THE IMPACT OF STREETSCAPES, ON VEHICLE USERS: INSIGHTS FROM GANNORUWA – PERADENIYA ROADS IN SRI LANKA

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Abstract

A good road system that is pedestrian friendly and free of chaos is always a sign of a well-designed town or city. The surrounding environment of the road networks which are the structural features, referred to as the streetscape, plays a major role in defining the identity of roads, streets, and places which is important for attracting visitors and making the city user-friendly. The visual quality of this streetscape, in particular, can have a major impact on a vehicle user's attitude by giving them varied feelings towards the roadway, which can lead to more relaxing or stressful states.

This study aims to determine the effects of the natural environment and built environments on the visual quality of streets and their impact on vehicle users. The complexity level, imageability, and sense of the environment are observed in two selected roads in Kandy both of which have different visual qualities with streetscape elements. The "locomotion method" and an online questionnaire are used to collect data on the street elements and vehicle users' opinions and behaviours.

The findings reveal that over 80% of vehicle users choose reduced complexity and higher imageability levels of a streetscape above the sense of the region, which gives the streetscape its uniqueness. Streets with a low level of complexity help to reduce stress among drivers and passengers during heavy traffic hours. The study further shows that an open landscape, a clear sky view, and fewer tree obstructions are the positive environment variables that contribute to visual quality and a better streetscape.

Keywords: Visual Quality, Streetscape, Complexity, Imageability, Sense, Vehicle Users

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Introduction

The human visual system plays a pivotal role in enabling individuals to effectively navigate and interact with the surrounding environment. (Sivak, 1996) found that 90% of all information used while driving is visual, emphasizing the importance of good vision for safe and appropriate driving. The visual quality of the streetscape also plays a significant role in drivers' behaviour and mental state. Providing pleasant streetscapes can reduce stress and improve relaxation for both drivers and passengers, leading to safe and enjoyable rides. The visual quality of a streetscape is composed of various elements that can affect drivers' mental state.

The visual quality of a streetscape can impact driving behaviour. In recent times, many roadside issues have been resolved through the implementation of traffic measures and guidelines for drivers. However, without addressing the attitudes of drivers, it can be difficult to change their behaviour. The aesthetic design of a road, or a unique characteristic of a roadway, can be used to change drivers' attitudes and improve traffic flow, as well as increasing road safety and the overall environment. When evaluating the character of a streetscape, planners often use terms such as "sympathetic," "compatible," "historically significant," and "sense of place." However, these descriptions are subjective and can lead to debate and over-democratization of public spaces. Some of the major characteristics that affect the quality of a roadscape include coherence, imageability, simplicity, visibility, maintenance, naturalness, integration, contrast, variety, aesthetics of flow, legibility and orientation. These characteristics are largely influenced by visual factors such as the built and natural landscapes in the street. The appearance of road shoulders, hardscape elements and softscape elements, their distance to the road, and the placement of trees all have an impact on drivers' mentality and can influence their choice of roadway. Additionally, these factors can improve driving conditions and reduce discomfort caused by traffic congestion. It is suggested that if these three visual factors (vehicular traffic, natural and built environment) are harmoniously related, it can create a relaxed environment that positively impacts the mental state of drivers and passengers.

Aims and Objectives

The Environmental Planning and Assessment Act (1979) defines streetscape as the character of a locality defined by the “spatial arrangement and visual appearance of built and landscape features when viewed from the street” (Tucker, Ostwald and Chalup, 2004). This research will explore the impact of three main visual factors on vehicle users' mentality:

- natural landscape
- built environment
- vehicular traffic congestions

This will be done by considering a specific location with different visual qualities represented by different visual factors as mentioned above.

The main objectives of this research are to understand the impact of visual factors on vehicle users, identify behavioural changes in drivers and passengers by considering various visual factors in a specific location, discuss ways to mitigate traffic, promote road safety through enhancing the streetscape visual quality, and address passengers' need for a relaxing ride while also considering the impact of visual quality on their experience.

Connection Between Street and Landscape

Streets are an essential part of an urban environment and contribute significantly to a city's liveability (Cavalcante *et al.*, 2014). They are designed to facilitate people's transportation (Marusi, 2004)and the movement within these spaces contributes to the overall liveability of a city. Streets play an important role in every town and city by serving as a directing pathway to build or natural destinations and displaying the environmental quality of the area to the public. Studies have shown that roads are one of the most common forms of landscape approach and frequently provide an initial image of the landscapes a person visit, emphasizing their significance in daily lives. (Junta da Andalucia, 2009 as cited in Blumentrath and Tveit, 2014)) Additionally, streets are not evaluated as individual designs within an urban or suburban area, but rather as a part of the surrounding landscape. In a street, landscape values include natural and cultural aspects, as well as their composition, organization, dynamics, and relationships, as perceived by individuals and society. Therefore, landscape values are a unique form of all the possible uses in spatial development processes. (Marusi, 2004)

Streetscape Elements and Their Visual Impact

The research, conducted by (Tucker, Ostwald and Chalup, 2004) examines the concept of streetscape and its impact on urban planning. The study, published in the journal "Urban Design," found that the quality and character of a streetscape are influenced by the surrounding landscape and the spatial arrangement and visual appearance of built and landscape features viewed from the street. The authors cited the Environmental Planning and Assessment Act (1979) and (Yumpu.com, nd)in defining streetscape as the natural and built landscape of the street, and the importance of designing streets to reflect the character of the context to attract or distract the public.

