

## An Investigation of the Relationship of Streetscape Visual Enclosure and the Pedestrian Movement in Selected Case Studies in Colombo

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### Abstract

The streets are the most significant urban feature which unlimitedly open for the general public. Pedestrian activities and physical features directly involved in enhancing the quality and level of functionality of the whole city. Planners need to aware of how pedestrians and street uses think about the street and its designs. Only providing walkable amenities such as sidewalks, micro environmental features, street furniture and more other facilities is not enough. Perceptions or experience that feel by the uses also important to create active street in urban area. Sense of enclosure is a fundamental element of urban planning in European countries. In Sri Lanka also there is a trend of creating high rise buildings along the main highways and it creating more enclosed streets. Hence, this study has investigated the relationship of streetscape enclosure & the pedestrian movement in the Sri Lankan context. For the analysis here used the world wide freely available data of google street view images and pedestrian perception survey. For this study, there were three case studies have selected in Colombo District. Findings of research may important to the arrangement of streets, building blocks, vegetation and other vertical elements along the streets to provide pedestrian-friendly enclosed streets and comfortable streets for street uses. Because findings show the significant association between streetscape enclosures by trees, buildings with pedestrian movement. Walkability is a green type transport method. Therefore, to improve the sustainability of city walkability is an important element.

**Keywords:** Urban design qualities, sense of enclosure, walkability

### 1. Introduction

Urbanization leads to create high density build-up areas. Therefore, morphology of Colombo is changing rapidly and it is continuously affecting the urban density, land cover and also the streetscape variation. It may destroy the quality and create meaninglessly. Every space is getting compact with several multistory buildings. Especially Colombo core area having a trend of the multistory building along the main arteries Therefore, it destroys the diversity of streetscape & creates visual pollution. Then it is creating more enclosed streets in Sri Lanka. Lots of empirical researchers have studied the walkability in macro and micro level measurements (Ernawati, 2016; Lawrence, et al., 2005; Ranasinghe. et al, 2016). However, streetscape variations directly affect the perceptual urban design qualities which are the feelings or sensations that generate according to the physical elements of streetscape.

Within urban design qualities of the streetscape, there is less empirical literature regarding the sense of enclosure of streetscape. Urban planning and designers studies suggest that there is a significant impact from the visual enclosure for the pedestrian movement (Stamps & Arthur, 2005). Because it effecting to safety and the comfort of the pedestrians (Bereitschaft & Bradley, 2017; Li, et al., 2018).

If simply describes the mean of the enclosure, it is the idea of being sheltered or protected from the surrounding environment. "Enclosure refers to the degree to which streets and other public spaces are visually defined by buildings, walls, trees and other vertical elements. Spaces, where the height of vertical elements is proportionally related to the width of the space between them, have a *room-like quality*." (Ewing & Handy, 1993, P.75). Simply it feels like an outdoor room. Streetscape Enclosure affects the local awareness and it contributes to the imageability, spatial identity (Lynch, 1960). It has direct interaction with the human-scale & it describes how human perceived space (Jacobs, 1993; Cullen, 2012).

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Hence, the enclosure can be transformed into practical planning & design strategies, and guidelines when developing urban areas. The arrangement of roads, buildings and other vertical elements on both side of the street is an important action of urban planning. However, recent studies moved into visual enclosure or sky visibility measurements to measure streetscape enclosure. In the Sri Lankan context, also lacking studies about the enclosure of streetscape regarding walkability. Hence, this study focuses on the influence of Visual Enclosure on the pedestrian movement and the street user in quantitative and qualitative way.

#### Research Question

- i. What are the physical features that contribute to sense of enclosure?
- ii. How the urban design quality of enclosure influence on the pedestrian behavior in Sri Lankan urban context?
- iii. What are the better types of the enclosure to provide a comfortable walkable environment?

#### Main Objective

- To Investigate the relationship of streetscape enclosure and pedestrian movement in selected case studies in Colombo Sri Lanka.

#### Sub Objectives

- To understand the level of physical features that contribute to the sense of enclosure
- To find out the types of enclosure that gives a comfortable walkable environment

Research Hypothesis- There is a relationship of streetscape enclosure and the pedestrian movement in Sri Lankan Urban context.

#### Scope and Limitation

There are 53 perceptual urban design qualities in the concept of walkability (Ewing & Handy, 2009). However, this study considers only the sense of enclosure.

Study limited to three case studies due to the availability of time for analysis and data collection.

Here, the study used the Arc GIS image classification tool for classifying the google street view images. However, it has a limitation to objectively classify the images.

