sensory transient	the presence of unique sensory transients may be the key to predicting attentional capture
04	(Yantis S. &.,	Abrupt visual onsets and	attentional capture can be

1990)	selective voluntary automatic allocation	attention: versus	suppressed
05 (Lamy, 1999)	A salient distractor does not disrupt search	conjunction	The key seems to be that this suppression is more likely if the primary task is very demanding and requires a focused attentional state, but that such suppression becomes less likely as the primary task becomes less demanding, requiring a less focused attentional state
06 (Young, 2009)	Conflicts of interest: the implications of roadside advertising for driver attention	the poorer recall of road signs (suggesting greater attention to roadside advertisements) are consistent	

Theoretical aspects on involuntary attentional capture are complicated compared to voluntary attention capture. Also, distraction can be occurred due to driving/ cycling or walking while talking over the phone to someone or passenger looking at the scenery and roadside visual elements. Specially, people who unfamiliar with the route will easily get distracted by visual elements in roadscapes.

#### 2.4.1.2 Attentional biases

‘Attention’ usually depends on the emotionality of information and mostly, it changes surprisingly rather pre-planned. For an instance, weird sound will likely change the perceiver’s attention. But, in the context of road safety, security and comfort, attention biased reactions are less appreciated because, personality factors differ from person to person which ultimately impact on the way of reacting to the external emotionality information. Aforementioned reaction is primarily a survival factor which stimulates adrenalin in body fluids in order to escape from any life threatening materials in roadscapes.

Above all research materials evident that visual elements in roadscapes have potential and chance to attract and hold the attention of receptor and will result in decrements in road user's performance such as drivers, cyclists, pedestrians and secondary users such as people who maintain the roadscapes.

#### 2.4.1.3 Limited capacity of attention

In simple terms, limited capacity of attention can be experienced in a situation like couple of actions are doing simultaneously. the result is processing attention has limited capacity of attention. for an instance, writing something while having a phone conversation will fail to catch the attention purely on one or the other action.

This is the result of restricting drive while having phone conversation by low. That is because, driving relies so heavily on visual information processing, driving and comprehension performance are better when instructions are presented verbally while driving than if they are presented visually. (Parkes, 1990)

Large in size outdoor advertisements install along the roadways capture the attention and reduces the processing capacity of either driver, cyclist or pedestrian who requires visual information processing for their main task such as driving, cycling, walking etc.

### 2.4.2 Perceptual issues

#### 2.4.2.1 Eyes off the roadway

Since the visual elements in roadscapes impact on processing capacity on roadscape performance by all types of user such as driver, cyclist, pedestrian and secondary users like people who maintain the roadscapes. Not only the processing capacity, but also the performance of users on the roadscaes are impact on safety, security in comfort in roadscapes. it is inappropriate visual fixation, usually away from the forward roadway.

In terms of driving, (Klauer, 2006) found that glances away from the forward roadway for more than two seconds doubled the near-crash and crash risk compared to baseline. This result is averaged across all road types and traffic conditions.

#### 2.4.2.2 Visual clutter

As justified above sub sections, roadscape elements along the roadways and in the roadscapes hinder the capturing of relevant visual information. the main reason for that is increase of visual clutter which results the decreases the ability to form important information in roadscapes. High clutter is resulting from more errors when searching for a target sign. (McPhee, 2004) found that this kind of impairment was further exacerbated by requiring participants to engage in a listening and comprehension task simultaneously with the search task. In addition, they found that older adults performed more poorly than younger adults on the search task.

The condition of the roadway and roadside visual elements decrease the clarity of scenes due to visual clutter. Through these findings, when designing roadscapes and in the policy making process, it is important to understand that the visual installations provide objective measuring of visual clutter.

Referencing Example:

*“... The central issue of building technologies is often remote, partly tacit. Those in practice have tended not to publish the full richness of their knowledge and experience, their know-how, relying instead on oral traditions and the examples available in existing buildings. Even today, even in highly industrialized economies, this remains largely the case...” (Groak, 1990, p.67)*

## 2.5 Chapter Conclusion

In this chapter, it has been identified different types of roadscape installations with reference to the commercial roads and summarized visual effects on users which may impact on their activities on road in different magnitude. that is because humans have a limited capacity for processing information simultaneously there is the potential for the processing of roadscape installations to interfere with the processing of information critical for road users.

Under the commercial roadscape installation types, it has been identified four types of installations such as Traffic installations, Outdoor advertisements, temporary retail installations and Infrastructure & service installations. While elaborating the characteristics and its behavioural factors, another main concern was to identify the

visual effects of pre-identified installation types. Therefore, using quality and recommended literature, it was listed and briefly explained the effects such as Automatic capture attention, attentional bias, limited capacity of attention under nature of attention of users and eyes off the roadway, visual clutter under perceptual issues.

Considering all the information gathered from literature and some other research materials, following chapter, chapter three focuses on the physical safety and comfort consideration with reference to the pre-identified roadscape installations.

### **3. CHAPTER 3: PHYSICAL SAFETY AND COMFORT CONSIDERATIONS IN COMMERCIAL ROADSCAPE**

#### **3.1 Physical Safety and Comfort in Roadscape**

Roadscapes to be safe and comfortable for all users. Therefore, prioritize the safety of, drivers, cyclists and pedestrians and the most vulnerable users among them: children, seniors, and people with disabilities. Safe roadscapes have lower speeds to reduce conflicts, provide natural surveillance, and ensure spaces are safely lit and free of hazards.

Since, roadscape has shared by different users, physical safety and comfort in urban roadscapes cannot grasp easily because, it is subjective to type of user. Whereas, safety of individual in roadscape (pedestrian and driver) should be a shared responsibility of road users as well as roadscape designers, planners and decision makers.

According to World Health Organization (WHO) recent reports, physical harassments and road traffic accidents in urban setups have been increased mainly due to poor concern of pedestrian facilities and unnecessary road elements and installations which directly influence on attention and distract the performance of pedestrian and drivers. Hence, the traffic accidents entrap pedestrian who avoid pedestrian space in urban setting. In particular, this preventative behavior can be frequently identified in elderly, children, or disabled person groups.

Improving qualities of roadscape factors such as directness, continuity, distance, visibility, pleasantness, sense of enclosure and safety have influence on conserving safety and comfort rather introducing new set of policies to safeguard the user in urban setting.

In the physical environment of urban settings, most crucial factor is safety. Comfort is result of safety in any context. Therefore, every single element or installation in roadscape supposed to establish or confirm the safety of users.



(Porter, et al., 2018) indicates that spatial interventions such as traffic restrictions, pedestrian friendly facilities, traffic calming measures, redesign of streets, etc. can reduce the risk of safety in terms of vehicle and pedestrian accidents.

### **3.2 How roascape installations impact on safety and comfort**

In the context of physical environment, there are components related to safety and comfort which are related to natural environment and built environment factors. As this study focuses on built environment factors, (Edquist) findings are incorporated in order to conceptualize the roadscape installations factors as follow,

1. Built (buildings and other infrastructure)
2. Designed (traffic control devices)
3. Situational (vehicles and other road users)

In this study, visual installation in built environment will be discussed as the core concern in order to get base line for the analysis. Also, in order to examine the relationship between each factor (built, design and situational) contribute to the safety and comfort in roadscape, correlated indicators will be addressed in this subsection.

#### **3.2.1 Built factors**

The relationship between built factors, user safety, and their comfort in commercial environment has been assessed in different urban roadscape settings, using different qualitative and quantitative methods particularly.

Since the study focuses on safety and comfort impacts of visual installations in roadscape, built factors depend on the type of visual installations identified such as outdoor advertisements, temporary retail installations and Roadside infrastructure and service accessories.

Following details will be taken in to considerations in order measure the behavior of roadscape visual installations under the category of built environment factors.

**Table 7: Built factors evaluation**

	Description		Built installations in <i>Roadscape</i>				
			Outdoor Advertisements	Temporary retail installations	Infrastructure and service accessories		
<b>Principal Influence Factor of driver–pedestrian safety and comfort</b>	General	Type					
		Location					
		placement					
		Placement level from ground level					
		Average distance between two devices					
	<b>Physical features</b>	Visual appearance and type					
		Size					
		Color schemes					
		Animation					
		Prominence					
		Illumination	Type				
			Mounting height				
			spacing				
			Blockage of light reaching ground				
			visibility				
			Color of light				
			glare				
			Wasted light				
		Over lighting					
	Light trespass						
	<b>Functional aspects</b>	Durability					
		Current condition					
		Long term/ short term purpose					
		Resistant to micro climatic aspects (precipitation, wind, heat etc.)					
		Strength					
	<b>Technical safety precautions</b>	Indicated safety notes					
		Safety color code included					

**3.2.2 Designed factors**

Design factors are mainly considered as traffic control devices such as traffic signage, traffic lights, midblock crosswalk, tree buffer, road isle installations etc. which have influence on visual effect on users in urban roadscape setups.

In order to assess visual impact with regards to aforementioned design factors in roadscapes, following measures will be taken in to consideration.

**Table 8: Designed factors evaluation**

	Description		<i>Built installations in Roadscape</i>						
			Road intersections	Tree buffer	Road isle installations	Midblock crosswalk	Traffic signage	Traffic lights	
<b>Principal Influence Factor of driver –pedestrian safety and comfort</b>	<b>General</b>	Type							
		Location							
		Type of placement							
	<b>Physical features</b>	Visual appearance							
		Size							
		Color schemes							
		Animation							
		Prominence							
		Illumination	Type						
			Mounting height						
			spacing						
			Blockage of light reaching ground						
			visibility						
			Color of light glare						
			Wasted light						
	Over lighting								
	Light trespass								
	<b>Functional aspects</b>	Durability							
		Current condition							
		Long term/ short term purpose							
Visibility from distance									
Resistant to micro climatic aspects (precipitation, wind, heat etc.)									
Strength									

### **3.2.3 Situational Factors**

Situational factors consider as types of users such as pedestrians, drivers, cyclist and other users who use the roadscape for different activities either daytime, night or both. In this study, most affected user categories have been selected to inquire their safety and comfort factors with regards to the visual installations in roadscape.

Since all visual installations cater for user's necessities, it is important to check whether the listed installations create satisfactory environment together with natural environmental situations also. Subjectively, overstimulated outdoor advertisements, over-lit illumination, bright/luminous colors etc. influence on users in different magnitude.

Depending on the activity/s that have been engaged by roadscape users in different location, different time lines, the impacts will be differ. Therefore, the amplitude of the impact will be decided along with the process that the user have been engaged in the particular roadscape. In addition, impacts can be long term as well as short term which depends on the type of visual installation and the receptor capacity of tolerance.

Here upon, situational factors also crucial factors in order to identify the impacts of visual installation in roadscape. Therefore, following chart identifies the particular factors of individuals in roadscape and the factors will be marked subjectively with regards to their physical tolerances.

**Table 9: Situational factors evaluation**

	Description		<i>Built installations in Roadscape</i>									
			OAs	Temporary retail installations	Infrastructure & Service accessories	Road intersections and crossings	Tree buffer	Road isle installations	Midblock crosswalk	Traffic signage	Traffic lights	
<b>Principal Influence Factor of driver–pedestrian safety and comfort</b>	General	Age										
		Gender										
		Location										
	User factors	preference										
		Effective to the user										
		Visually annoy										
		Match with sensitivity level										
		Visible in daytime										
		Visible during night										
		Nature of attention										
		Automatic capture of attention										
		Attentional biases										
		Perceptual issues										
		Eyes-off road roadway										
		Visual clutter										
		Overall read										
		perspective effect										
		Read as a fabric										
		Weather condition matters										
		visibility in precipitation										
Tolerance to reflections												

### 3.3 Chapter Conclusion

In this chapter, it has been considered the user safety and comfort factors under build, design and situational factors which bringing down from the chapter two. Under each factor, pre-identified commercial roadscape installations were listed and prepared an evaluation criterion in order to record suitable gathered data and information and finally to evaluate its influences accordingly. Those results aims to extract for the final stage to assess the visual impacts due to commercial roadscae installations.

## **4. CHAPTER 4: RESEARCH DESIGN**

### **4.1 General**

This research has been designed according to pragmatic research which is formulated using sequential and inter-linked steps. Using quantitative and qualitative research methods, research objectives will be accomplished in order to tackle the research outcomes.

### **4.2 Stage one – Review and ranking of Ranking of Roadscape Installations**

As the research sequence is mainly divided in to three stages. Stage one is aims to identify and list out the commercial roadway and roadside installations which influence on user safety and comfort and rank them direct observations, participant's observations, formal and informal interviews. In order to identify and list out the aforementioned installations, few pilot surveys will be conducted with reference to the commercial roads including interlinked public activities to the particular road.

#### **4.2.1 Pilot surveys**

Within the given limited time period, investigation of visual impacts in Galle road as a whole is not practicable, following steps were carried out.

Author will be observed 1.5 km of three different commercial road sections along the Galle road from Galle-face roundabout up to Dehiwal canal in order to identify roadscape installations and identified installations will be listed according to Table 10.

\*\* In the middle of the pilot surveys, it was noticed that where there are dense roadscape installations, there are high user activities including vehicle traffic.

Then, the identified and listed roadscape installation will be finalized using small scale panel of experts. The panel of experts will be represented urban design postgraduate and master students and level 5 architecture students from University of Moratuwa.

**Table 10: Density of roadscape installation – Pilot survey**

No	Area	Installation Category <sup>5</sup>	Roadscape installation	Quantity

Finalized list of roadscape installations will be ranked by above small scale panel in the first stage and in order to verify the ranked installations will be re-ranked by moderate scale of panel experts who represented the Urban Design and Planning academic background and practitioner in Urban Design.

Photographic surveys and video clips along the selected pilot areas will be used in order to feed the above panels. Expert panel was selected in the purpose of covering different government organizations who are related to urban design and planning as follow.

### **4.3 Stage Two – Assessing Roadscape Installations**

First phase of stage two aims to identify and select detail case study area/s in Galle road in order to analyse visual impact on user safety and comfort due to roadscape installations.

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<sup>5</sup> Each installation has been fallen in to identified category as A, B, C & D.  
A - Traffic calming installation. B – Outdoor advertisements C – Temporary retail Installations  
D - Temporary Retail Installations

### 4.3.1 Background of road network in Sri Lanka

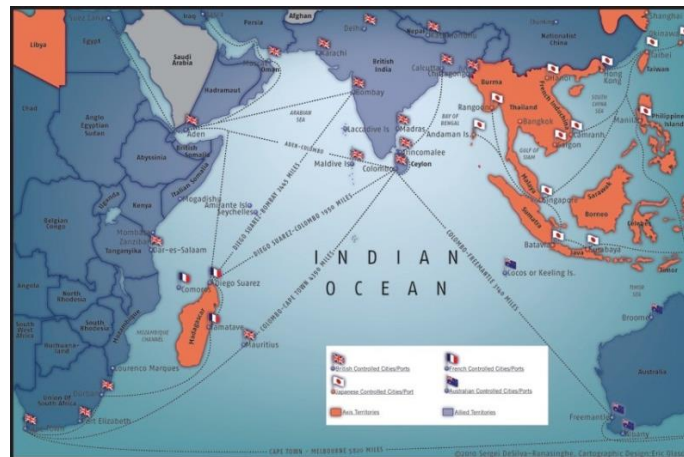


Figure 18: Evaluation of inland road network of Sri Lanka

Source: <https://images.search.yahoo.com>

Since, Ceylon is in the prime location of Indian Ocean, famous for trade. Since then, Colombo has been developing as node of trade network within the country and all over the world. in the meantime, in order to transfer trade items which were imported and export the local material etc. gathered from several parts of Sri Lanka, transportation was given the priority accordingly.

Therefore, inland road network has been gradually developed all over the country which are now being turned in to spine of development. People's day-to-day activities based upon the roads and streets.