(Fukahori and Kubota, 2003)claims that the streetscapes include road paving, street furniture, greenery, and buildings along the road. The authors also mention that the road structure, background, human activities, and underground structures and utilities are important elements that make up a streetscape and control the cost and visual quality of a design. The authors also cited (Sauter and Huettenmoser, 2008)and (Sivak, 1996),(Crundall, 2015)to emphasize that increasing the quality of streetscape features in an urban setting would help to prevent or reduce social issues that arise in an area and for vehicle users, as majority of the information used in driving is visual, maintaining better visual quality in a streetscape would motivate for healthier, safer and satisfying ride for drivers as well as passengers

The research, conducted by (Tang and Long, 2019), (Cavalcante *et al.*, 2014), (Harvey,2014), (Gibson and Crooks, 1938), (Phillips and Sagberg, 2013), (Antonsen, 2009) and (Abele and Moller, 2011)examines the impact of streetscape elements on the visual quality of a street from a vehicle user's perspective, and how it affects their behaviour and perception. The study found that streetscape elements can be divided into two main categories: static or fixed elements (natural elements such as trees, turf, shrubs, borrowed landscapes, soft shoulders, water bodies, etc., and built elements such as buildings, shops, residencies, billboards, hard shoulders, etc.) and dynamic or non-fixed elements (pedestrians and vehicles). It also highlighted that visual quality and service quality of street spaces are known to influence people's behaviour in urban environments, and that designing human-oriented street spaces can increase attraction towards streetscapes. Additionally, it highlighted that while moving through a streetscape, visual factors such as natural elements, architectural patterns, colours, forms, materials, and their arrangement, and their changes with the movement of the vehicle can impact the mentality of vehicle users towards a

roadway. They also noted that the driving speed increases when there are no trees or when driving through open landscapes, and that the colour contrast, which creates a mental illusion in the driver's mind, affects the speed of the vehicle while going through soft shoulder areas more than hard shoulder areas

Enhancement of Safety through Visual Quality

According to (Abele and Moller, 2011), (Gibson and Crooks, 1938), (Antonsen, 2009), (Appleyard and Lintell, 1972), (Tucker, Ostwald and Chalup, 2004) and (Blumentrath and Tveit, 2014) improving the aesthetics of a road or improving a unique characteristic for a roadway can change the driver's attitude, leading to safer and healthier driving patterns, and also that the surrounding environment can change the vehicle speed by creating "self-explaining" and "predictable" ways. It also highlighted that from a safety standpoint, the surrounding landscape should be one of the major considerations for a safe driving, as human activities have both physical and psychological impacts. Additionally, it explained that the visual quality of streetscape can change the stress and relaxation levels of drivers, and that the characteristics that affect the quality of a streetscape are built-up with visual factors like built and natural landscapes in the street, such as the appearance of road shoulders, hard landscape elements and soft landscape elements, and the distance and placement of trees.

Theoretical applications in describing visual quality of a place

Cities can be represented diagrammatically as a collection of characteristics that distinguish distinct portions of the urban fabric, and the streetscape character analysis tries to achieve the same thing on a much smaller scale (Tucker, Ostwald and Chalup, 2004).

According to Blumentrath and Tveit (2014), they have identified 12 visual characteristics and variables to analyse the visual character of streetscapes through literature surveys. These characteristics are considered in this research to evaluate the visual quality. Three characteristics were selected from them to formulate the theoretical framework of the research.

i. Imageability

It is the ability of objects in a city setting to make a significant impression on a viewer based on their shape, color, and placement. (Tucker, Ostwald and Chalup, 2004) , (Banai, 1999a) state that clarity of visual organization and streetscape elemental arrangement are key variables in determining the imageability. A streetscape with high clarity and arrangement will have a higher imageability, while low clarity and arrangement can make it difficult for vehicle users to navigate.

ii. Sense of place

(Shamai, 1991) defines "sense of place" as a concept that encompasses attachment to place, national identity, and regional awareness, and reflects subjective perceptions of society. Robinson (2006) adds that sense of place is comprised of intangible features that are crucial to understanding the notion of sense of place. These factors can be divided into two main criteria:

- natural/environmental sense,
- socio-cultural sense,

but typically, the natural sense of a place is preferred by people. The final two variables, character/significance and intangible quality variances, are within the theoretical area of "sense".

A streetscape's character should reflect the uniqueness of an area. As the streetscape is often the first impression a vehicle user has when entering a town or city, maintaining sense along a streetscape is important to make a positive impression. This can be developed in two ways, as outlined by (Shamai, 1991) and (Robinson,2006). One is by highlighting the unique topographical characteristics of an area and the other is by emphasizing the socio-cultural or architectural sense of an area through a dramatic streetscape design.