## 1. Literature Review

### 2.1 The Streetscape

The streetscape is defined by the elements of the street such as roads, adjacent buildings, micro-environmental features, etc (Fitzsimons, 2013). According to literature, streetscape can classify into five subject areas such as “Sense of Place, Safety, Comfort, Interest, Legibility, Way-finding and Feasibility” (Southworth, 2005; Gehl, 2006; Stamps & Arthur, 2005). However, it is a critical environmental condition for walkability

### 2.2 Concept of Walkability

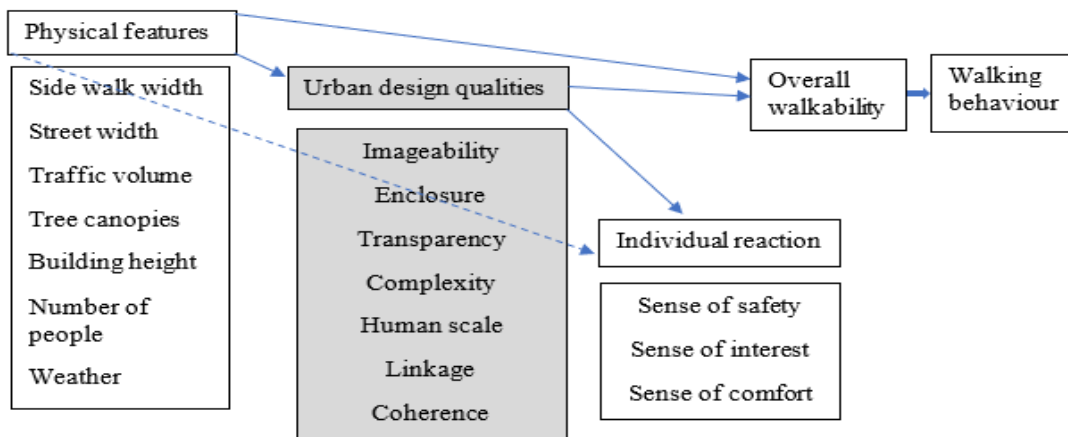
Walking is the oldest transport mode in the world. However, widely spreading of urbanization, unplanned cities and increment of urban sprawl lead to discourage the ability to walk. *Walking* is a movement from one point to another point. It is a transport mode. *Walkability* is the measuring of ability to walking. It is a concept that examines the experience of walking (Burden, 2010; Rafiemanzelat, Emadib, & Kamalia, 2017). The pedestrian movement, accessibility are relevant fields regarding walkability. Walkability means measuring walk-friendly. There are physical features that contribute to the walkability. As well as there are perceptual qualities that explain the experience of walking which contribute to the overall walkability.

### 2.3 Physical and Urban Design Qualities Related to the Comfortable Walkability

For the analysis of walkability or pedestrian movement, scholars are mainly considered the availability of physical features such as sidewalks, street furniture or amenities, etc (Ernawati & Jenny, 2016; Ranasinghe. et al, 2016; Zakaria & Ujang, 2014). However, only the physical features cannot explain the overall experience of the environment & walkability of the relevant street. Because, it cannot capture the overall perceptions of people about the walkability.

Because “perceptions that may have complex or subtle relationships to physical features” (Ewing & Handy, 2009, P.67). The way of thinking about the street also contributes to the walkability.

That’s why it is important to study how perceptual qualities of streetscape can contribute to the walkability to identify how individuals feel about the street or place. According to the Handy, 1992; Ewing, 1996 there are 53 urban design qualities related to the walkability such as complexity, human scale, imageability, transparency, enclosure, etc.

**Figure 1 Conceptual framework of Walkability**

Source: Measuring Unmeasurable, (Ewing & Handy, 2009)

“Perception is the process of attaining awareness or understanding of sensory information” (Ewing & Handy, 2009, P.67). However, the research of “*Measuring unmeasurable*” by Ewing & Handy 2009 identified that those unmeasurable things can be measured in objectively (Ewing & Handy, 2009). Ewing and handy 2009 introduce a new methodology to measure perceptual urban design qualities related to the walkability in objectively. That identified by visual assessment studies.

#### 2.4 Enclosure of Streetscape

According to recent medical and environmental scholars, the enclosure is an important factor in environmental physiology. Because, it is a crucial feature. Health scholars explain that the human brain has directly responded to the image that the explanation of the sense of enclosure (Ruoyu ,et al., 2019). The response of the human brain function has significant influence due to enclosed or opened spaces (Holden, 2000;Li, et al., 2018).

However, important to understand physical features that contribute to the sense of enclosure within the urban environment. “*Enclosure refers to the degree to which streets and other public spaces are visually defined by buildings, walls, trees and other vertical elements. Spaces, where the height of vertical elements is proportionally related to the width of the space between them, have a room-like quality*” (Ewing & Handy, 1993, P.75).