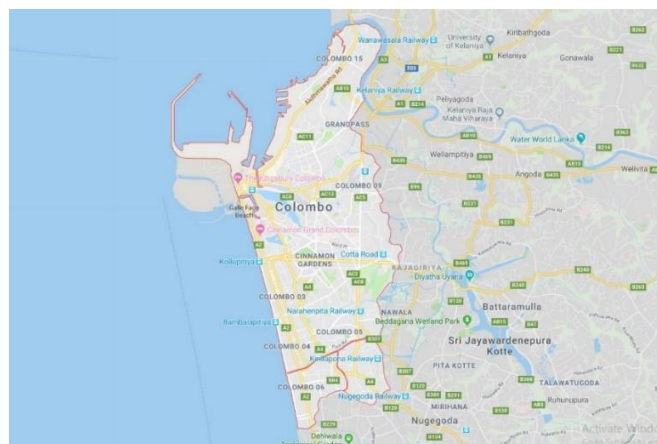


Figure 19: Road network in colombo

Source: Google maps (<https://www.google.com>)



### 4.3.2 Why Galle Road?

Galle road has a great history rooted back to colonial period and even before. Today, it has become major road in Colombo region which is given key attention by local and foreign investors including GOSL<sup>6</sup> for their prime developments locations either sides of the Galle road. Along with these developments, divers installations such as traffic calming elements, outdoor advertisements, infrastructure and service accessories etc. are incorporated in roadscape as secondary needs.

Since there is no proper guidance for aforementioned installations by related governing bodies in Sri Lanka, user get suffered and disturbed through unnecessary roadscape installations. throughout the preliminary observation in order to select a case, Galle road as one of the major roads that has almost affected by above mentioned installations.

### 4.3.3 Reviewing the pilot surveys

- a) Compare gathered data and information of three different road sections in Galle road in the stage one.

In order to verify the pilot case locations, have absolute visual impacts on users, author managed to conduct few random informal interviews with 3 local pedestrians, 3 foreign pedestrians, 3 drivers and 3 motor cyclist. Following table used to record gathered data and information.

**Table 11: User response - Pilot survey**

No	Area	Installation	Roadscape	User response	
				Day time	Night time

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<sup>6</sup> Government of Sri Lanka

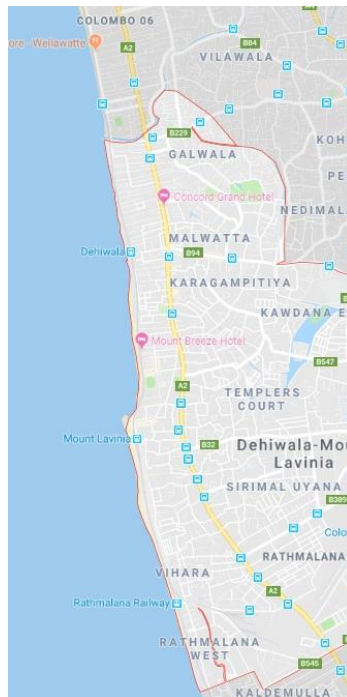
		Category	installation/s	Pedestrian	driver	Motor cyclist	Pedestrian	driver	Motor cyclist

0-35% Poor  36-65% Moderate  66-100% Good

Above interviews conducted based upon the personal preferences on visual pleasing/annoy, tolerance, visibility, level of attention and aesthetic preference. The final results will be reflected using color code as above key.

Then,

- a) Compared all collected records/ materials of pilot case areas in Galle road which have potential in high magnitude of visual influences due to pre-identified roadscape installations.
- b) Reference to all gathered data and information, three road sections in Galle road will be taken in to consideration in order to proceed ranking procedure.



**Figure 20: Dehiwala, Colombo**  
Source: <https://www.google.com>

- c) As a result of evaluating gathers data and information, 200m distance of roadway and interlinked roadside activities were finalized.

In order to rate visual installations in selected roadscapes based on the classification and characteristics study which have been explained in chapter two. The purpose is to categorising identified installations into an order based upon the ranking and weight of visual installations in selected roadscapes.

#### **4.3.4 Qualitative information on visual installations.**

Above information has been collected through public opinions, interviews, participant observations and direct observations in order to enlist roadscape installations in commercial roadscapes which influence on public safety, security and comfort.

#### **4.3.5 Technical measures**

As per the type of roadscape installations which were selected in couple of roadscape, Galle road, their effective technical parameters will be taken into consideration such as illuminance level, flux etc.

1. Ranking and weighting roadscape installations in selected 2 segments in Galle road.
  - i. Rank and weight the visual installations with participant observation, direct observations and public surveys based upon safety and comfort factors.
  - ii. And, panel of experts have been selected in order to rank weight visual e installations.
2. Selection of type and size of the panel experts and their identification<sup>7</sup>
  - i. Professional were selected from,

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<sup>7</sup> Cross reference- (Peterson, Silsbee, & Schmoldt, 1994) and (Al-Harbi, 2001)

- Urban design related academia,
- Colombo municipal council,
- Urban Development Authority,
- Civil society members,

having a concern on impacts of visual installations in selected Segments in Galle road.

- ii. Typical comparison, the expert decides which among outdoor advertisement (A) and wall chalking (B) is the bigger contributor to safety and comfort due to visual installations.
3. Identification of characteristics of each roadscape installations and list accordingly. (refer to the chapter 2)
    - i. Based upon the characteristics of identified roadway/roadside installations that have a relationship with the visual impact will be identified by the panel members.
    - ii. rubric values have been defined against each characteristic.
  4. Visual installations were ranked according to the qualitative measures as aforementioned. In order to verify the weighted ranking, stage three will be carried out as following sub chapter.

Rated visual installations in selected commercial stretch in Galle road had been assessed in order to measure the impact levels on public safety and comfort.

Assessing criteria consists of following 3 factors<sup>8</sup> which have quantitative and qualitative research measurements.

- a) Built factors
- 

<sup>8</sup> Chapter 3 explains built, designed and situational factors in detail and the tables under each factor will be used to assess the real world impact on user safety and comfort in roadscares.

- b) Designed factors
- c) Situational factors

Gathered data and information will be evaluated in two levels. In the first level, giving its priority to the quantitative methods raw data and information will be recorded in the following table 1,2,3 and 4 under build, designed and situational factors.

In the second level, gathered qualitative data and information under above tables will be projected using following color code<sup>9</sup> and numerical data<sup>10</sup> will be analysed and final results will be reflected using suitable graphical presentation in each sub sections of the selected case study area.



**Table 12: Final evaluation of Key factors impacting on User safety and comfort in roadscapes**

Key factors	Measurements	Case 1	Remakes
Built factors	Visual characteristics		
	Functional aspects		
Designed factors	Visual characteristics		
	Functional aspects		
User factors	Preference and Visibility		
	Nature of attention		
	Perceptual issues		
	Overall read		
	Weather condition matters		

<sup>9</sup> Color code is introduced in order to clearly identify the magnitude of visual impact of roadscape installations.

<sup>10</sup> Quantitative values such as luminance levels etc. are presented with reference to the table 2 to 5.

#### **4.4 Stage Three –Rating of identified Roadscape Installations in terms of public safety and comfort.**

Identified roadscape installations which were ranked and assessed in the stage one and two are rate accordingly.

#### **4.5 Chapter Conclusion**

Chapter four discussed the detailed research design which focuses on assessing visual impacts of roadscape installations cascading three stages while covering listed objectives in the early stage of the research.

In the main three stages of the research, it has been adopted qualitative and quantitative research methods as depicts in the figure 1- research methodology flow chart.

Using all the methods, next chapter, and chapter five is to be explained the detailed cases studies which drives towards to assessment of visual impacts.

## 5. CHAPTER 5 : DETAIL CASE STUDIES

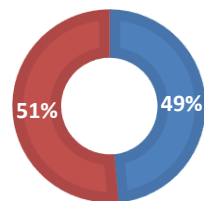
With reference to all the information and data gathered in the above four chapters of the research, this chapter aims to elaborate particular case studies which are suitable for the research base in order to assess the visual impacts due to readscape installation identified in the chapter two as the main outcome of the research.

### 5.1 Case Study – Dehiwala Junction, Galle Road

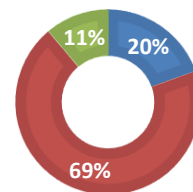
Table 13: General information of Dehiwala

Name	Status	Population 2001-07-17	2012-03-20
Dehiwala	Divisional Secretariat	101,830	88,962
Area - 8.00km <sup>2</sup>	Density – 11,120/ km <sup>2</sup> (2012)	Change – 1.26%/ year (2001-2012)	
Gender –( C 2012)		Age group (C 2012)	

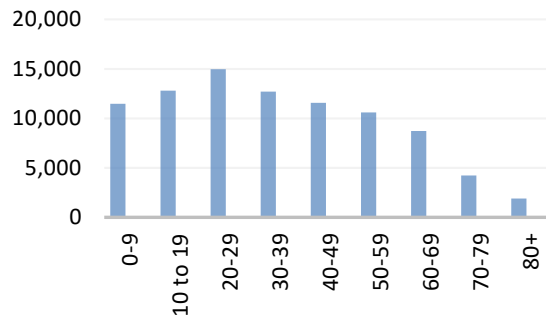
■ males ■ females



■ 0-14 ■ 15-64 ■ 65+ ■



Age Distribution



## 5.2 Stage one – Ranking of Roadscape Installations

As per the similarity of different types of roadscape installations were managed to categorise into 4 major groups which were found in 150 distance from Dehiwala junction and results of pilot survey has been considered in order to rate and weight the impact of roadscape installation as one of the key objectives of the study.

As per the table 14 below, each criterion was compared according to pair-wise comparison. This point method refers to Saaty scale. In a typical comparison, the expert decides which among outdoor advertisement (A) and Traffic features (B) is the bigger contributor to safety and comfort in Roadscapes.

Table 14: Summary of the expert rating

Criteria		More important?											
A	B	A or B											
		Day					Night						
		P	D	C	P	D	C	P	D	C	P	D	C
		Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5	Scale 1-5
Traffic features	Outdoor Advertisements	B	7	B	5	B	5	B	1	B	5	B	5
	Temporary retail installations	B	5	A	5	A	5	A	3	A	3	A	3
	Infrastructure & service accessories	B	5	A	1	A	1	A	1	A	1	A	1
Outdoor	Traffic features	A		A		A		A		A		A	



Advertisements	Temporary retail installations	A	3	B	5	B	3	A	5	B	1	B	1
	Infrastructure & service accessories	A	5	A	7	A	5	A	3	A	5	A	5
Temporary retail installations	Outdoor Advertisements	B		A		A		B		A		A	
	Traffic features	A		A		A		A		A		A	
	Infrastructure & service accessories	A	5	A	5	A	5	A	3	A	3	A	3
Infrastructure & service accessories	Outdoor Advertisements	B		B		B		B		B		B	
	Traffic features	A		A		A		B		A		A	
	Temporary retail installations	B		B		B		B		B		B	




**Table 15: Key for Intensity of Impact**

Intensity of impact	Definition	Explanation
1	Equal impact	Two installation types contribute equality to the objective
3	Moderate impact	Experience and judgment slightly favour one installation type over other
5	Strong impact	Experience and judgment strongly favour one installation type over other
7	Very strong impact	One installation is favoured very strongly over another, its dominance is demonstrated in practice
9	Extreme impact	The evidence favouring one installation type over another is of the highest possible order of affirmation

2,4,6 & 8 can be used to express intermediate values

Table no.9 reflects the summary of perceived responses from each individual expert in the panel on 4 types of roadscapae installations in terms of its visual impact. Accordingly, weighted and rated 4 types of installations are analysed under Built, designed and sensational factors in order to identify its visual impacts and level.

### Ranking results of Roadscape Installations

No	Ranking	Installation category	Installation	
01	High Impact	Outdoor Advertisements	Over bright lit-digital signboards	
			Bill-boards	
			Political & commercial advertisement	
			Banners & Posters	
		Traffic calming Installations	Roadway illumination	
02	Moderate Impact	Traffic calming Installations	Traffic calming features	
		Temporary retail installations	Out of box structures	
			Shop extensions	
		Infrastructure & Service installations	Outdoor AC units/transformers	
03	Low Impact	Outdoor Advertisements	Way guiding installations	
		Traffic calming Installations	Midblock crosswalk	
			road crossing	
		Infrastructure & Service installations	Hanging wires	
			Light poles	



High

Moderate

Low

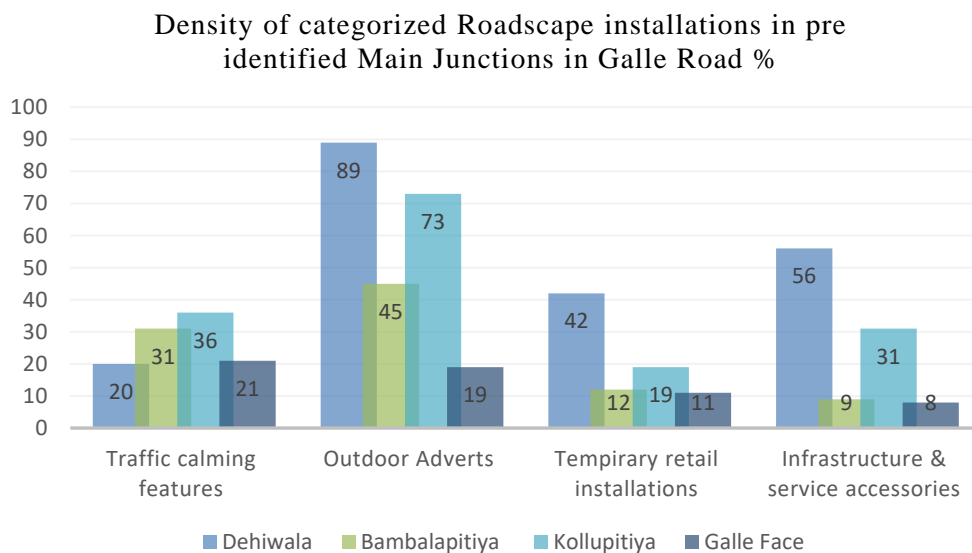
### 5.3 Stage Two –Assess visual impact of Roadscape Installations

150m distance of roadscape section at Dehiwala junction has been selected using criteria that explained in sub-section 4.2.2. In the selection process of detail study area, it was decided to consider majority of commercial land-uses and mix of classified<sup>11</sup> roadscape installations.

Results of pilot surveys for selection of location for detail study.

#### a) Pilot survey results - Density of roadscape installation

Graph 1: Density of pre-identified roadscape installations



As per the above quantitative survey results, Dehiwala Junction has been noted as the high density 4 types of roadscape installations.

#### b) Pilot survey results – User response on identified roadscape installations

<sup>11</sup> Roadscape installations are classified in the section 2

Below chart shows the extracted results from conducted interviews and

Area	Installation	Roadscape	User response
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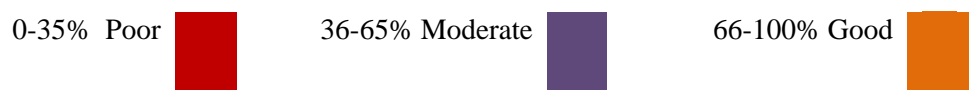
participant/direct observations in Dehiwala junction which has high score in terms of negative visual impacts.

Through the pilot surveys in order to identify the receptors/users response on roadscape installations in terms of visual impacts, Dehiwala Junction from 150m distance as per the map had highly negative response.

After the analysis of above pilot surveys, among 4 junctions which was selected, Dehiwala junction was at the top ranking of moderately affected area due to roadscape installations on visual impact on users.

Therefore, incorporating stage one results, second stage of the detail study was initiated in order to rank and weight the listed and counted roadscape installations.