In addition, sense of place and imageability connect with each other and create a clear perspective of the specific place in the driver's mindset. For example, a tree or a specific recognizable natural feature that appears in an open area can help define the depth of a space while a landmark made by a structural element or related to a cultural aspect can facilitate orientation and mental mapping of a route. (Kaplan & Kaplan, 1989; Lynch, 1960, as cited in (Antonson *et al.*, 2009).

iii. Visual Complexity

A measure of visual complexity is the rate at which usable information is made available to the viewer, or the rate at which noticeable distinctions change. Depending on how variations are gradually revealed, walking down a street can feel repetitive, frightening, or familiar. Discrepancies stand out against a familiar background and contribute to complexity when the streetscape is visually homogeneous with only minor variations. (Tucker, Ostwald and Chalup, 2004); (Banai, 1999); Lynch, 1960) Local contrast and spatial frequency are the two characteristics that influence visual complexity. When there are more contrasting objects in the streetscape, and when there is a greater frequency of change, the stress level of vehicle users may increase, and the space's clarity will be lost. (Cavalcante *et al.*, 2014)

Theoretical framework

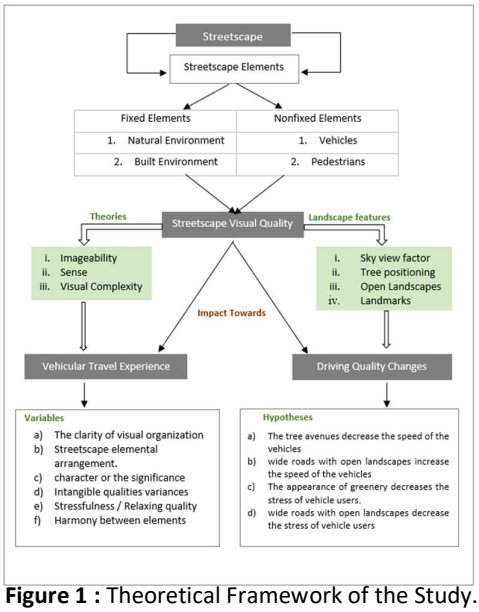

Figure 1 : Theoretical Framework of the Study.
Source: author

The research paper categorizes streetscapes into two types based on their physical structure or character: fixed elements and non-fixed elements, as shown in Figure 1. Proper implementation of "streetscape design theories" can effectively arrange elements or maintain existing landscapes. The study focuses on the impact of visual changes in streetscapes on vehicle users, using streetscape design theories and literature as the two main components.

The study employs three major theories, namely imageability, visual complexity, and sense, to analyse six selected variables' impact on the vehicular travel experience, as outlined in Figure 1. These three theories will be applied to the streetscape designs to evaluate their impact on the mentality of drivers and passengers.

The paper aims to collect and analyse data on how changes in landscape features affect the driving experience of drivers and passengers, as depicted in Figure 1. Selected landscape features for this purpose include sky view factor, tree positioning, open landscapes, and landmarks, as mentioned by Abele and Moller (2011) and Tucker, Ostwald, and Chalup (2004). Five hypotheses were formulated by considering these physical landscape features, along with a literature survey.

Natural settings can reduce stress (Antonson et al., 2009; (Abele and Moller, 2011), open landscapes that are not too expansive can be perceived as calming and safe. The positioning of trees and greenery beside the streetscape can also reduce stress for drivers, but the positioning of trees, their canopy changes, distance, and other factors can affect the level of relaxation for vehicle users. The appearance of the sky, views and vistas are also considered in these hypotheses, made from the selected landscape features (Tucker, Ostwald and Chalup, 2004).

Methodology of the Study

As this study is focused on analysing the visual quality factor which affects towards the vehicle users, the study method is basically carried out as a mixed method of qualitative data collection analysis and quantitative measurements to rate some of the areas along the streetscape and to check some behavioural changes with vehicles.

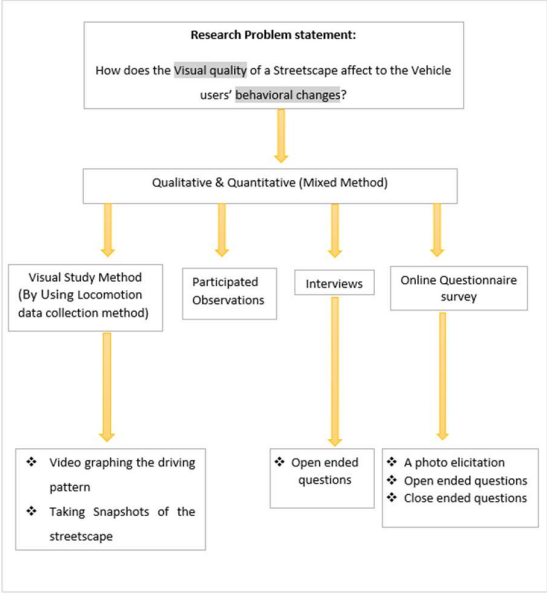

Figure 2. Identification of the Research Study Methods and Formation.
Source: author

As mentioned in Figure 2, this mixed data collection is done by using four main methods and they are, Locomotion Study Method, Participated Observations, Interviews, Online Questionnaire Survey.