In the urban context building blocks and streets are the primary elements. Most of the time buildings define the enclosure of the streets. Vertical elements can create places and streets as memorable places for pedestrians. When the outdoor space has a definite & district shape and moreover that shape has importance as the surrounding buildings, it will be a more successful place (Alexander et al., 1977). Especially the building height required to keep a comfortable level of feelings (Alexander et al., 1977). “*The enclosure quality is affected by the proportion of the street wall represented by buildings, the skyline, trees and even the arches and shelters*” (Osman, 2018, P.37). Because, as explained by number 1 digram sense of enclosure depend on the physical enclosure of the streetscape. Enclosure creates place memorable and safe. According to different scholars, streets that enclosed by buildings safer than the streets enclosed by trees (Alkhresheh & Majdi, 2007).

However, different scholars tried to measure this sense of enclosure by objective ways. There were scholars who argued that the physical features that can be caused the sense of enclosure. There are different interpretations for measuring visual enclosure using different physical features. However, recent studies moving to measure visual enclosure using sky visibility measurements.

#### 2.5 Individual Reactions Regarding Walkability

According to the concept of walkability explained that dependent variables such as the sense of safety, sense of comfort and sense of interest have strong relationships the independent variables of physical features and urban design qualities. (Ewing & Handy,2009). According to Alexander et al (1977) explainedthat building height & Street width also needs to arrange as comfort level. Because, if the width of the streets exceeds the scale of the building height in surroundings it also feels less comfortable (Alkhresheh,2015). Different scholars argued that perceived safety, interest and comfort have a linear relationship with visual enclosure(Stamp,2005). Some scholars argued that those variables have U-Shaped relationship with streetscape enclosure (Harey, Aultman-Hall, Hurly & Troy,2015; Majdi,2015; Singh,2015).

**2.6 Google Street View Image**

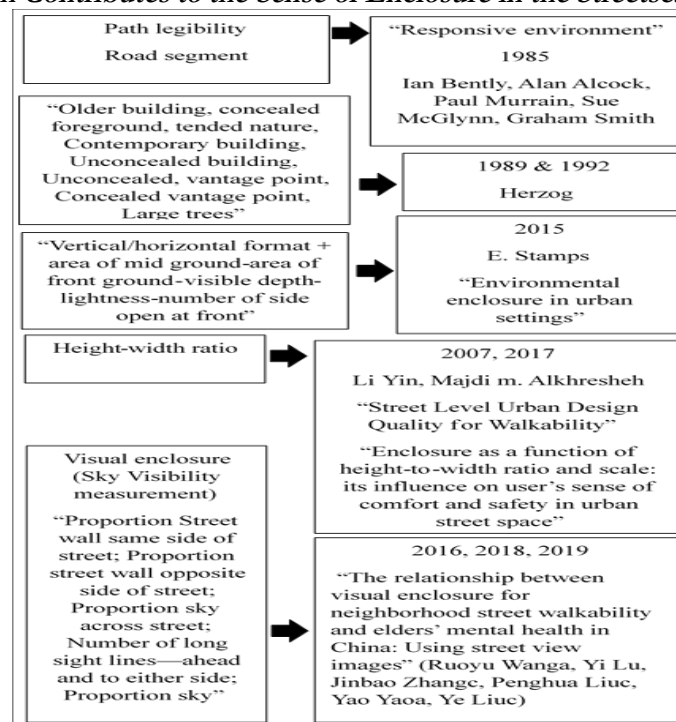
According to the Diagram 1 *Factors which Contributes to the Sense of Enclosure in the Streetscape*, explained that how different scholars and studies used different elements to find out the streetscape enclosure in a different time period. However, recently (2018, 2019) studies moving in to sky visibility measurement to measure streetscape enclosure. Therefore, recent studies used google street view images to find out the streetscape enclosure.

Because, currently, Google Street view images have become an important flat form within the field of urban planning, environment and health as, it has spread widely around the world. It can provide eye-level views of the street. Street view images can provide reliable information on streets and urban spaces. It represents the alternative data source on urban planning. It can capture every element of the streetscape and provide recent data (Li, et al., 2018; Li Yin a, 2016). Because, when doing larger-scale studies and researches finding of reliable data is limited and difficult to collect information. Therefore, this is a very valuable source for collect relevant data and there are no barriers to get. Hence, recent researches focused to use google street view images to study walkability(Ruoyu ,et al., 2019).

Classification of street view images in objectively can determine the features that contribute to the enclosure of streetscapes and find out the level of the enclosure with proportionately with sky visibilities (Badland et al., 2010; Lu et al., 2018; Lu, 2018; Rzotkiewicz et al., 2018). “Simulated hemispherical images” also can be used for this study. Because, those can measure the visual enclosure of streetscape. Hence those are important sources for measuring the streetscape enclosure.