**Table 16: User response on identified roadscape installations**

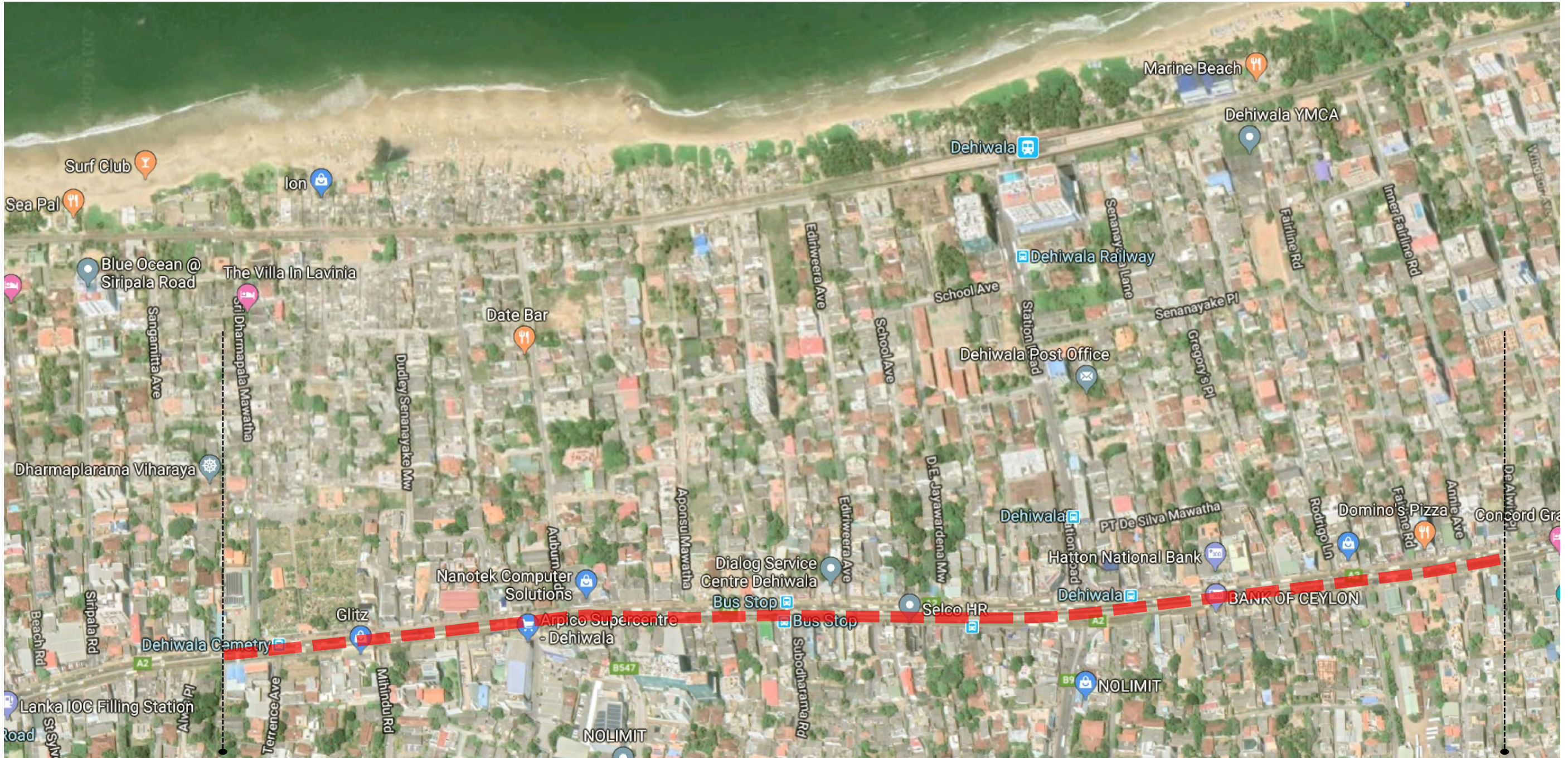


			Day time			Night time		
			Pedestrian	Driver	Motor cyclist	Pedestrian	Driver	Motor cyclist
Dehiwala	Traffic features	Traffic calming features						
		Midblock crosswalk						
		road crossing						
		Roadway illumination						
	Outdoor Adverts	Over bright digital signboards						
		Billboards						
		Political & commercial advertisement						
		Way guiding installations						
		Banners & Posters						
	Temporary retail installations	Out of box structures						
		Shop extensions						
	Infrastructure & service accessories	Hanging wires						
		Outdoor AC units/ transformers						
		Light poles						

### 5.3.1 Detail case study area

With regards to the pilot survey's findings, suitable area was selected where most vibrant performance of roadscape installations take place. Following map shows the detail area in order to conduct the different types of research methods to find to which extent the commercial roadscape installations influence on user safety and comfort.





6.844117, 79.866326

6.854882, 79.865505



**a. Evaluation of Built factors of Roadscape installations in Dehiwala Junction area**

Under built factors, sub- categories<sup>12</sup> of outdoor advertisements, temporary retail installations and Infrastructure & service accessories are evaluated.

**Table 17: Build factors evaluation**

	Description		Built installations in Roadscape											
			Outdoor Adverts					Temporary retail installations		Infrastructure and service installations				
			Bright lit digital adverts	Billboards	Political & commercial adverts	Way guiding installations	Banners & Posters	Out of box structures <sup>13</sup>	Shop extensions	Hanging wires	Outdoor AC units/ transformers etc.	Light poles	Street Night lighting	
Principal Influence Factor of driver-pedestrian safety and comfort	General	Day and Night time rating	D N	D N	D N	D N	D N	D N	D N	D N	D N	D N	D N	
		Type of placement	Fixed on frame, hanging on bars, ground fixture	Top & side hung/ fixed, Ground supported	Fixed on frame, hanging on bars, ground fixture	Top hung	Wall stick, top and side hung	Under umbrella, caravan and mobile structures	Huts and canopies	Over hang	Ground supported and external wall mounted	Ground supports	Ground supports	
		Placement level from ground level	0.5m – 10m	1.5m-4m	1m – 10m	15m	depends	Not certain	Not certain	5m - 6m	3m	-	-	
		Minimum distance between two devices	0.3m min.	0.4m min.	3m min.	7m	Overlapped	-	-	-	-	1m – 5m	3m- 5m	
	Physical features	Visual appearance		Square shaped, 3D	Square shaped, 2D	Square shaped, 2D	Rectangular shaped, 2D	Rectangular & square	3D open structures	3D open structures	Insulated Wires	Box type	Pole	Pole
		Size		2 m <sup>2</sup> to 100 m <sup>2</sup>	0.5 m <sup>2</sup> to 50 m <sup>2</sup>	9m <sup>2</sup> - 125m <sup>2</sup>	50 m <sup>2</sup> - 100 m <sup>2</sup>	0.2m <sup>2</sup> – 10m <sup>2</sup>	1m <sup>2</sup> -5m <sup>2</sup>	2m <sup>2</sup> -6m <sup>2</sup>	-	2m <sup>3</sup> – 6m <sup>3</sup>	0.25m <sup>2</sup>	0.25m <sup>2</sup>
		Animation		X	X	-	-	-	-	-	-	-	-	-
		Colors	Warm bright colors	X	X	X		X	X					
			Cool colors							X			X	X

<sup>12</sup> Sub-categories of 4 types of roadscape installation have been taken in to consideration.

<sup>13</sup> out of box installations are considered as structures which does not covered 100% and install outside of a permanent structure

			Luminous colors				X							
			Black and White							X	X	X		
			Mix of bright and cool colors											
	Text	Presence	Yes	Yes	Yes	Yes	Yes	limited	No	-	No	No	No	
		Clarity							-	-	-	-	-	
Characteristics	Illumination	Presence	Yes	Not all. Some of the billboards	Flash lights to illuminate the boards	No	No	Yes	Yes. Few occasions	-	-	-	Yes	
		Type	HPS	X										
			LED	X	X	X								
			Neon						X	X				
			Low energy prismatic											X
			No Illumination				X	X			X	X	X	
		Colors	White			X								
			yellow	X	X	X			X	X				X
			Orange											
			Other						X	X				
		spacing	Vary											
		Blockage of light reaching ground	Yes	Yes	Yes	Yes	-	No	Yes	-	-	-	-	No
		luminance (cdm <sup>2</sup> )	High	1055	825	734	250		430	320				250
			Low	870	530	253	210		140	260				200
		Average Illuminance (cdm <sup>2</sup> )	962.5	677.5	493.5	230			285	290				225
		Illuminance uniformity ratio	1:1	1:1	2:1	1:1			2:1	1:1				1:1
		Sense of safety	Low	X	X	X								
Medium					X		X	X				X		
High														



		visibility	low				X	-			-	-	-	
			Medium			X			X	X				X
			High	X	X									
		glare	low						X	X				X
			High	X	X	X	X							
		Wasted light	Yes	X	X	X	X		X	X				X
			no											
		Over lighting	Yes	X	X				X					
			no			X	X			X				X
		Light trespass	Yes	X	X	X	X		X	X				
			no											X
		Durability					-	-			-	-	-	
		Fit for use												
		Disturbance to Adjacent land-use/ activity/s												
		View hindrance												
	tolerance	daytime												
		night time												
	Visibility	daytime												
		night time												
		Clarity												
	<b>Functional aspects</b>	Durability												
		Current condition												
		Resistant to micro climatic factors												
		Strength												
		Long term/ short term purpose	Long term	Long term	Short term	Long term	Short term	Short term	Short term	Long term	Long term	Long term	Long term	Long term
	<b>Technical safety precautions</b>	Indicated safety notes	No	No	No	No	No	No	No	No	No	No	No	No
		Safety color code included	No	No	No	No	No	No	No	Yes	No	No	No	No

**b. Evaluation of Designed factors of Roadscape installations in Dehiwala Junction area**

Table 18: Designed factors evaluation

	Description		Built installations in Roadscape					Traffic lights		
			Road intersections and crossings	Tree buffer	Road isle barrier	Midblock crosswalk	Traffic signage			
<b>Principal Influence Factor of driver –pedestrian safety and comfort</b>	<b>General</b>	Day and Night time rating	D N	D N	D N	D N	D N	D N		
		Distance between 2 installations (min)	100m	Linear stretch	continuous line	100m	Depends on the traffic condition	-		
	<b>Physical Features</b>	Visual appearance		White thick paint strips	Square shaped tree bed	Steel framework		2D ion boards fixed on ground	Top hang or ground fixed color lights	
		Size		Road width	0.25m <sup>2</sup>	5m L x 1.6 H		Various	Various	
		Colors	Warm bright colors		X				X	X
			Cool colors							X
			Luminous colors						X	
			Black and White				X			
			Mix of bright and cool colors							
		Illumination	Presence		No	No	No	No	No	Yes
Type	HPS		-	-	-	-	-			
	LED		-	-	-	-	-	X		
	Neon		-	-	-	-	-			
	Low energy prismatic		-	-	-	-	-			
	No Illumination		X	X	X	X	X			
Colors	White		-	-	-	-	-			
	yellow		-	-	-	-	-			
	Orange		-	-	-	-	-			
	Other		-	-	-	-	-	X		

		spacing	-	-	-	-	-	Vary
		Blockage of light reaching ground	-	-	-	-	-	No
		luminance (cdm <sup>2</sup> )	High	-	-	-	-	250
			Low	-	-	-	-	190
		Average Illuminance (cdm <sup>2</sup> )	-	-	-	-	-	220
		Illuminance uniformity ratio	-	-	-	-	-	1:1
		Sense of safety	Low	-	-	-	-	
			Medium	-	-	-	-	
			High	-	-	-	-	X
		visibility	-	-	-	-	-	High
		glare	-	-	-	-	-	No
		Wasted light	-	-	-	-	-	No
		Over lighting	-	-	-	-	-	No
		Light trespass	-	-	-	-	-	No
		Disturbance to Adjacent land-use/ activity/s						
		View hindrance						
	Visibility	Day						
	Visibility	Night						
	Tolerance	Day						
		Night						
	Clarity							
	<b>Functional aspects</b>	Durability						
		Current condition						
		Long term/ short term purpose	Short term	Short term	Long term	Long term	Long term	Long term
		Visibility from distance						
		Resistant to micro climatic aspects						
		Strength						

**c. Evaluation of Situational factors of Roadscape installations in Dehiwala Junction area**

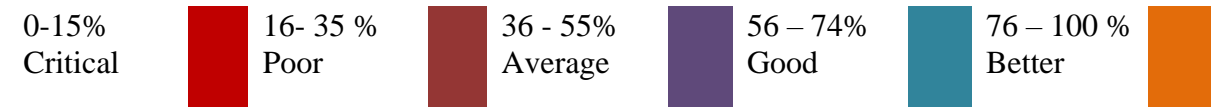
This chart is summary of all questioners, formal and informal interviews from 10 commuters, 5 residents, 4 foreign visitors and 2 local visitors.

Table 19: Situational factors evaluation

Principal Influence Factor of driver –pedestrian safety and comfort	Description	Built installations in Roadscape																
		Outdoor Adverts					Temporary retail installations		Infrastructure & Service accessories			Traffic installations						
		Bright lit digital adverts	Billboards	Political & commercial adverts	Way guiding installations	Banners & Posters	Out of box structures	Shop extensions	Hanging wires	Outdoor service units/ transformers etc.	Light poles	Street Night lighting	Road intersections and crossings	Tree buffer	Road isle installations	Midblock crosswalk	Traffic signage	Traffic lights
User Factors	Tolerance																	
	Visually annoy																	
	Match with sensitivity level																	
	Visibility																	
	Visibility (daytime)																	
	Visibility (night)																	
	Nature of attention																	
	Automatic capture of attention																	
	Attentional biases																	
	Perceptual issues																	
	Eyes-off road roadway																	
	Visual clutter																	
	Readability																	
	perspective effect	No	Yes	Yes	No	No	No	Yes	No	No	Yes	Yes	No	Yes	Yes	No	No	Yes
	Read as a fabric	No	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes
Overall impact for preference																		
Preference level	24.1	18.6	9.4%	59%	8.9%	27.4	32.8	12.7	11.1	14%	36.3	64.5	48%	61%	60.7	27%	69.1%	



Key



#### **5.4.1 Sub-sectioning case study area**

As selected and finalized the detail case study area through three pilot surveys and other related research methods, 1.3km of distance have been divided in to 13 segments in order to conduct detail surveys in accurate and easy manner.

Using an updated satellite map, 13 segments were measured and marked. Accordingly, the detail studies were carried out in each sub sections as per the above figure.

#### **5.4.2 Analytical results of Roadscape installations in Dehiwala Junction area**

With regards to the research methods, analytical studies have been carried out in order to analyse particularly the quantitative set of data and also secondarily the qualitative data and information gathered from direct observations, participant's observations, formal informal interviews etc.

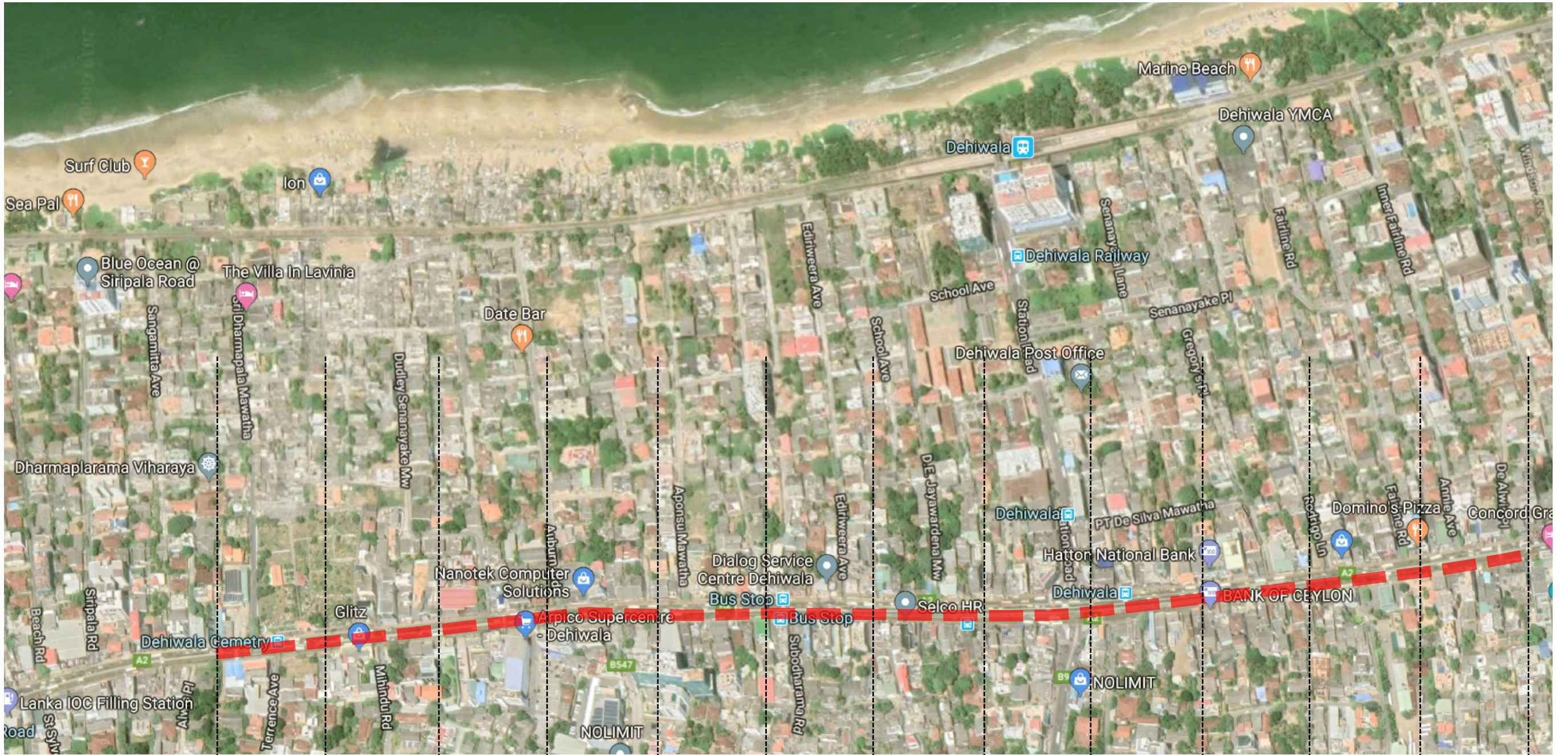
In order to establish the significant discussion between safety, comfort and roadscape installations in commercial roadscape following parameters were analysed.