Locomotion Study Method

This research employed a visual study method that utilized a mobility facility to conduct observations and interviews while riding in a vehicle. The study involved several drivers as participants, with observations and interviews conducted as passengers in the vehicles. The resulting visual experiences and observations can be used to identify changes in the visual quality of the streetscape and recognize the behavioural patterns of vehicle users in response to changes in the streetscape environment. The method involved observing 10 drivers and recording their vehicle speed changes and road selections, which proved highly useful in identifying practical impacts. Given the focus on the movements and impacts of vehicles on users, conducting surveys while moving through roadways is beneficial for collecting more practical data.

Along with that, the interviews are also done by asking drivers free opinions on the two selected road ways.

Data Collection

The research involved ten drivers, for participant observations of two selected streetscapes - Peradeniya Old Road and Gannoruwa Bypass Road - to analyse their visual quality and impact, providing them with guidelines before the ride, including the freedom to choose their path and speed. Videography and snapshots were used to record drivers' speed changes and streetscape changes in every 30 seconds. The survey was conducted during severe traffic on Peradeniya Old Road, during the day, with similar conditions for all participants. Participants were not classified by age or gender and were all familiar with the selected roadways. The study was conducted by a researcher with a partner's help.

In addition, an online questionnaire was created based on preliminary data and a theoretical framework. Interviews were conducted using open-ended questions about selected landscape features, and an online questionnaire survey was conducted with 70 participants, using a combination of open and closed-ended questions to identify the impact of streetscape visual quality on vehicle users. The study surveyed and interviewed 10 drivers

The questionnaire was divided into three sections based on the theories of visual complexity, imageability, and sense to analyse fluctuations of these theories along the streetscapes.
In Section 1, eleven photographs of each road were shown to participants and they were asked to rate the visual quality based on six criteria, which represented visual complexity and imageability.

a) Stressfulness
b) Relaxing quality
c) Clarity and order / Arrangement
d) Harmony in between landscape elements
e) clearness of the road for the driver / Recognizable level

Representing Visual Complexity

Representing Imageability

In this section, the photographs are given for the participants to rate by using a Likert scale.

Likert scale is used to collect data via questionnaires in order to measure attitudes and ideas. People's satisfaction with the above-mentioned criteria, are added in this scaling system. (Likert, 1932) By taking the average of all responses, the final answers were formulated.

Section 2, is based on hypotheses and selected landscape features (see Figure 1) It includes two types of questions: The study focuses on qualitative measures, making open-ended questions useful for analysing different users' ways of thinking. Closed-ended questions were used for qualitative analysis.

Section 3, is based on a series of questions related to the "Sense" factor, to identify the idea of the users with responds to natural/environmental sense and socio-cultural sense.

Selected streetscapes

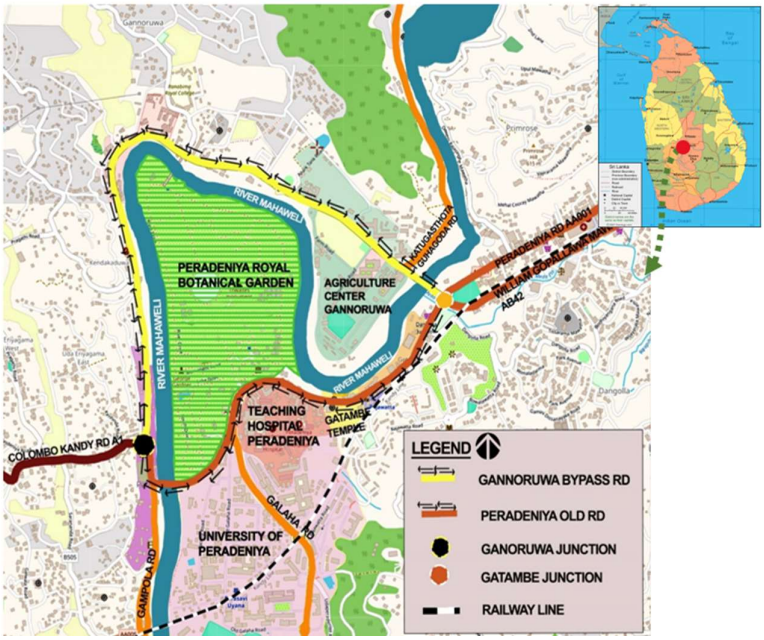

Figure 3: Selected streetscapes and the existing context layout. Adapted from Satellites Pro and oneillcrosscsizma.net. Edited by the author.

Two streetscapes, located in Kandy District, Sri Lanka are taken as the references in this study.

a) Peradeniya Old Road
b) Gannoruwa Bypass Road

Two roads were selected for the study as they lead to the same destination but have distinct differences in geomorphological changes and landmarks. This allows for better observations of roadway selection by vehicle users and identification of their impressions towards the roads. Additionally, the two streetscapes have varying levels of vehicular traffic congestion

Figure 4: Peradeniya Old Road

Figure 5: Gannoruwa Bypass Road

a) Peradeniya Old Road

Gannoruwa Bypass Road is a new 4-lane road. It features a view of Hanthana mountain range from all angles while driving towards Kandy and views of the Mahaweli river in some areas. It also has an open landscape with fewer nearby trees, a lengthy road shoulder, and road islands.

b) Gannoruwa Bypass Road

Peradeniya Old Road has unique aesthetic qualities and reflects the characteristics of the Kandy city environment. It features the Mahaweli river and vegetation as major elements of the streetscape, with landmarks such as the University of Peradeniya, Peradeniya Royal Botanical Gardens, and Gatambe Rajamaha viharaya located nearby. The pathway is mostly covered in vegetation, with soft shoulders and tree avenues. The botanical garden and university are represented by vegetation and decorative, green road islands. It also gets decorated during the flowering season, making it more attractive for vehicle users.