2.7 factors which Contributes to the Sense of Enclosure in the Streetscape

**Diagram 1 Factors which Contributes to the Sense of Enclosure in the Streetscape**



Source: Compiled by Author

### 1. Research Design

#### 3.1 Data Collection Methods

**Table 1 Primary Data Collection Methods**

Data Collection Methods	Use
Pedestrian Questionnaire Survey	To get pedestrian perceptions about the sense of the enclosure due to streetscape variation. That helps to identify the proper enclosure type for streets to provide comfortable street or spaces.
Field Observation	Used to identify the physical elements that contribute to the sense of enclosure in streetscapes
Google street view images	To numerically measure the enclosure of streetscape to find out the level of enclosure in selected case studies.
Pedestrian count survey (Using video clip)	To find out the relationship of enclosure level & pedestrians' movement. Pedestrian count data were collected by on-site observation during four peak hours in non-holiday weekdays. Pedestrians were recorded using video clips by capturing each 100m sample interval of both sides of the selected roads.

*Source:* Compiled by Author Sampling method for Google street view images & Questionnaire survey

#### 3.2 Sampling Technique

For samples of google street view images suitable to get 100m per samples from a total distance as, for one view of the street view image it captures at least elements of 100m distance. The total distance of case study roads is around 13 Km and the sample size is 130.

This study used a non-probabilistic sampling method which is “Convenience Sampling” method. That particular technique is suitable for this study due to the diversifying pedestrian flow according to the time and the places. Therefore, sample selection is based on randomly. This study investigates the perceptions of the users/pedestrians on selected case studies in the selected distance. There will be 100m per randomly selected pedestrians' samples from case studies.

The Perception survey conducted by capturing every perception from different stakeholders of pedestrians/user which consider every socio-economic factor such as Age category, Gender, User category, Route details, Details of living place, etc. However, the perception survey used 3D model to get people's opinions about type of enclosure. It represents different type of enclosure in the surrounding environment. According to the pedestrian count survey conducted by field observation in three different case studies, average pedestrian count(*per meter per hour*) used as total population size (300). By considering all the above factors and *average per meter per hour* population size total will be 300 samples for perception survey. It has spread within three case studies and a survey was conducted using at least two people per 100m distance.

#### 3.3 Method of Analysis

The enclosure is a sense/feeling. Online street view images cannot capture the people's opinions about streetscape enclosure. Therefore, the study is a combination of objective analysis and the perception survey also.

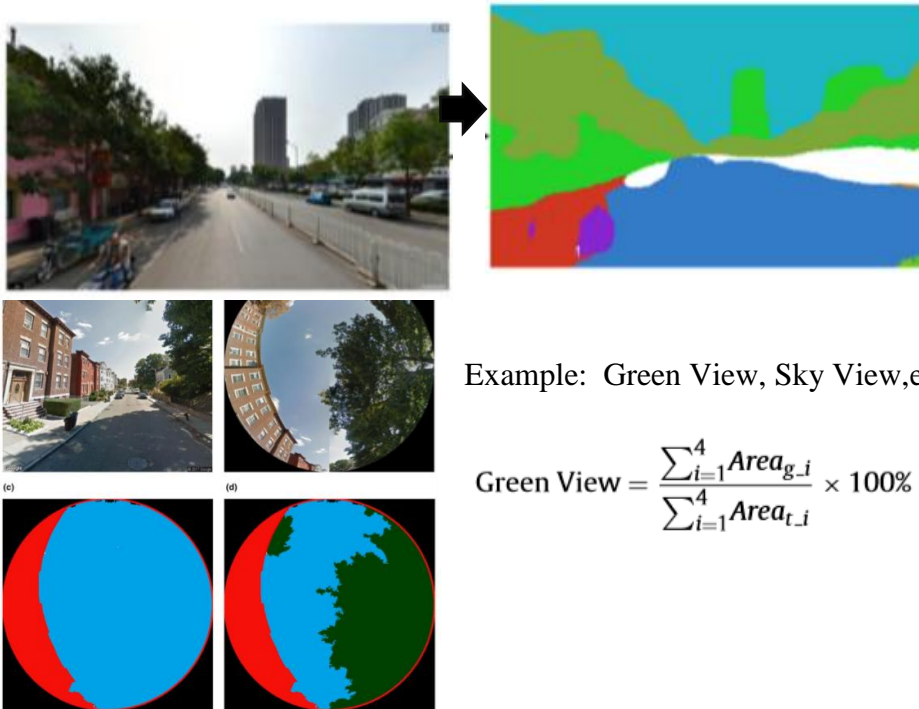
**01** – Using Arc GIS (Geographic Information System) software quantifies the level of the enclosure of streetscape of google street view images in selected case studies using the image classification tool. Then OLS regression model in Arc GIS use the find out the relationship among numerically measure enclosure level and pedestrian count. Because it is a spatial regression model. Findings will map out.