- a) Illumination characteristics and its behaviour/ performance in terms of user safety and comfort.
- b) Color vibrancy in pre-identified installations
- c) Visibility in day and night time
- d) User tolerance to the performance of pre-identified installations

Following situational factors are the parameters which directly depends on the performance of aforementioned parameters.

- a) Attentional bias
- b) Automatic capture
- c) Eyes off roadway effect

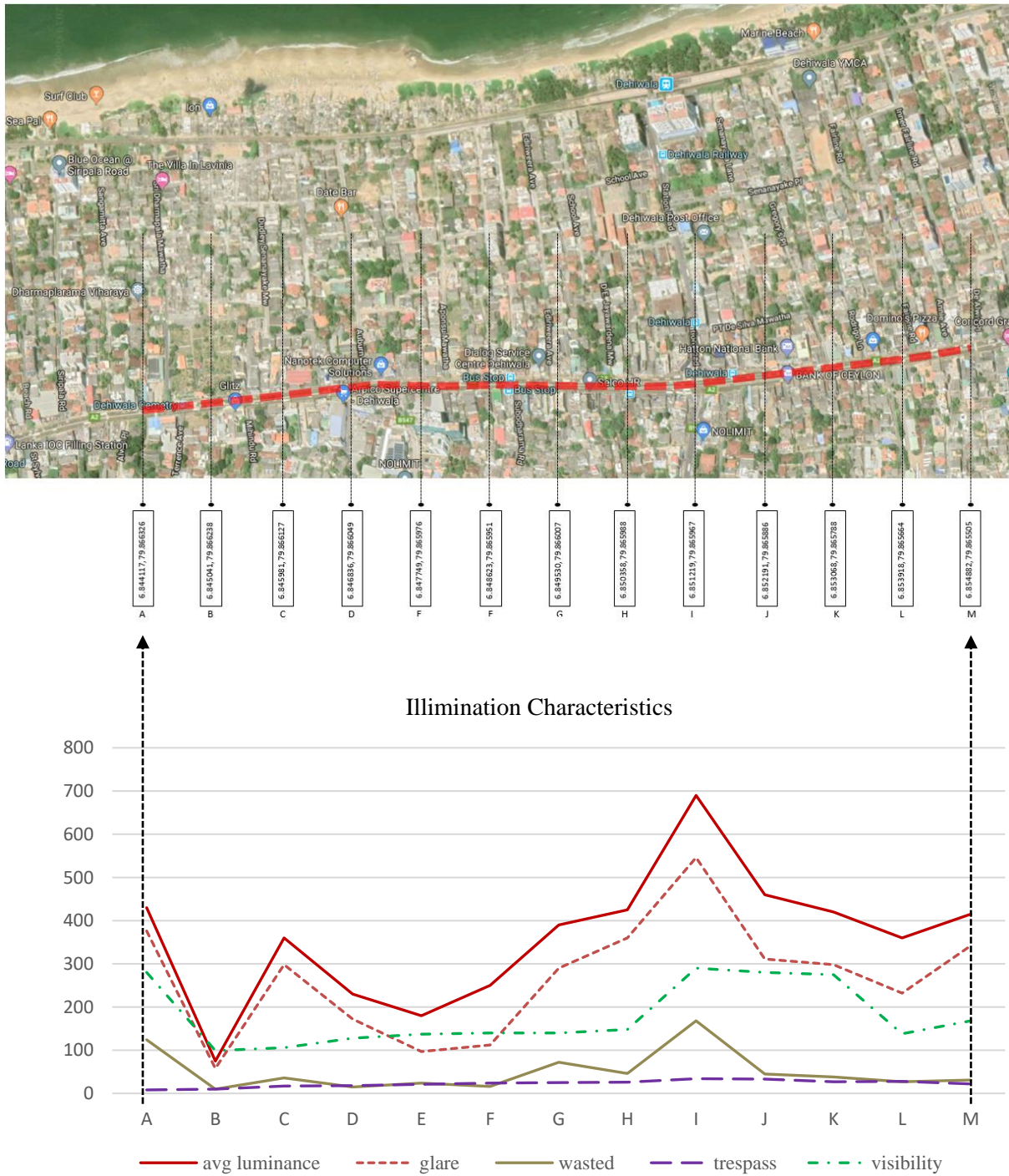




A	6.844117, 79.866326
B	6.845041, 79.866238
C	6.845981, 79.866127
D	6.846836, 79.866049
E	6.847749, 79.865976
F	6.848623, 79.865951
G	6.849530, 79.866007
H	6.850358, 79.865988
I	6.851219, 79.865967
J	6.852191, 79.865886
K	6.853068, 79.865788
L	6.853918, 79.865664
M	6.854882, 79.865505

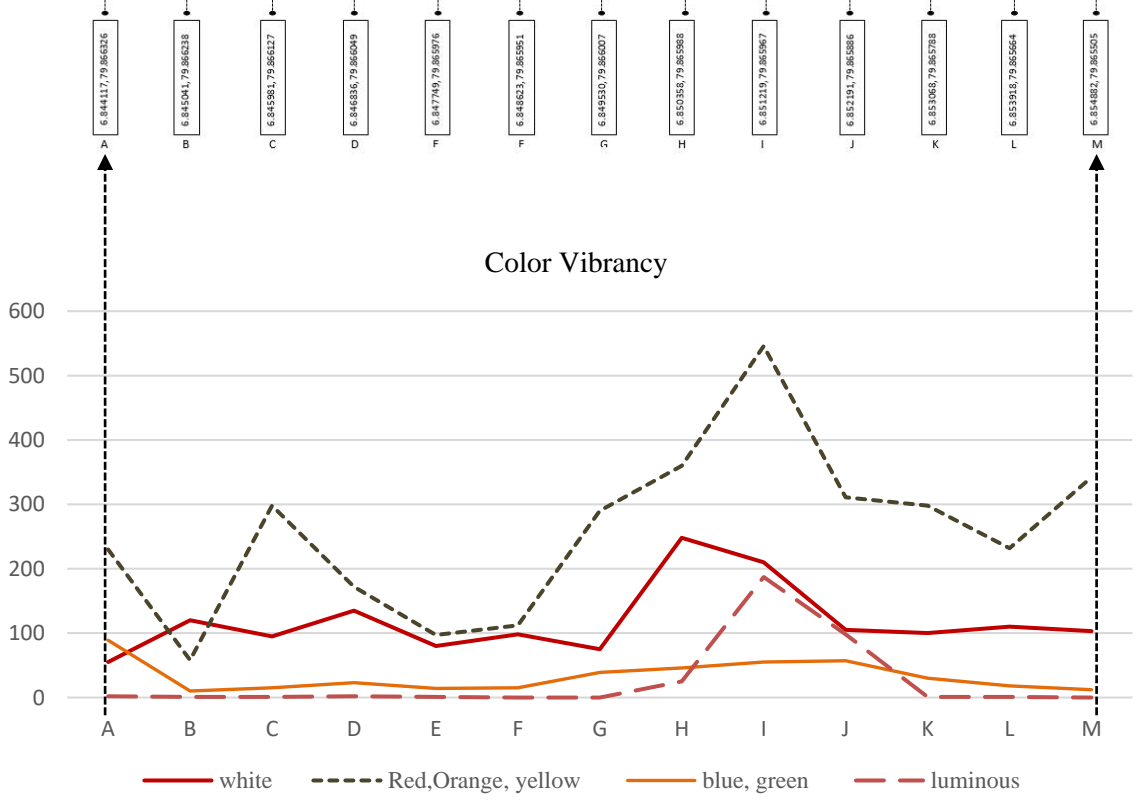
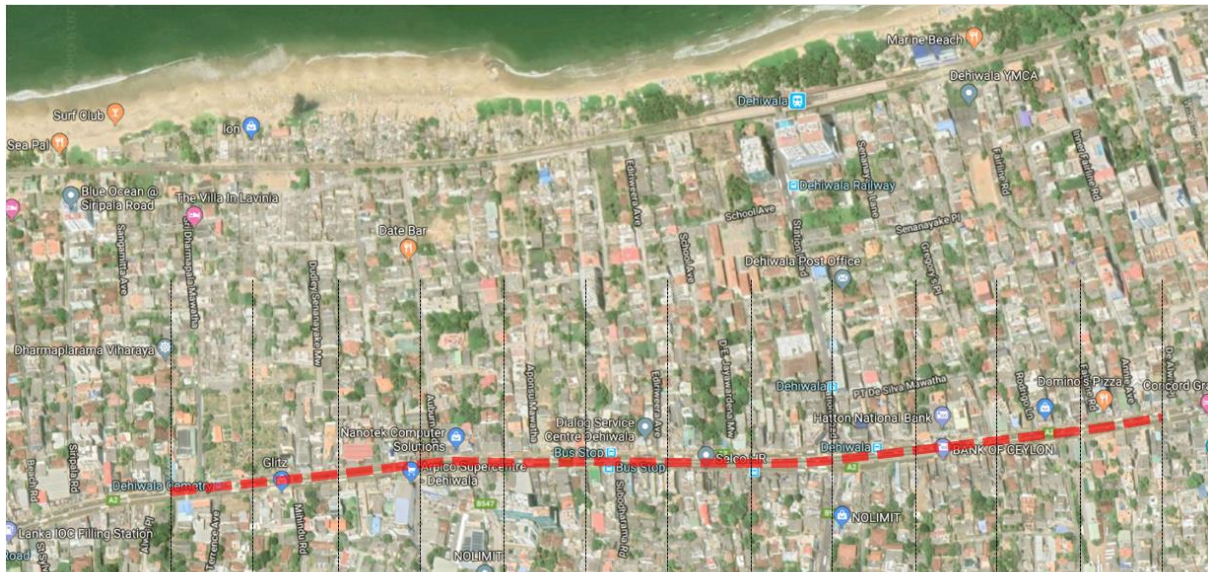