As this study is based on the vehicular travel experience, mainly two categories of vehicle users are taken as participants and they are the drivers and passengers. For the locomotion study and online questionnaire.

The visual character of the selected streetscapes is quantified in this study by using Locomotion Study Method and through participated observations during rides, as shown in the graph below.

Table 1: Visual observations of Peradeniya Old Road and Gannoruwa Bypass Road

Peradeniya Old Road	**Gannoruwa Bypass Road**
Basic observations	
Distance 2.1 km (same destination)	Distance 3.1 km (same destination)
Two lanes / four lanes road	Four lane road
Going through the Peradeniya town	Away from the Peradeniya main town
Environmental observations	
Surrounded by an enclosed area with both trees / greenery and built environments	Surrounded by an open landscape
Visualising a lot of geographical and social factors Ex- River, Tree setback, significant places and land marks (Bridge, botanical garden, Peradeniya teaching hospital, University of Peradeniya entrance, Gatambe rajamaha viharaya)	Visualising a lot of geographical characteristics, no significantly showcasing any social factor Ex- River, Mountains, trees
Soft shoulders are the majority	Hard shoulders are the majority
Majority of the sky view is blocked with the tree canopies (Concealed)	Open sky view throughout the ride (Revealed)
A bridge to cross the river Mahaweli	A Bridge to cross the river Mahaweli (One edge of the bridge demarcates the Kandy city boundary)
Narrow view with nearby elements	Can be seen a broad angle with the views coming from distance The wide view of the Hanthana mountain range appearing though the open landscape due to the agriculture lands, in Gannoruwa agriculture centre.

Identification of the Visual Character of streetscapes Along with the Vehicular Travel Experience

A vehicular travel experience across a streetscape is always accompanied by a series of fast-changing visual frames that change every second. Therefore, creating pleasant and attractive visual frames in a roadway will enhance the travel experience for vehicle users. In this study, eleven selected snapshots were used to construct a continuous collection of still visual frames captured throughout ten rides in the locomotion study method. These two sets of photo trails with eleven images of each roadway were used in the first section of the online questionnaire to determine vehicle users' attitudes towards the selected streetscapes by allowing them to rate each photograph according to five given criteria as mentioned in page 10. The locations of each photograph in the streetscape are marked in the layout of Figure 10 for Peradeniya Old Road (named P1-P11) and Figure 22 in page 30 for Gannoruwa Bypass Road (named G1-G11).

Peradeniya Old Road – Photographs taken in the Locomotion Study

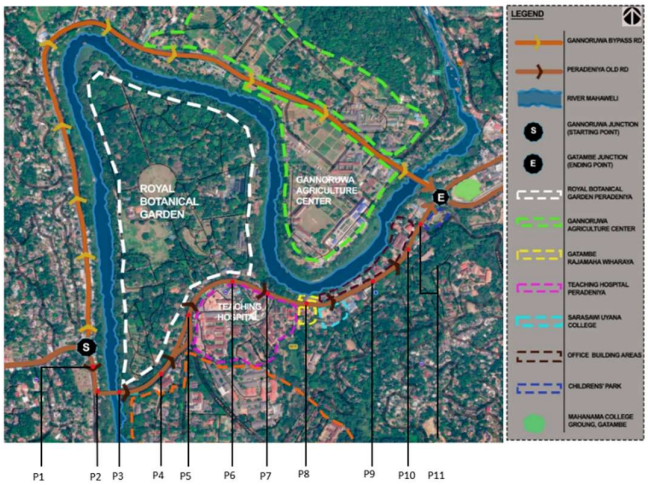

Figure 6: Context Layout of the Selected Streetscapes and the routes of the Locomotion Study
Source: author

Figure 7: P1.
Source: author

Figure 8: P2.
Source: author

Figure 9: P3.
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Figure 10: P4.
Source: author

Figure 11: P5.
Source: author

Figure 12: P6
Source: author

Figure 13: P7.
Source: author

Figure 14: P8.
Source: author

Figure 15: P9.
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Figure 16: P10.
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Figure 17: P11.
Source: author