**Table 2 Variables for the Analysis (Arc GIS)**

Independent variables (X)	Dependent variables (Y)
The Enclosure level of particular road segment(100m)	Pedestrian count in each segment(100m)
Buildings	
Vegetation Other vertical elements	
} Proportionate with the sky visibility	

*Source:* Compiled by Author

Figure 2 Use of Panorama& Google Street View Images in Similar Case Studies



Source: Similar Case Studies (Li, et al., 2018)

**02** -As the second analysis methods, to find the relationship *Bivariate Analysis Method* and *Chi-square test in Descriptive statistics* under the SPSS technique used for this analysis. It investigates the relationship between multiple independent variables and dependent variable. P-value used to find the significant of the relationship in multiple-choice answers.

Table 3 Variables for the Analysis (SPSS)

Independent variables (X)	Dependent variables (Y)
Enclosure level (3D model)	Social Factors (Age, Gender, etc.)
	Pedestrian Preference (Root choice, etc.)
	Perceived safety, comfort & Interest

Source: Compiled by Author

3.43D Model for Perception Survey



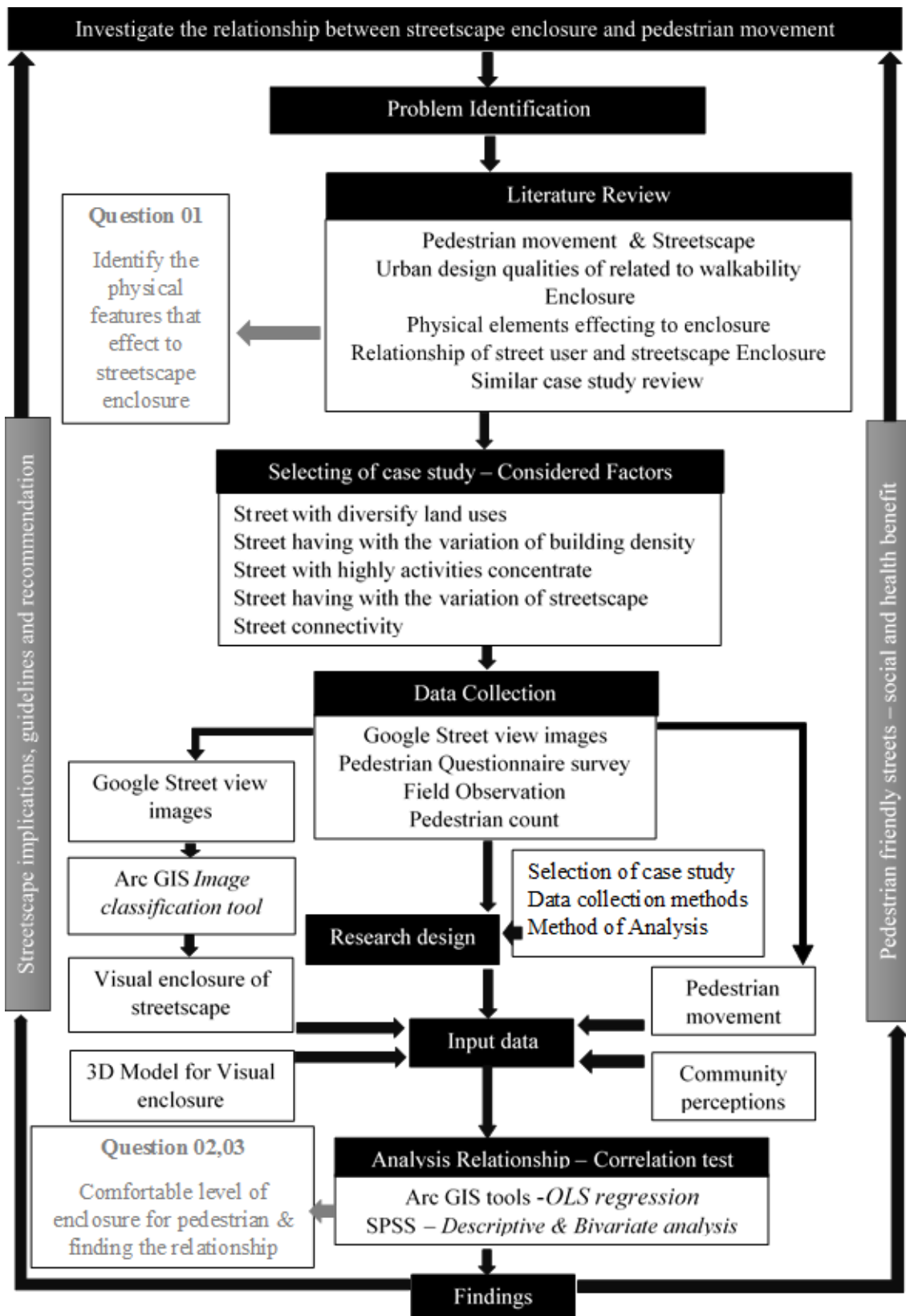
*Figure 3 3D Model for Perception Survey*