Graph 2: Illumination Characteristics

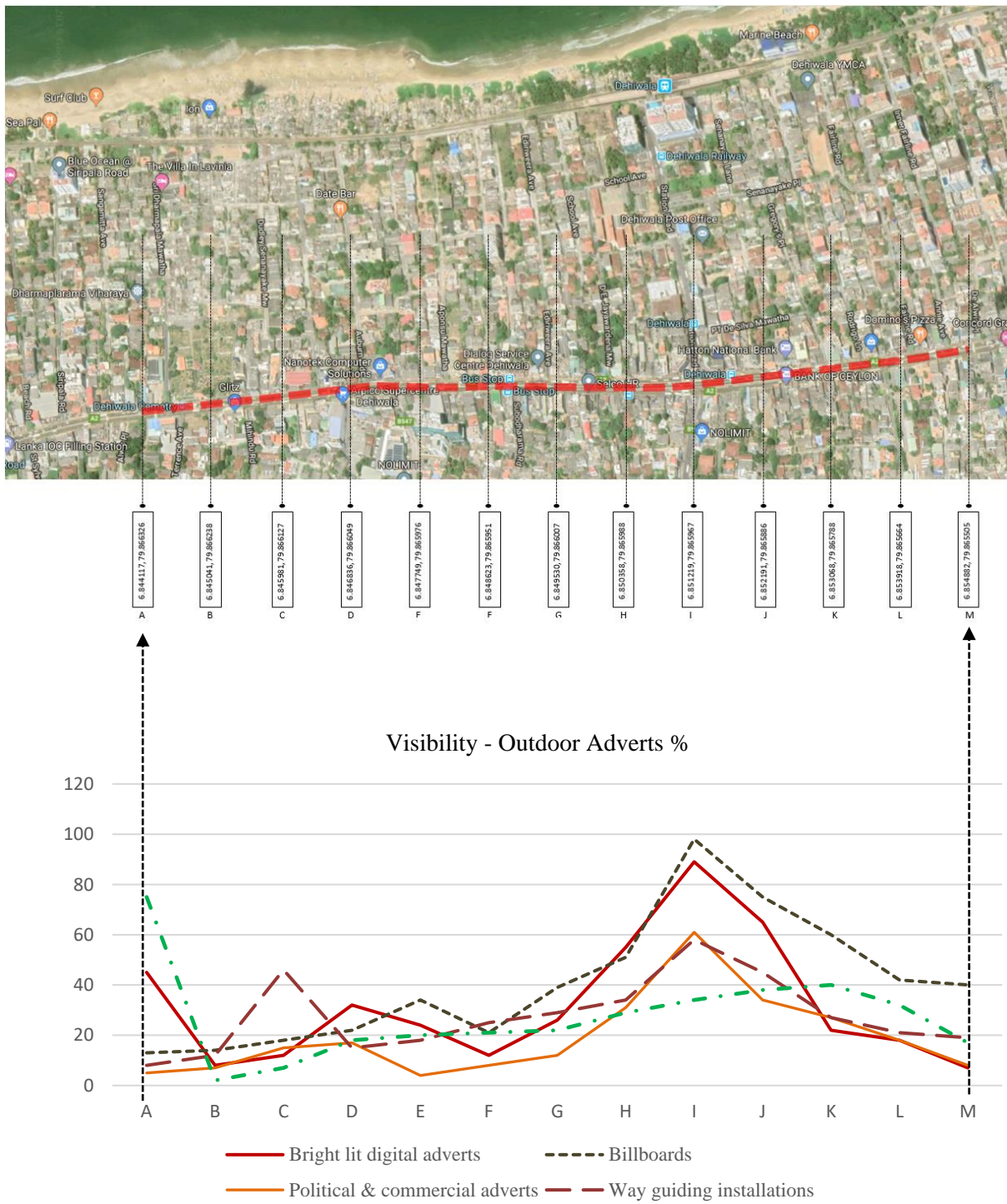




Graph 3: Color Vibrancy

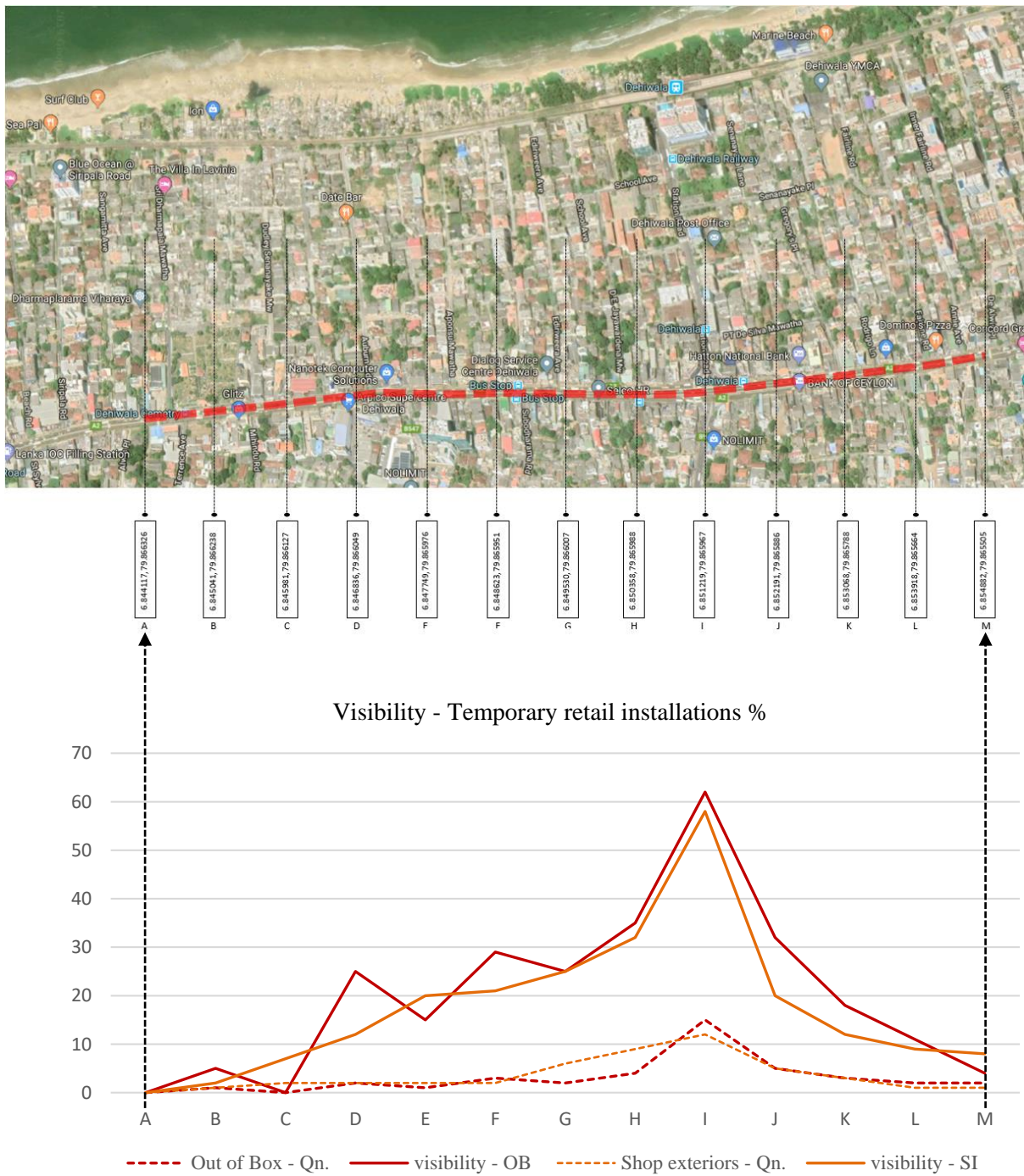


**Graph 4: Visibility of Outdoor advertisements**

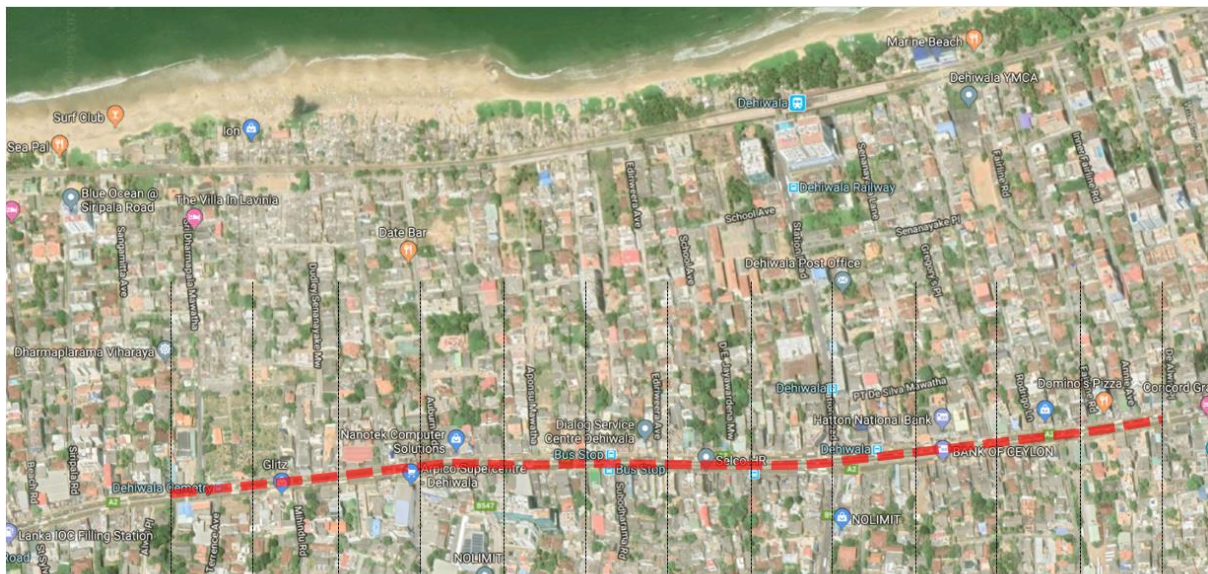




**Graph 5: Visibility- Temporary retail installations**

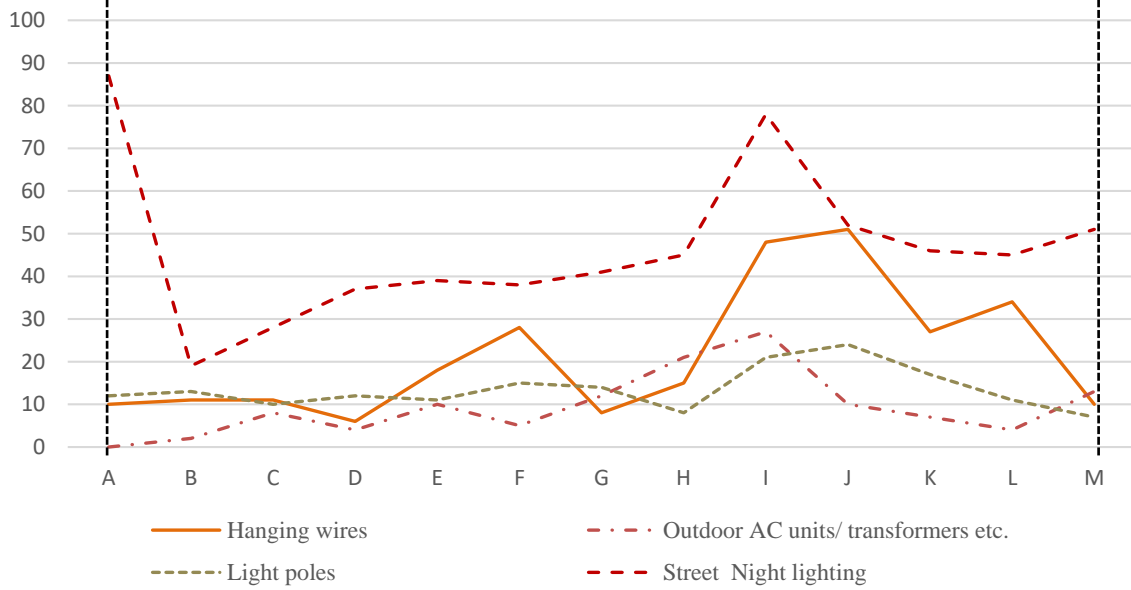


**Graph 6: Visibility- Infrastructure & service installations**



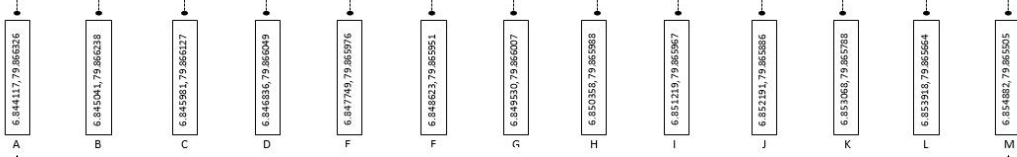
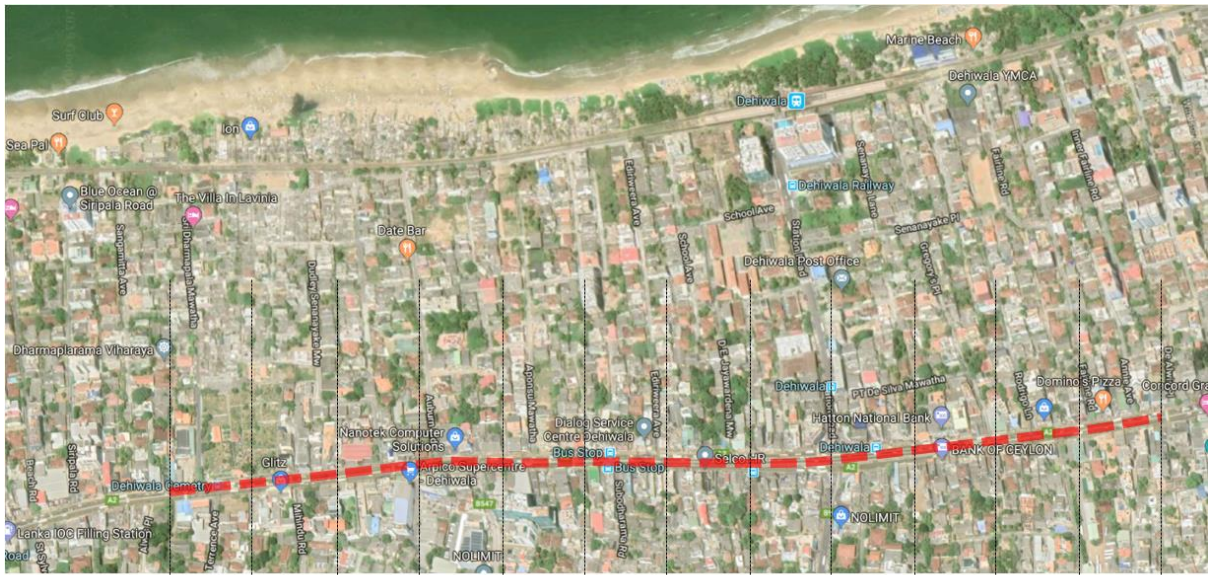
- A 6.844117, 79.866326
- B 6.845041, 79.866238
- C 6.845981, 79.866277
- D 6.846836, 79.866049
- F 6.847740, 79.865976
- F 6.848623, 79.865951
- G 6.849530, 79.866007
- H 6.850358, 79.865988
- I 6.851219, 79.865967
- J 6.852191, 79.865886
- K 6.853068, 79.865788
- L 6.853918, 79.865664
- M 6.854882, 79.865505

**Visibility - Infrastructure & Service installations**

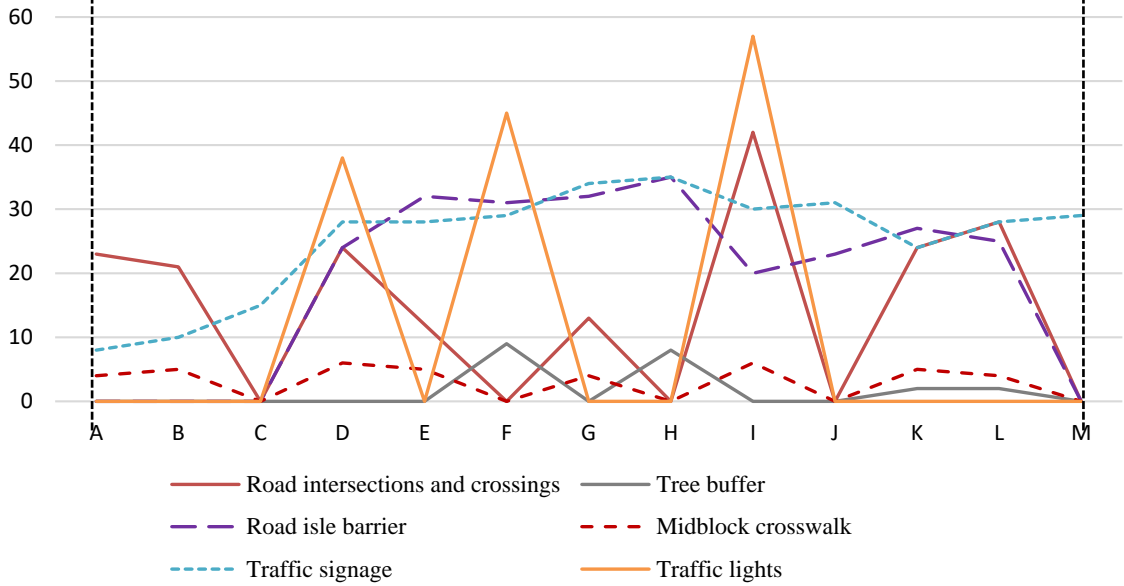




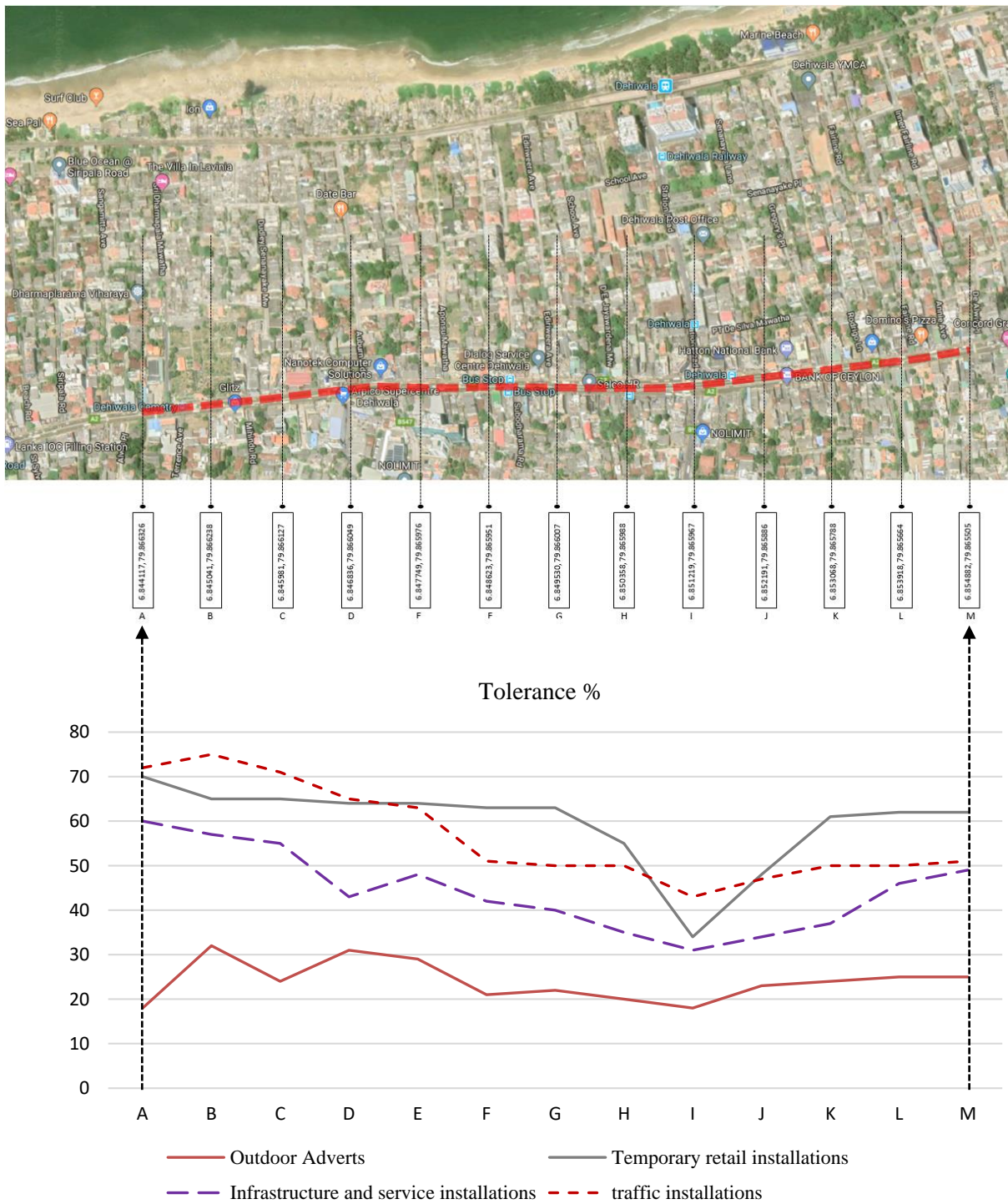
**Graph 7: Visibility- Traffic Installations**