Gannoruwa Bypass Road – Photographs taken in the Locomotion Study

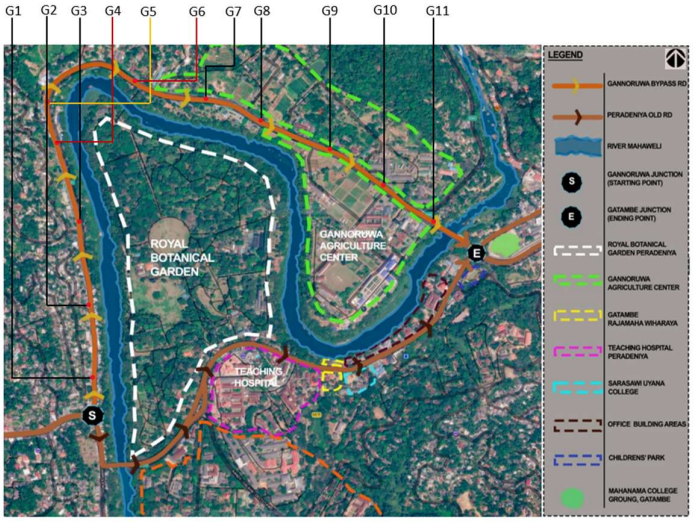


Figure 18: Context Layout of the Selected Streetscapes and the routes of the Visual Study Field Program
Source: author

Figure 19: G1.
Source: author

Figure 20: G2.
Source: author

Figure 21: G3.
Source: author

Figure 22: G4.
Source: author

Figure 23: G5.
Source: author

Figure 24: G6.
Source: author

Figure 25: G7.
Source: author

Figure 26: G8.
Source: author

Figure 27: G9.
Source: author

Figure 28: G10.
Source: author

Figure 29: G11.
Source: author

By using above given photo trials, and the responses of the online questionnaire, the identification of the impact of visual changes for the vehicular travel experience was defined below, with the comparison of two graphs (see Figure 34, Figure 35) concerning the theoretical framework

Table 3:
Findings of Online questionnaire – Section 1 - Averages of P1 to P11 photographs (Likert scale: 1- lower, 5- higher)

Peradeniya Old Road	Stressfulness	Relaxing Quality	Clarity & Order / Arrangement	Harmony in between landscape elements	clearness of the road for the driver
P1	3.56	1.97	1.96	1.97	2.29
P2	2.43	3.29	3.1	3.34	3.21
P3	2.33	3.63	3.43	3.66	3.33
P4	1.96	3.61	3.51	3.61	3.67
P5	1.9	3.39	3.44	3.54	3.5
P6	3.46	2.23	2.26	2.4	2.2
P7	3	2.51	2.66	2.77	2.59
P8	3	2.69	2.61	2.77	2.51
P9	2.53	2.84	2.7	2.79	3.2
P10	2.96	2.37	2.53	2.51	2.33
P11	2.87	2.4	2.57	2.61	2.83

Peradeniya old road - visual quality analysis by using P1-P11 photographs

Table 4:
Findings of Online questionnaire – Section 1 - Averages of G1 to G11 photographs (Likert scale: 1- lower, 5- higher)

Gannoruwa Bypass Road	Stressfulness	Relaxing Quality	Clarity & Order / Arrangement	Harmony in between landscape elements	clearness of the road for the driver
G1	2.79	2.5	2.51	2.49	2.77
G2	2.53	2.79	2.86	2.79	3.24
G3	1.56	3.7	3.73	3.66	3.94
G4	2.36	3.17	3.19	3	3.61
G5	1.56	3.64	3.69	3.64	3.73
G6	1.87	3.44	3.5	3.53	3.7
G7	1.37	3.86	3.83	3.74	4.06
G8	1.54	3.87	3.7	3.67	3.99
G9	1.79	3.5	3.56	3.47	3.6
G10	1.96	3.19	3.31	3.44	3.34
G11	2.09	3.34	3.47	3.46	3.66

Gannoruwa bypass road - visual quality analysis by using G1-G11 photographs

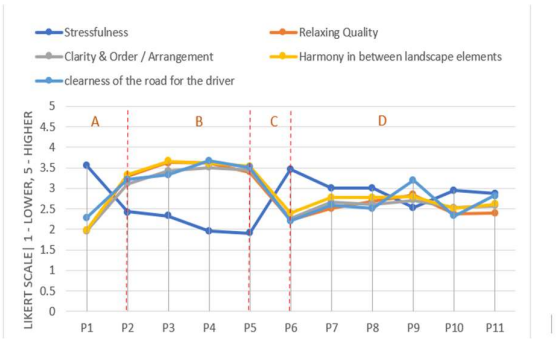


Figure 30: Visual analysis graph of Peradeniya Old Road by using responses of online questionnaire – section 1
Source: author

Figure 31: Visual analysis graph of Gannoruwa Bypass Road by using responses of online questionnaire – section 1
Source: author

The study assesses Peradeniya Old Road and Gannoruwa Bypass Road streetscapes using five criteria: stress, relaxation, arrangement, harmony, and clarity. Results indicate that Gannoruwa Bypass Road is less stressful than Peradeniya Old Road, providing drivers with a better overall driving experience. Stress on Peradeniya Old Road decreases from P1 to P5 but increases again from P5 to P6, remaining average for the rest of the road. (See Figure. 30)

In contrast, the stress level on Gannoruwa Bypass Road decreases from G1 to G3 and remains low or lower throughout the rest of the road. Other criteria like clarity, relaxation, and harmony remain mostly unchanged for Gannoruwa Bypass Road, indicating a better attitude from drivers towards this road. (See Figure.31)

The study employed a locomotion study method with ten drivers to select their preferred streetscape based on scenery and comfort. Results indicated that seven drivers favoured Gannoruwa Bypass Road, while three chose Peradeniya Old Road. Drivers driving on Gannoruwa Bypass Road described their experience as "relaxing," whereas those on Peradeniya Old Road used the word "complex." Furthermore, in the online questionnaire, 75.7% of respondents preferred Gannoruwa Bypass Road.