*Source:* Compiled by Author using Google based on the literature review

### 3.5 Methodology of the Study

#### *Diagram 2 Methodology of Study*



Source: Compiled by Author

### 3.6 Case Study Selection



**Figure 4 Selected Case Studies in Colombo**

Source: Compiled by Author

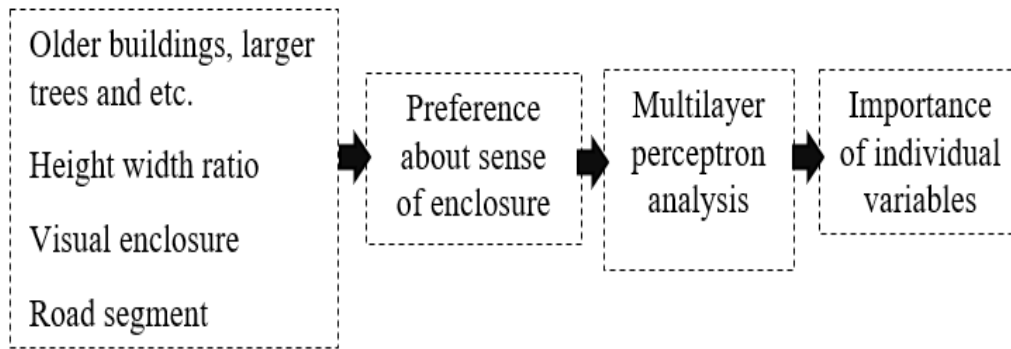
Colombo is the largest urban area in Sri Lanka which is under the process of urbanization. It has a trend of creating massive multistory buildings along the main arteries and it creates more enclosed streets (Alvis,2004). Therefore, Colombo is the most suitable area for this study. There are three different selected case studies in the Colombo Municipal Council area for the research findings. Those are the Galle Road, Marine Drive Road and Duplication Road (Galle Face to Wellawatta 7 km, Duplication 3km & Marine Drive 3km). However, it is limited to three case studies due to study convalescence. To get errorless findings, there are considerable factors for selecting case studies. The Street with diversified land uses – If there is diversity of land uses there is no bias for pedestrian movement. It disperses the pedestrian movements within different areas along the roads. Selected case studies mixed with different land uses such as residential, office, commercial, etc. Diversity of width of the roads – According to the previous scholars, the height width ratio is also a variable for the change in the level of enclosure in the streets. Selected case studies have the variety of nature in the enclosure level due to height width ratio.

The street having with the variation of building density - Variation of building density leads to create a variation of the streetscape and if there is high building density, there is high population density also. Hence it produces activities within the area. The Street with high activities concentration - Due to high activity concentration, it leads to produce high pedestrian movement. Therefore, it helps to success counting of the pedestrian. Street having with the variation of the streetscape – The Diversity streetscape leads to create diversified enclosure level. Therefore, it is easy to analyze the better enclosure level for pedestrian movement and community perceptions about that. Street connectivity - If highly connecting with street segments it will collect different activities and pedestrian movement. Those factors lead to errorless findings.