**Visibility- Traffic installations**

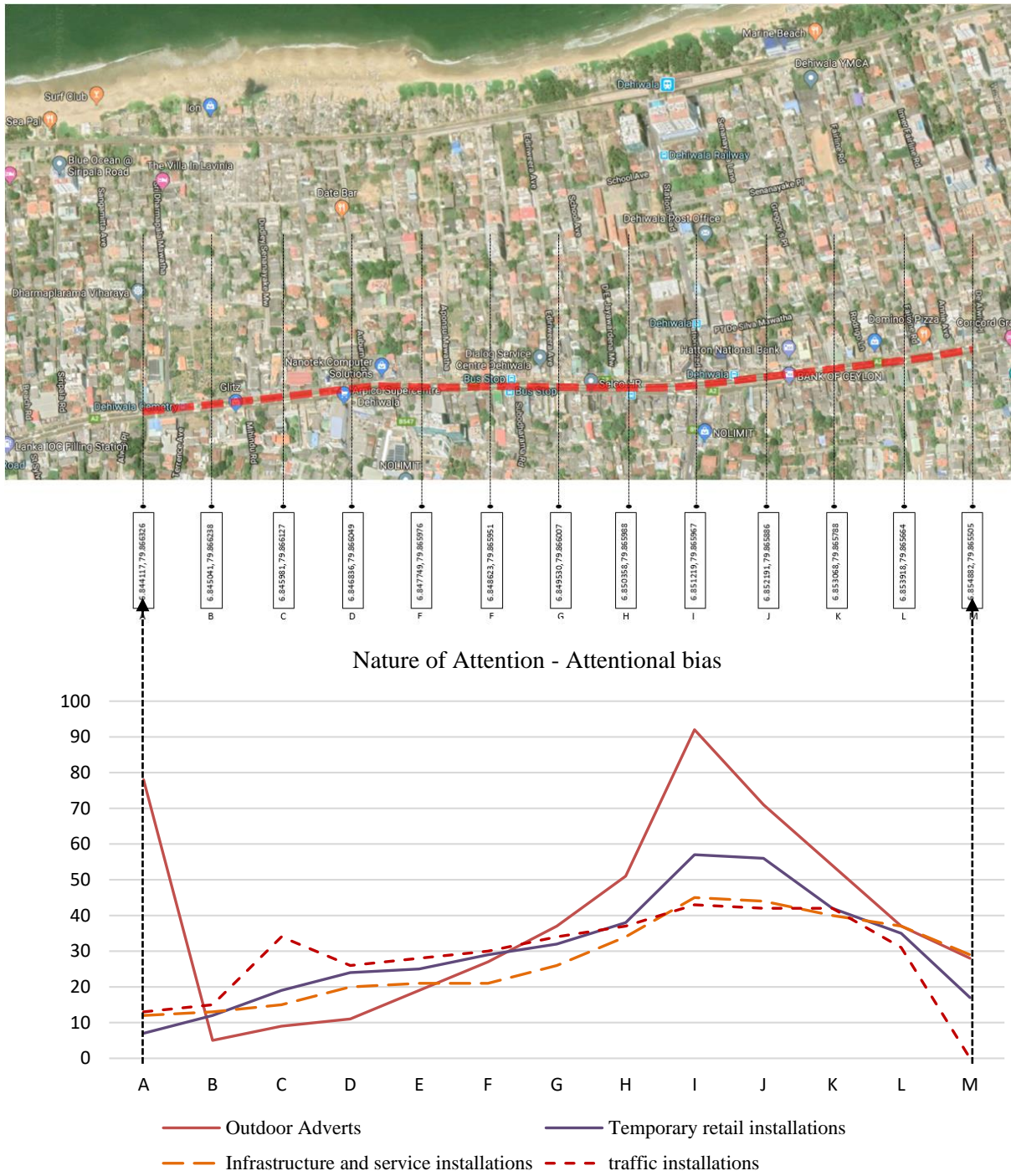


**Graph 8: Tolerance level**

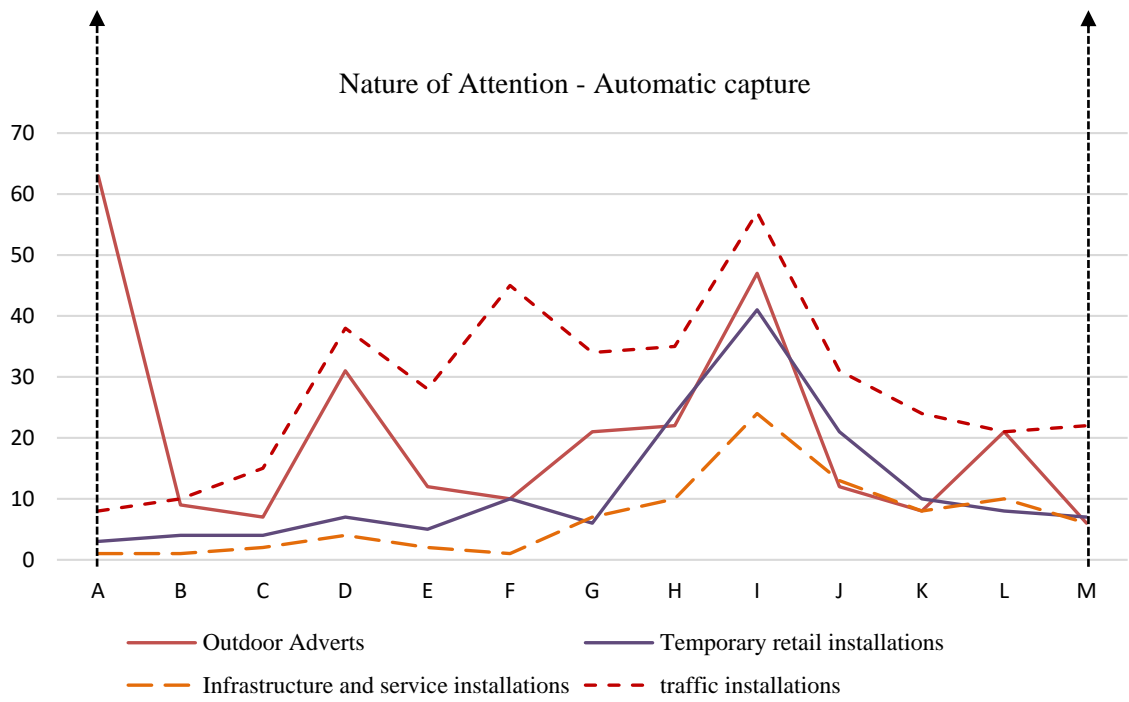




**Graph 9: Nature of Attention- Attentional Bias in commercial roadscape**

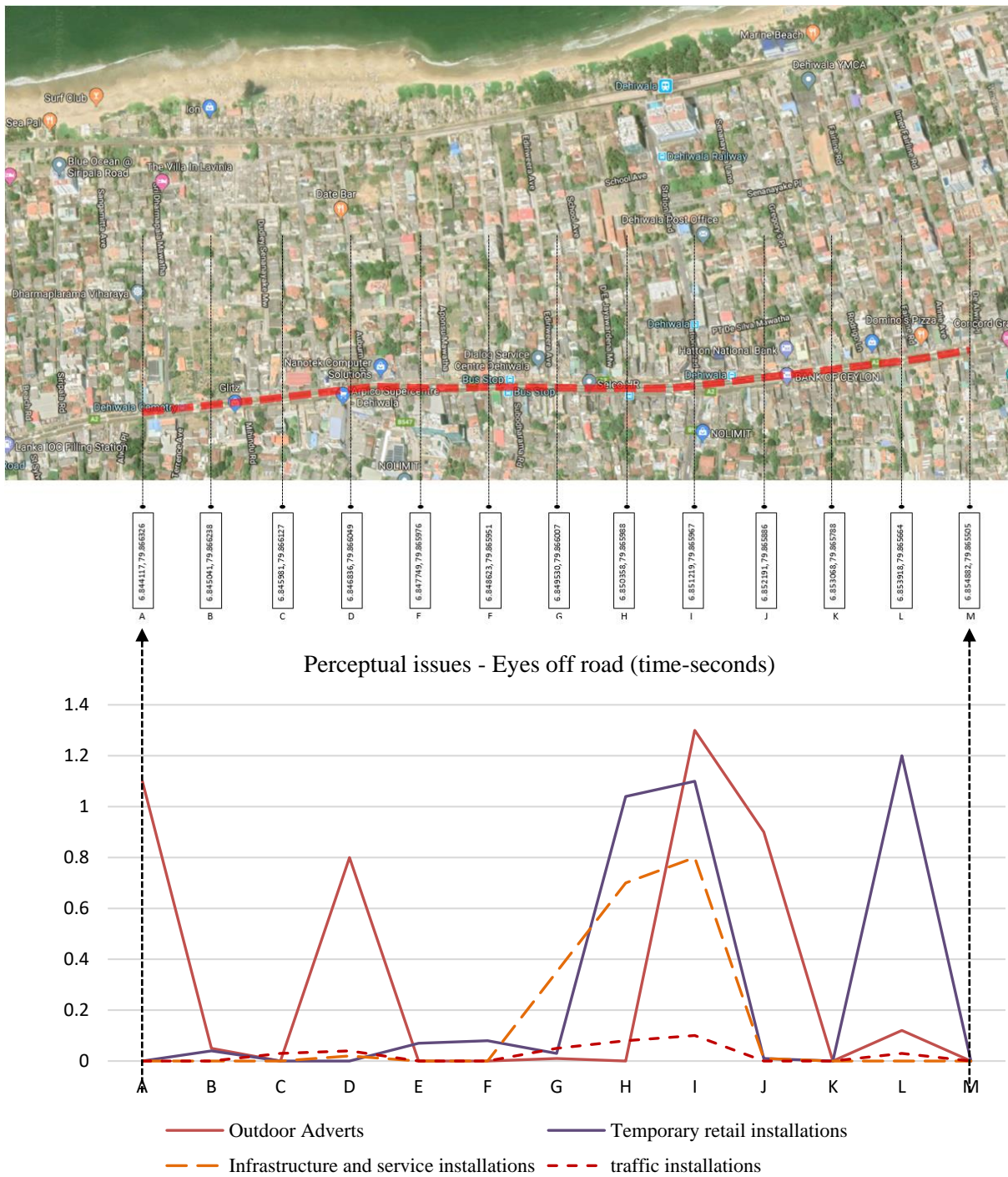


Graph 10: Nature of Attention- Automatic capture in commercial roadscape

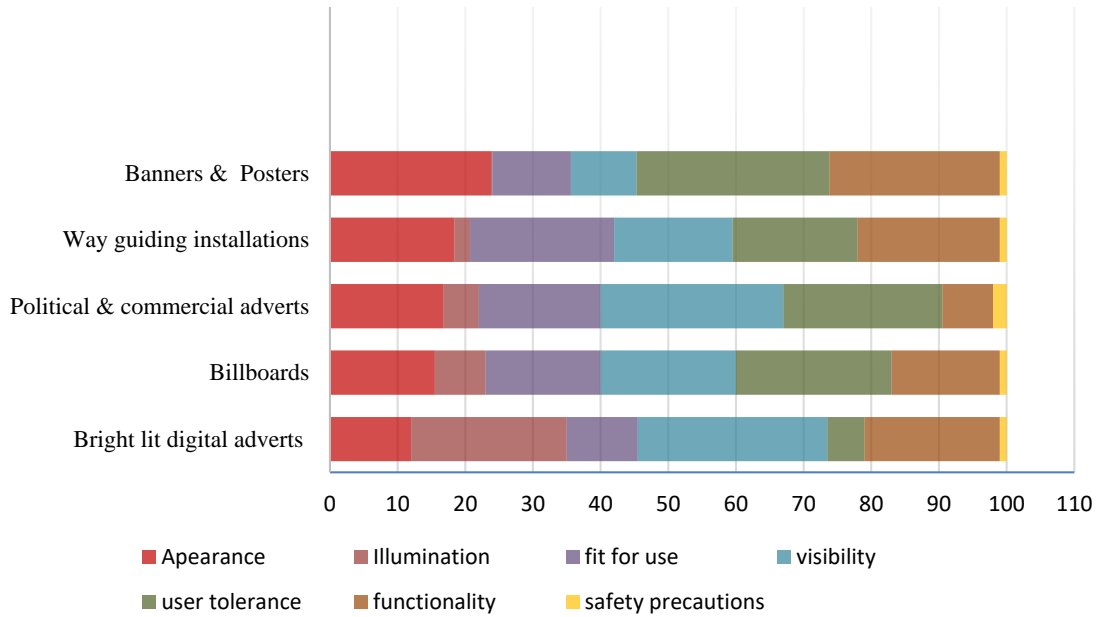




Graph 11: Perceptual Issues - Eyes off road effect



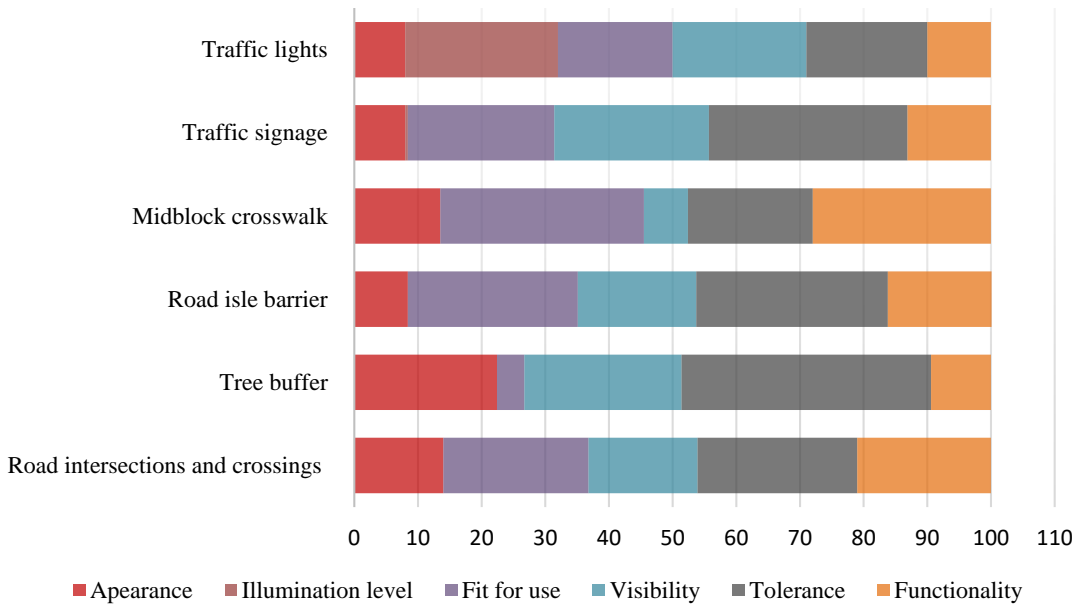
**Graph 12: Overall performance of Outdoor Advertisements in Dehiwala, Colombo**



Gathered information as per the table 10, it was converted to a graph which can be easily compared the magnitude of visual behaviour of built installations. Based on the numerical results, higher magnitude of overall visual performance is noticed in political & commercial advertisements, banners & Posters, bright lit digital advertisements and bill boards. Among the above visual installations, political & commercial advertisements have high influence on user in terms of visual performance.