The results were used to analyse the fluctuation pattern of criteria changes by dividing the graphs in Figure 30 and 31 into partitions. Peradeniya Old Road was divided into partitions A, B, C, and D (Figure 30), while Gannoruwa Bypass Road was divided into partitions A, B, and C (Figure 31), based on significant changes in those groups. The literature survey identified road layout structure and placement of fixed and non-fixed elements as factors contributing to these changes.

Impact of Road structure and Placement of Fixed and nonfixed elements

Peradeniya town area (P1, Figure 7) had highest stress level and lowest values for other parameters of two streetscapes. Irregular building lines in area degrade visual quality. Narrow route, few trees make path stressful, reducing clarity for vehicles.

Figure 32: P1 – P3 area in Peradeniya Old Road: Irregular Building Lines.
Source: author

From P2 to P5 (B) area has lots of greenery, with Royal Botanical Garden. P3 (Figure 9) is most rated, highest greenery, lowest stress level, highest scoring for harmony between landscape elements. P3 to P5 have many road islands, soft road shoulders, tree avenues, preserving botanical garden character and architectural pattern in other buildings like teaching hospital and University of Peradeniya-Galaha Road. Buildings, human activities happen in harmony, minimizing complexity in area

Figure 33: Soft Road shoulders and Road Islands in Peradeniya Old Road.
Source: author

Though greenery and shade from vegetation reduce stress, interviews using visual study method show some people experience slight stress enhancement due to enclosed sky view along pathway. People feel more comfortable in confined regions with open sky view, per theoretical study. This also found in online survey on traffic congestion issue common in area. Peradeniya Old Road is a two-lane route (four in some places) and surrounded by buildings and landmarks (Figure 7) which makes road appear busier. Participants in online survey were asked if Gannoruwa and Peradeniya streetscapes have similar traffic congestion and which streetscape is more comfortable to ride through. The following is the conclusion:

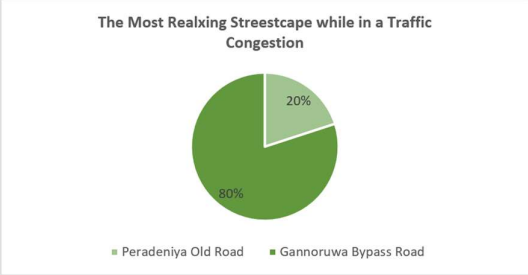


Figure 34: The Most Relaxing Streetscape while in a Traffic Congestion
Source: author

Old Peradeniya Road has relaxing environment with vegetation and tree avenues, but Gannoruwa Bypass Road has additional characteristics for visual quality enhancement, as shown in graph. 80% responses favour Gannoruwa Bypass Road. Sky view factor, tree placement away from road, and Open Landscapes are among them. Except P2, P5, and P11, all other images on Old Peradeniya Road have hidden sky view due to trees. Due to road's bends, drivers and passengers unable to see long-distance perspective of streetscape. Gazing at distant views calms the eye and mind. Even though Old Peradeniya Road is surrounded by foliage, it creates hidden and enclosed locations.

When comparing to the Photographs taken from Gannoruwa Bypass Road (G1 to G11) all photographs show open sky view. Tree positioning around streetscape is important for good sky view. All these factors are proved by questionnaire survey. Graph shows preferred sky view factor by most vehicle users.