## 1. Analysis & Findings

### 4.1 Factors that contribute to the sense of enclosure

Figure 5 Flow of selecting importance of independent variables



### Independent Variable Importance

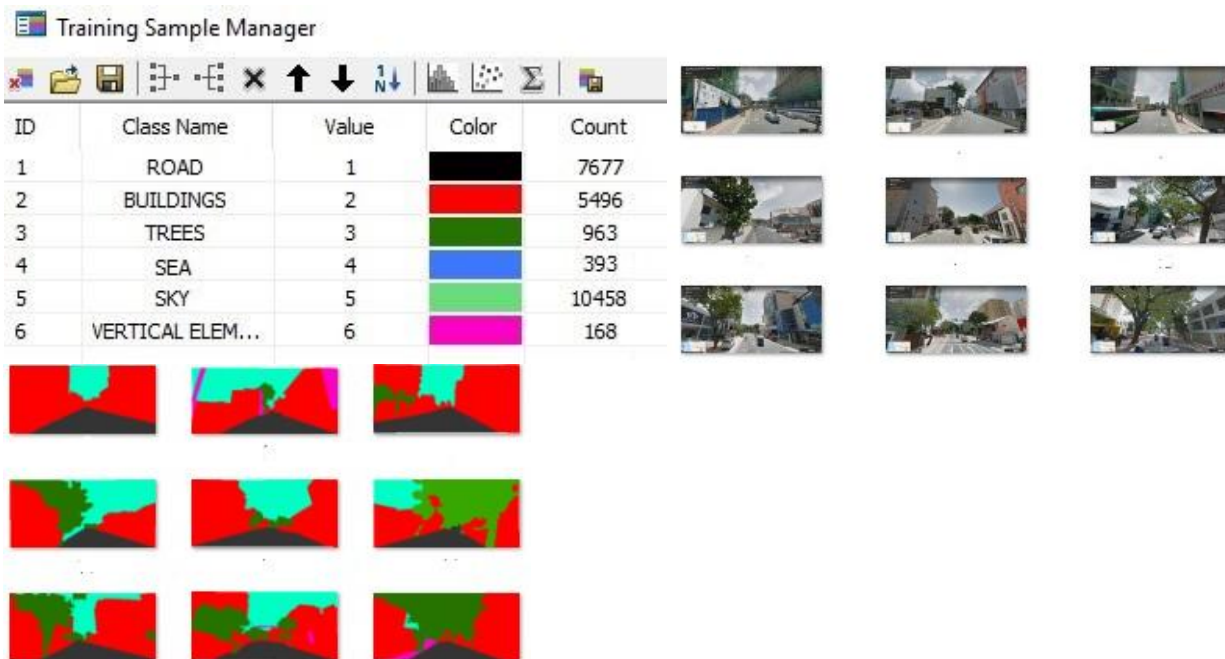
	Importance	Normalized Importance
Older_buildings_Larger_Trees_and_etc	.090	26.0%
Road_Segments	.047	10.0%
Height_Width_Ratio	.286	82.5%
Visual_Enclosure	.276	79.6%

Source: compiled by Author base on multilayer perceptron analysis in SPSS

Under chapter two in the literature review (*Diagram 1 Factors which Contributes to the Sense of Enclosure in the Streetscape*) has explained the different physical features that effects to streetscape enclosure. Based on the community perceptions with multilayer perceptron analysis height-width ratio and the visual enclosure is the most important factors that cause to sense of enclosure. Because those factors have non-linear relationships with the sense of enclosure. Visual enclosure highly depends on the height-width ratio of the street. Therefore, the height-width ratio is effects to the changes of the visual enclosure with the arrangement of buildings, trees and the sky visibilities. However, the study used sky visibility related method to measure the streetscape enclosure.

According to the recent empirical studies and scholars Buildings, Trees and the Vertical elements such as towers, signboards, and advertisement boards are caused to the sense of enclosure. According to Google Street View images classification, in the Sri Lankan context also streetscape shaped by 75% of building blocks and 19% by trees. Rest of 6% is due to vertical elements such as signboards and advertisement boards selected case studies. However, here achieves the research sub-objective of Understand the level of physical features that contribute to the sense of enclosure.

Figure 6 Google Street View Image Classification



Source: Compiled by Author

#### 4.2 Relationship of the streetscape enclosure and the pedestrian movement

##### 4.2.1 Results Based on Ordinary Least Square method (Arc GIS)

Correlation between Pedestrian movement and the independent variables

Table 4 Correlation between Pedestrian Movement and the Independent Variables

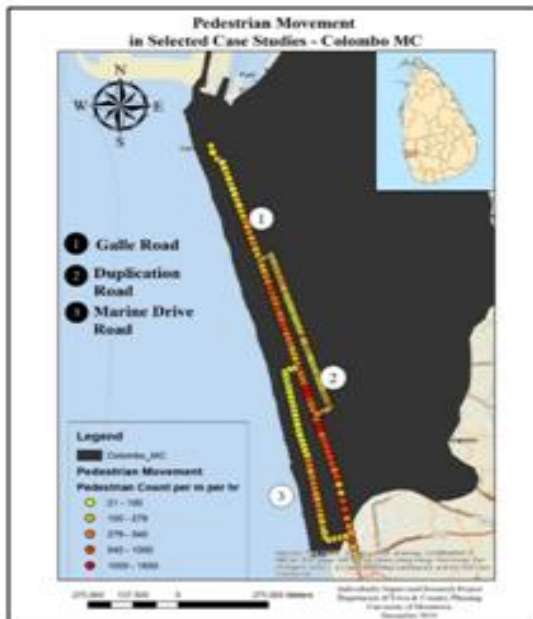
Independent Variables	Adjusted R squared	Coefficient	Significant
Streetscape Enclosure	0.526	0.728	.000*
Enclosed by trees	0.269	0.121	.000*
Enclosed by Buildings	0.749	0.825	.000*