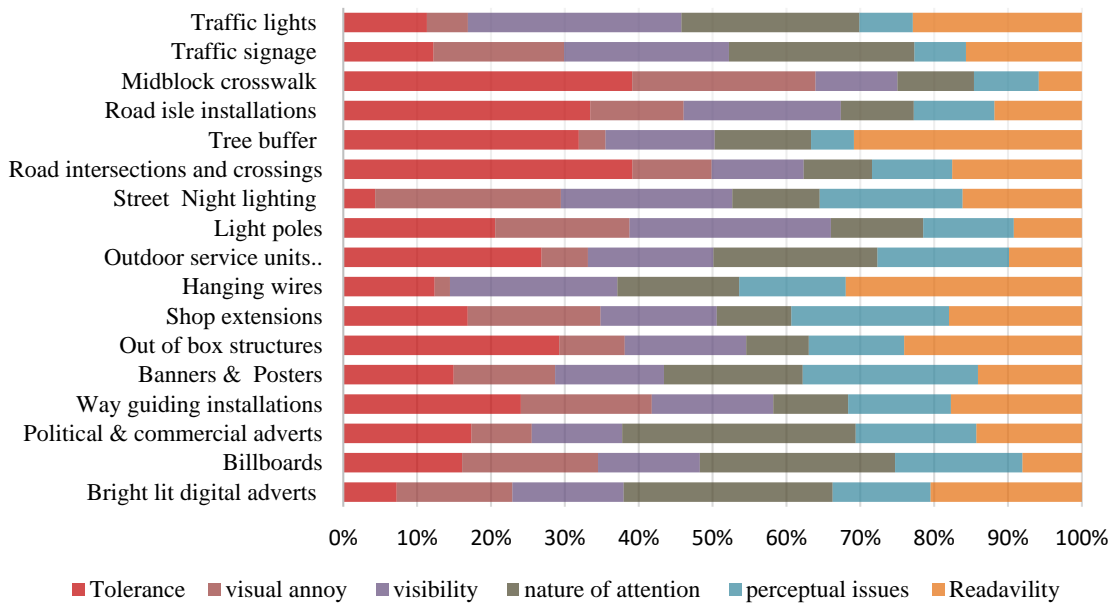
Summary of designed factors of Roadscape installations in Dehiwala Junction area

**Graph 13: Overall Performance of Designed factors in Dehiwala, Colombo**



Considering the overall performance of designed factors, above graph shows that traffic lights has higher visual impact, Road isle barrier and tree buffer have moderate influence and traffic signage, midblock crosswalk and road intersections/ crossing have lower influence on user in terms of visual safety and comfort in selected road section.

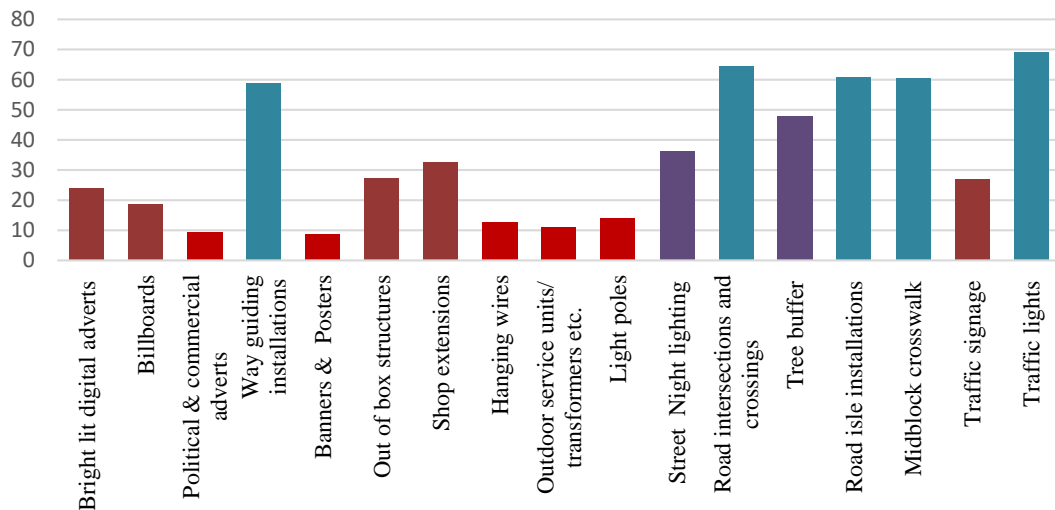
**Graph 14: Comparison of overall performance of Situational factors in Dehiwal, Colombo**



Situational factor is the crucial factors among others which directly reflects the magnitude of comfortability of user. Magnitude and its contribution of 6 major subjective influential factors have been analysed and above graph depicts the final results.

Reversing the method of analysing user responses, above results examined in order to convey the level of user preference level which directly reflects from users.

**Graph 15: User preference level of Build, designed and situational factors in Dehiwala, Colombo**

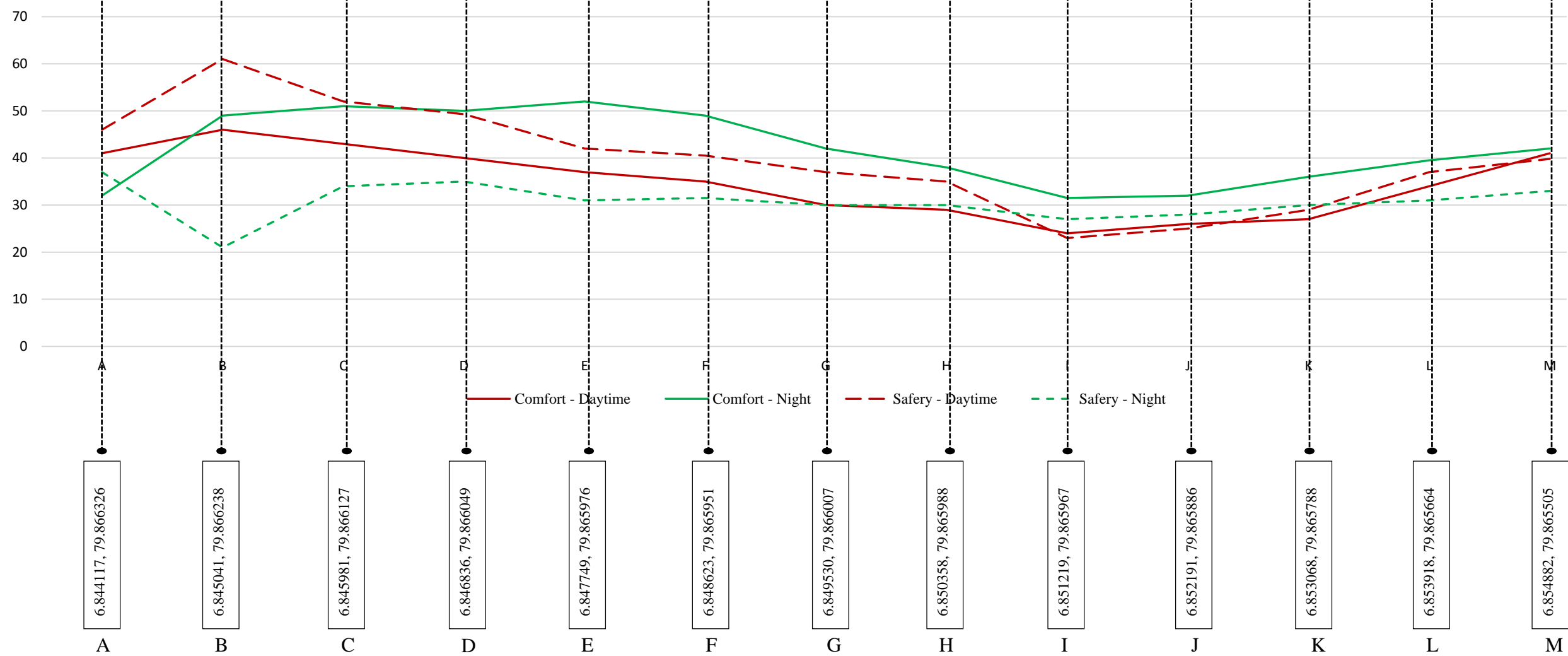
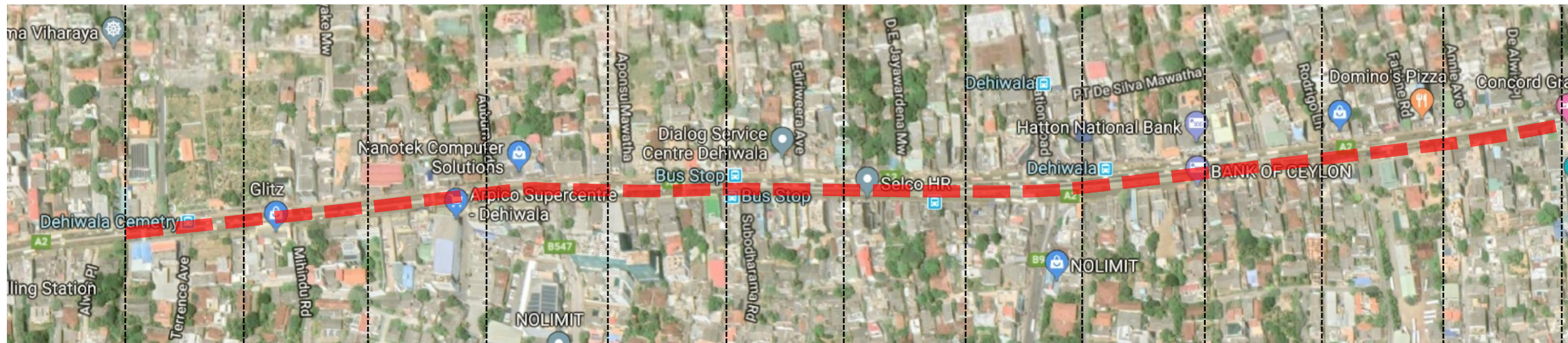


#### **5.4 Roadway and roadside Installations influencing Safety and Comfort in Commercial roadscape in Dehiwala, Colombo**

As the user safety and comfort have been measured in terms of 3 different factors such as build, designed and situational factors in commercial roadscape and it has been reflected with some identified parameters as per the table 17 table 18. The table 19 is consists of subjective parameters which influence on identified parameters in table 17 and 18. In simple terms, values in table 19 depends on the values in table 17 and 18.

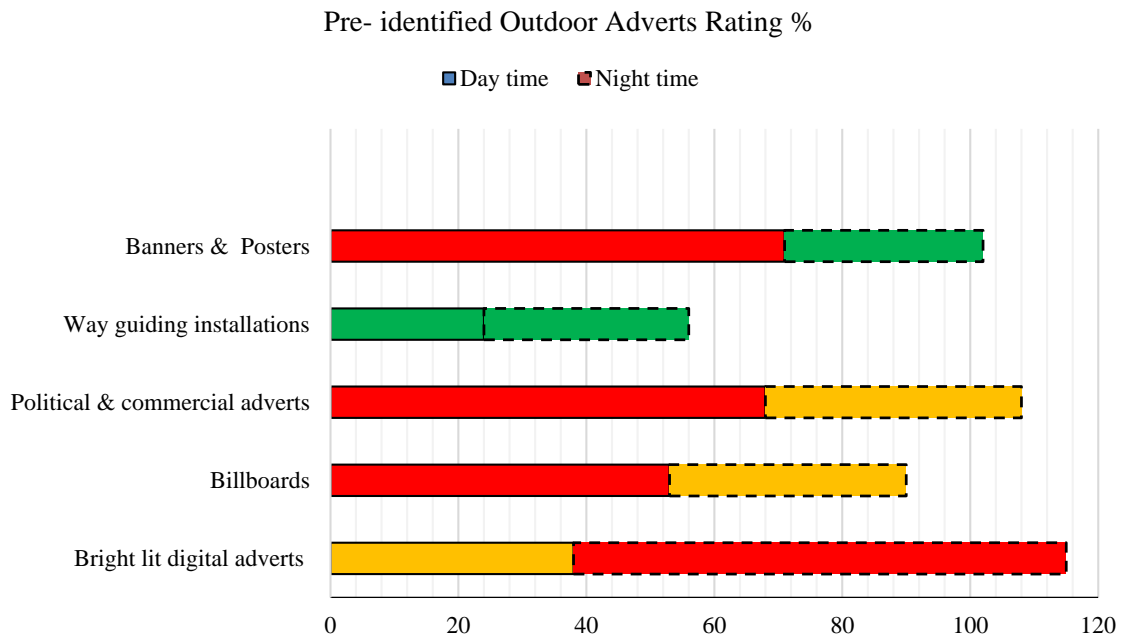
Therefore, results of graph 14 to 16 have been converted in to another version which reflects the level of user safety and comfort due to pre-identified commercial roadscape installations as below.



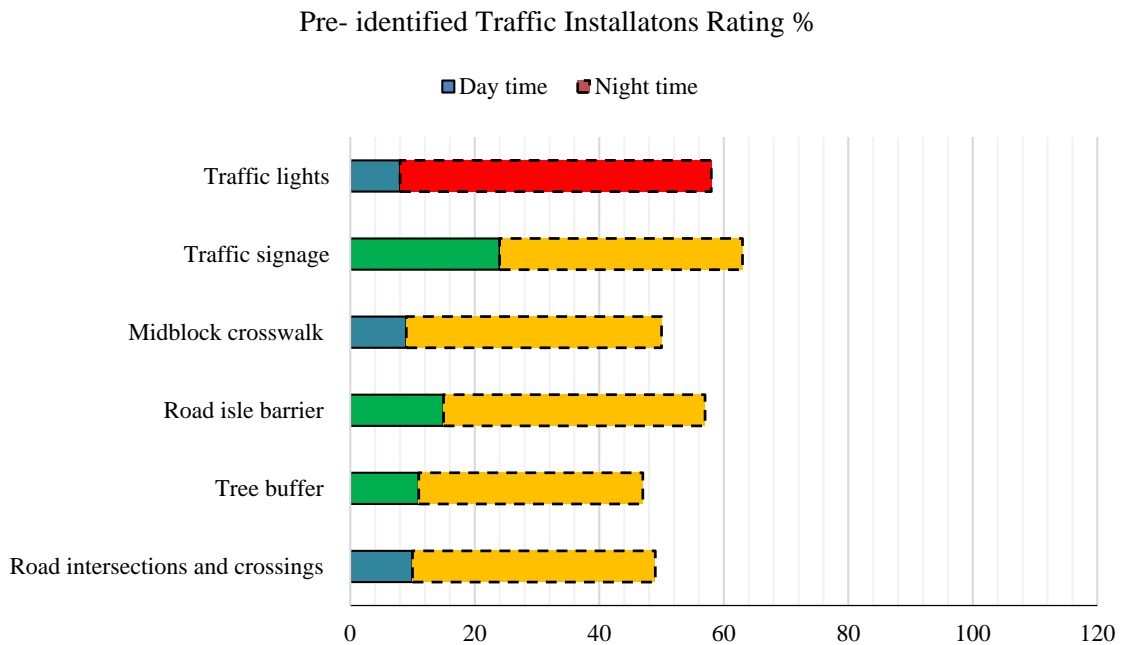


## 5.5. Rating of Commercial Roadscape installations in Dehiwal, Colombo

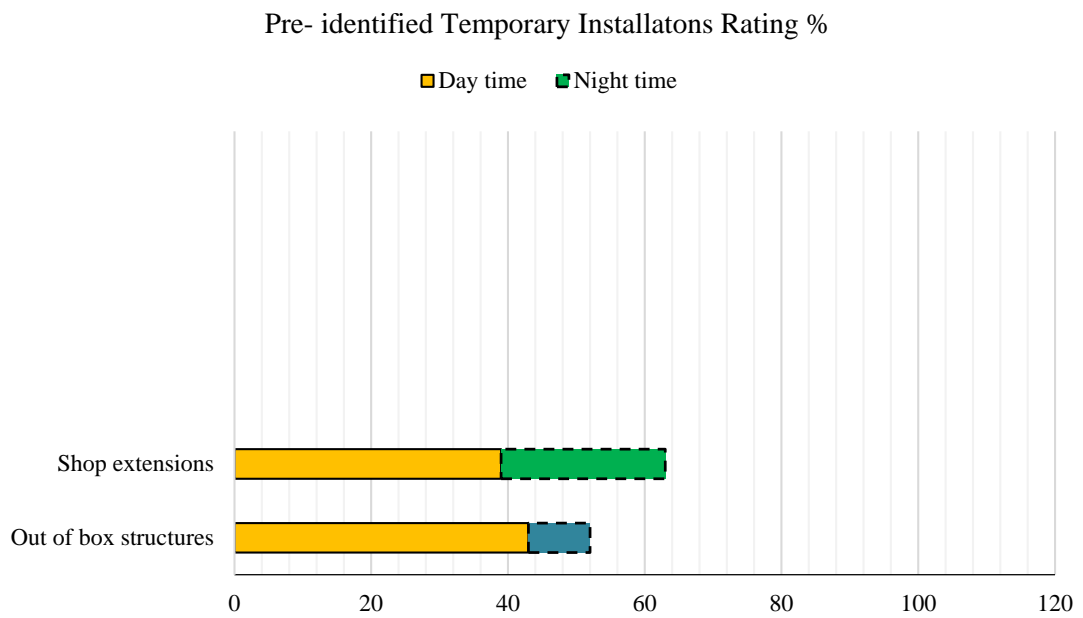
Graph 16: Rating of Outdoor Advertisements in Dehiwala, Colombo