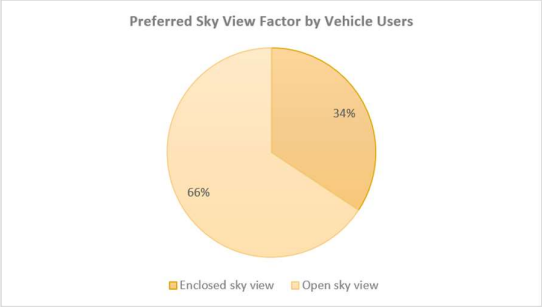


Figure 35: Preferred Sky View Factor by Vehicle Users
Source: author

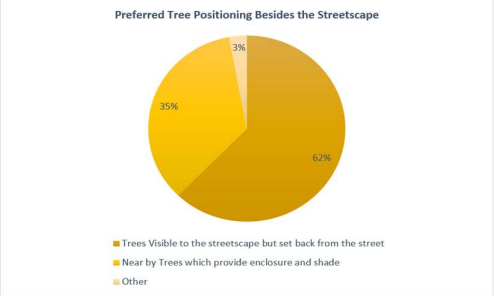


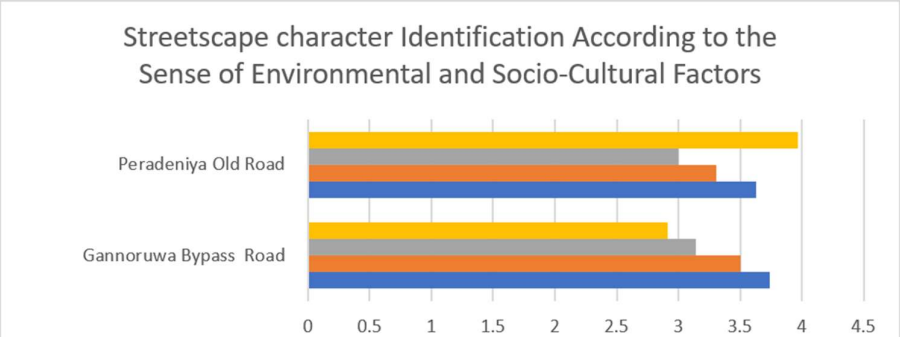
Figure 36: Preferred Tree Positioning Besides the streetscape
Source: author

66% of respondents prefer open sky view which makes vehicular experience more comfortable and relaxed, as shown in graph. Tree placement is crucial in creating pleasing visual component and calming experience. These factors show that all environmental features on Gannoruwa Bypass Road are favourable for users.

As shown in the analysis graph (Figure 31) of the online questionnaire survey, the best-rated photograph over both streetscapes, Gannoruwa Bypass Road and Peradeniya Old Road, is G7. G7 is rated lowest in stress level and highest in all other four criteria. This visual frame shows a large open landscape to the vehicle user from a distance. Trees not near the road, as on Peradeniya Old Road, with a wide view and vegetation away from the road structure, creates more greenery by merging with the distant view of the Hanthana Mountain range. Hard road islands and hard road shoulders create less contrast to the road colour and make the road visually wider. The open sky view factor creates a non-concealing environment and reduces the stress level of the vehicle user.

Identification of the Sensory Factor of the Selected Streetscape

In this study, sensory factors identified in two ways: social factors with built structures and environmental and geographical factors. In the online questionnaire, questions were taken out based on these two factors.



	Gannoruwa Bypass Road	Peradeniya Old Road
Landmarks/ Memorable places	2.91	3.97
Social factors (Human activities)	3.14	3
Positioning of trees	3.5	3.31
Environmental / Geographical features	3.74	3.63

Figure 37: Streetscape character Identification According to the Sense of Environmental and Socio-Cultural Factors (Likert scale: 1- lower, 5- higher)
Source: author

The Kandy City area is unique compared to other areas in Sri Lanka due to its cultural landmarks with historical background. Kandy City character is more evident on Old Peradeniya Road, per graph in Figure 37. People who live outside of Kandy appreciate Old Peradeniya Road for its distinct character, both environmentally and constructed. Examples include Gatambe Raja Maha Viharaya, Peradeniya Botanical Garden, Peradeniya Old Bridge. But geographical sensory factor of both roads is similar in rating, showing users prefer the sense built by geographical features more than landmarks and city built structural characters, as shown by preference for Gannoruwa Bypass Road by users.

Discussion and Findings

Three spatial theories used to identify streetscape as attractive environment with better visual quality according to theoretical framework of study: Imageability, Visual Complexity, Sense.

Gannoruwa Road has higher imageability level than Peradeniya Old Road. But P2 to P5 areas of Peradeniya Old Road can be identified as best imageability-maintained streetscape by observations and interviews. Reason is that all fixed elements such as vegetation and built structures, and nonfixed elements such as vehicles and human activities have higher density within the area and yet maintain harmony between all elements by preserving character of the area and merging all environmental and built structures into one concept. But overall, Gannoruwa Road creates best imageability level of all streets.

Therefore, the research suggests that open landscapes create the most relaxing driving environments, and the positioning of trees is key to achieving this. Trees should not be too close to the road, but instead provide a wide view of vegetation as a borrowed landscape, to create a non-concealing environment and reduce the stress level of drivers. Additionally, hard road islands and hard road shoulders can make the road visually wider and cause drivers to drive faster, while soft road shoulders can make the road visually narrow and result in traffic congestion.

The main findings of the study show that Gannoruwa Bypass Road has better visual quality than Peradeniya Old Road. Most outsiders prefer to use this road due to its characteristics. Tree avenues create enclosed areas, increasing stress for vehicular users. Road structure of streetscape has major effect on creating complexity or simplicity. Hard road shoulders may increase driving speeds and soft road shoulders may contribute to traffic congestion.

Conclusion

Each element in the streetscape can have a positive or negative impact on the vehicle user, depending on its placement. A well-organized streetscape with vegetation can improve relaxation for vehicle users, while an unorganized streetscape can increase collisions and accidents. An unplanned urban area with built environment can be distracting and unpleasant, while a well-planned urban corridor can create a pleasant and majestic city character for vehicle users.

The presence of greenery and shade from vegetation is generally associated with reduced stress, but some people experience slight stress due to an enclosed view of the sky along a pathway. Therefore, open landscapes with well-positioned trees away from the roadside are ideal for creating a relaxing driving experience. Also, the findings of this study suggest that prioritizing geographical features over socio-cultural elements in the design and planning of streetscapes can improve the overall travel experience for vehicle users and contribute to a more relaxing streetscape environment.

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