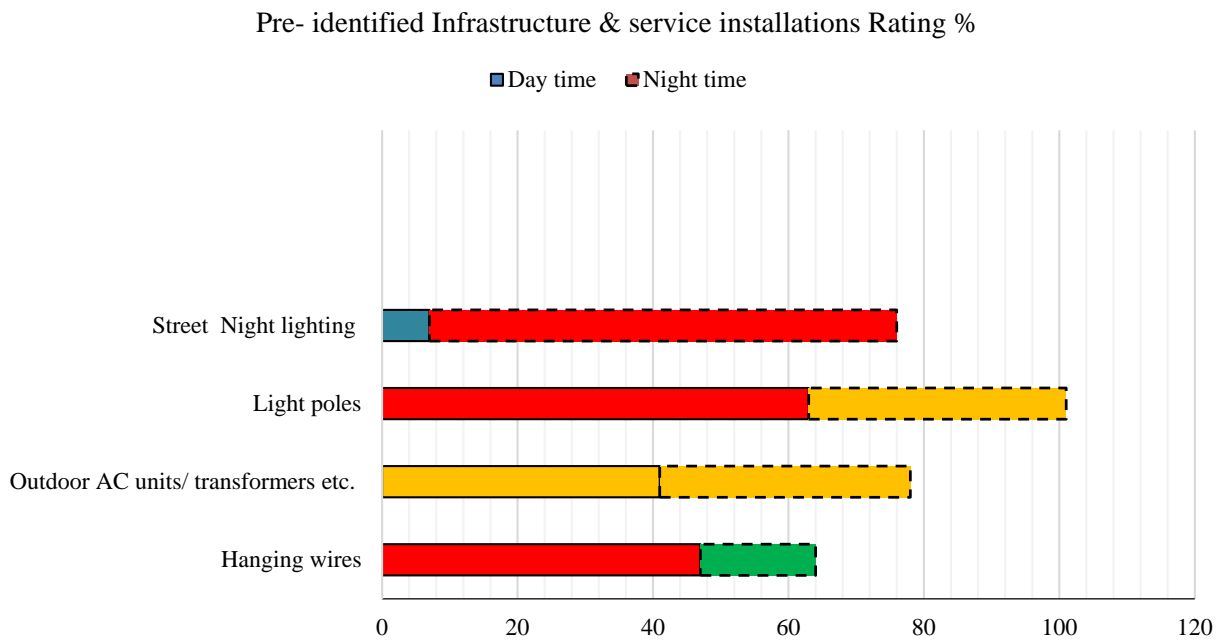
Graph 17: Rating of Traffic installations in Dehiwala, Colombo



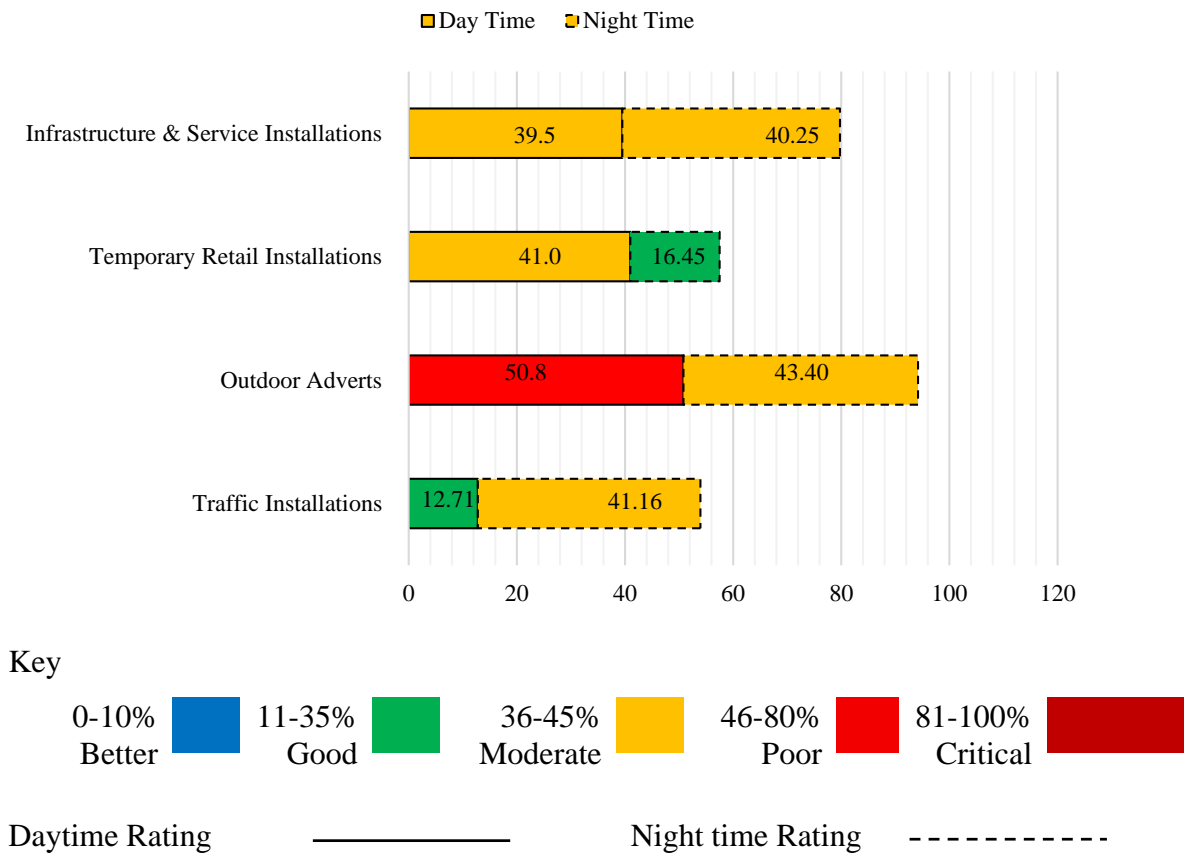
**Graph 18: Rating of Temporary retail Installations, Dehiwala, Colombo**



**Graph 19: Rating of Infrastructure & service Installations, Dehiwala, Colombo**



**Graph 20: Summary of rating of pre-identified Roadscape installations in Dehiwala, Colombo**



Summary of the expert panel responses were converted into bar chart which gives the direct outcome of conducted surveys as above chart.

According to the summary bar chart, among all other pre-identified installations, Outdoor advertisements affects for high magnitude of visual impacts on users in terms of safety and comfort in roadscapes.

Thereof, stage three aims to analyse the impacts of roadscape installations in detail which were rated and weighted.



## CONCLUSION

With the rapid urbanization in around the world, regardless of the magnitude of the development are resulting poor urban design qualities and physical features and behaviours which contribute to dearth of balanced and harmonious relationship between individual aspect in urban system even though they acknowledge planning and development of the built environment targets.

As a result, visual aspects as a tiny particle in the urban system is now being a causation for psychological and physical disabilities of user irrespective to their gender and age. Hence, it is a responsibility for scholars to identify and analyse the issue and then provide proper recommendation also, practitioners should apply those recommendations in practice.

Accordingly, based upon the research gap between roadside and roadway installations and its impacts in terms of visual characteristics, this study has examined the visual influence caused by the roadscape installations particularly in commercial roadscape which has been currently neglected in the urban environment. Prior to determine the visual impacts, research method has been designed by author in order to achieve the targeted objectives through three stages. Firstly, identify visually degraded commercial roadscape, then review and rate roadscape installations and finally, assess the impacts of ranked and rated visual installations for public safety and comfort.

The research was conducted under certain limitations in order to analyse gathered data, information through different research methods and finally to accomplish the research target.

Following results were picked in terms of build, designed and situational factors which have direct or indirect influence on urban safety and comfort.

- i. There is a direct relationship between commercial activeness and distribution of visual installations.

- ii. Situational factors depend on the build and designed factors in commercial roadscapes.

#### Build factors

- i. Build factors have high performance in commercial roadscapes. And, designed factors have fairly equal distribution along the commercial roads.
- ii. Designed factors have high visibility and lower user tolerance. Among the identified designed factors, outdoor advertisements are intentionally designed in order to get attraction. Therefore, users have attentional bias and eyes off roadway causing road accidents and other physical damages.
- iii. As a strategy build factors are concentrated in the agglomeration of commercial activities are take place which ultimately creates chaotic situation in terms of visual atmosphere.
- iv. Continuous layer of homogenous visual installations causes for visual clutter and monotony which has high magnitude of eyes off road effect once the user points highly contrasted visual installation.

#### Designed factors

- i. Traffic signage installations has steady visibility behaviour from A to M. other designed factors have deep fluctuations depending activeness of the place in terms of commercial activities.
- ii. Tolerance to the designed factors are higher rather build factors irrespectively to the commercial activeness.
- iii. Users have high attentional bias and automatic capturing capacity to the traffic lights rather rest of the designed factors.

Accordingly, tiny space for breaking road rules is lower even in the commercially active spaces.

- iv. Specially for the drivers, designed factors have negligible effect on eyes off roadway compared to the build factors which is a positive hint for low road accidents due to designed factors.

- v. Users have high sense in order to automatically capture the traffic installations rather build factors which have high visibility due to size, colors etc.

In the meantime, it was identified that there are few contractions over the analysis. Accordingly, following results will be an opportunity for further studies in terms of urban psychology and other related research grounds.

- i. Thus the users are highly sensitive to automatically capture the traffic installations but moderate attentional bias.
- ii. Build factors contribute to its high rating in terms of overall performance thus causing negative roadscape physical impacts, users are attracted to build factors especially outdoor advertisements and over bright lit advertisements.

In addition, the current global trend is towards a sustainability oriented planning and development. Therefore, city planning and designing should address all aspects in urban system collectively rather addressing individually. Accordingly, visual atmosphere is one of the segments in urban system, this research can be incorporate in order to prepare a model to assess urban comfort, safety and security of public realm focusing sustainable development.

As urban design is purely related to the urban system where all living and non- living beings exist, the results of urban system based researches and the practice should be aligned and incorporate prior to prepare policies, regulations, guidelines etc.

Finally, it is important to prepare proper guidelines and regulations specially for build factors in order to maintain the beauty of the city as well as mental and physical well-being of users.

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## ANNEXURES

Annexure 1: Summary of literature referred

KEY AREAS	RESEARCH CONSIDERATIONS	REFERENCE LITERATURE TITLE	AUTHOR	YEAR	FACTORS CONSIDERED
Physical Factors	01 Hazard survey	Evaluation of validity of two research methods for studying perception of road signs	Ann Arbor, Michigan state University	1985	<ol style="list-style-type: none"> <li>1. Described the road characteristics including road geometry, operations, environment and driver behavior related to accidents</li> <li>2. identified geometry elements common to all sites/areas</li> <li>3. identified the locations of above elements in entire road system</li> <li>4. classify the locations of above geometric elements as hazardous</li> <li>5. developed road designs or criteria to reduce hazards.</li> </ol>
	02 Roadscape research elements	Evaluation of validity of two research methods for studying perception of road signs	Ann Arbor, Michigan state University	1985	<ol style="list-style-type: none"> <li>1. Visibility of individual physical factors, the hierarchy of perceived elements or visual complexity of what is seen</li> <li>2. identified the relationship between colors in signs and detectability is typical of research on individual factors</li> </ol>
Behavior study	01 Eye movement patterns	An evaluation of diagrammatic signing using time laps photography	Hanscom F. R	1973	<ol style="list-style-type: none"> <li>1. studied the eye movement patterns during the driving experience</li> <li>2. identified how they respond to the particular colors, lights and figures along the roadway and roadside</li> </ol>
Psychological considerations	01 User factors considerations - perceptual issues	Autoroads research report: Impact of roadside advertising on road safety	Paul R. K. B	2013	1. Automatic capture attention & Attentional biases
		Contemporary ergonomics: Route guidance systems: a comparison of methods of presenting directional information to the driver, in Lovesey	Parks A.	1990	2. Limited capacity of attention
	User factors considerations - Described Nature of attention	The impact of driver inattention on near –cash/cash risk: an analysis using the 100 car naturalistic driving study data report	Klauer S.D	2006	1. Eyes off road
		Age differences in visual search for traffic signs during a simulated conversation: Human factors	McPhee L.S	2004	2. Visual clutter

Mapping techniques	01	Projective and reflective mappings	Viewshed simulation and analysis: an interactive approach	Fels, J.E.	1992	<ol style="list-style-type: none"> <li>1. Projective mappings are initiated from viewpoints within the development (inside looking out) while reflective mappings are initiated from viewpoints in the surrounding landscape (outside looking in).</li> <li>2. projective mapping is to reveal the extent of visibility of the development to its surroundings. The objective of reflective mapping is to determine whether, and to what extent, the development is visible from its surroundings.</li> </ol>
	02	Single and cumulative mappings	Viewshed simulation and analysis: an interactive approach	Fels, J.E.	1992	<ol style="list-style-type: none"> <li>1. Single viewpoints are useful in evaluating the effects of a specific component of the development. The use of multiple viewpoints produces composite intervisibility maps; true cumulative mapping is more useful than mapping from a predetermined set of points</li> </ol>
	03	Colour coded impact maps	Viewshed simulation and analysis: an interactive approach	Fels, J.E.	1992	<ol style="list-style-type: none"> <li>1. One version of such as evaluation can yield a qualitative impact, ranging, for example, from beneficial and benign to harmful and disastrous. You can produce an impact map using an evocative colour coding scheme, e.g. red for bad, green for good, yellow for neutral.</li> </ol>

Annexure 2: Summary of surveys conducted

RESEARCH STAGE REPRESENTS	TYPES OF SURVEY/INTERVIEWS ETC.	PURPOSE OF THE SURVEY	SURVEY DETAILS	
			PARTICIPANTS/GROUPS	NOS OF PARTICIPANTS
Stage 01	Observations using photographic resources and direct observations	To identify the types of roadscape installations	Researcher – scientific observations with a checklist	01
	Pilot surveys	01 To finalize the category types of roadscape installations	Urban design/planning/ Architecture	30
		02 Rank the identified and listed installations in terms of density	Urban design PG students, Masters Students and Architecture undergrads from University of Moratuwa	30
	Validation	03 Verify and validate the ranked installations	Panel of experts in Planning and Urban design (professionals and practitioners)	05
Stage 02	Pilot survey – observations	01 To Identify suitable case study locations which have visual impacts from the user view point	Researcher – unscientific observations without a checklist	01
	Pilot survey - Informal interviews to roadscape users	02 To identify suitable case study locations which have visual impacts from the user view point	Pedestrians –Local Pedestrians –Foreign Drivers Motor vehicles	12
	Validation	03 Establish the case locations	Urban design/planning/ Architecture Urban design PG students, Masters Students and Architecture undergrads from University of Moratuwa	30

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Panel of experts in Planning and  
Urban design (professionals and  
practitioners)

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