Source : Compiled by Author based on OLS in Arc GIS

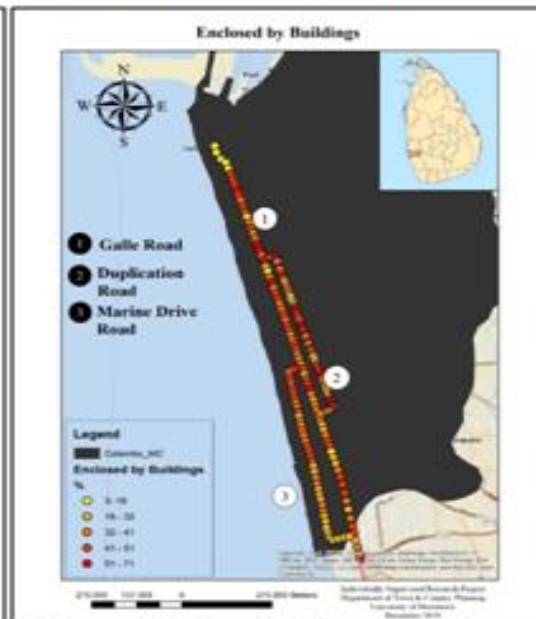
Note:

- 1) Adjusted R squared - Measures of model fit/performance, contribution
- 2) Probability and Robust Probability (Robust\_Pr): Asterisk (\*) indicates a coefficient is statistically significant ( $p < 0.01$ ); to determine coefficient significance.
- 3) Coefficient: Represents the strength and type of relationship between each explanatory variable and the dependent variable

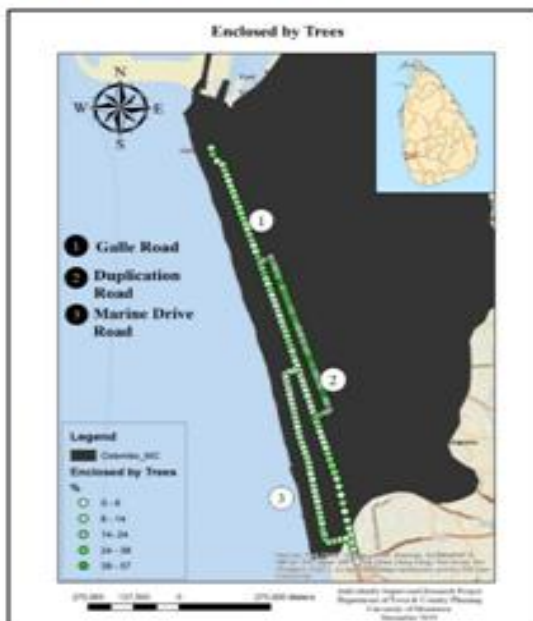
**Figure 7 Pedestrian Movement in Selected Case Studies - Colombo MC**



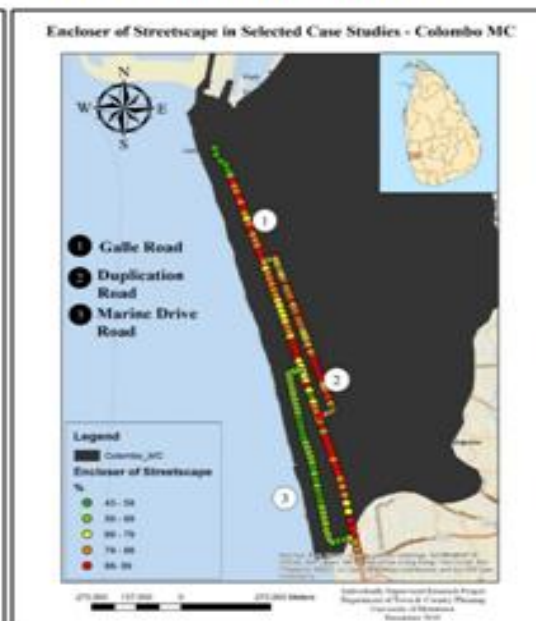
**Figure 8 Enclosed by Buildings**



**Figure 10 Enclosed by Trees**



**Figure 9 Enclosed of Streetscape in Selected Case Studies Colombo MC**



**Figure 7 Relationship of Visual Enclosure and Pedestrian Movement in Selected Case Studies - Colombo MC**

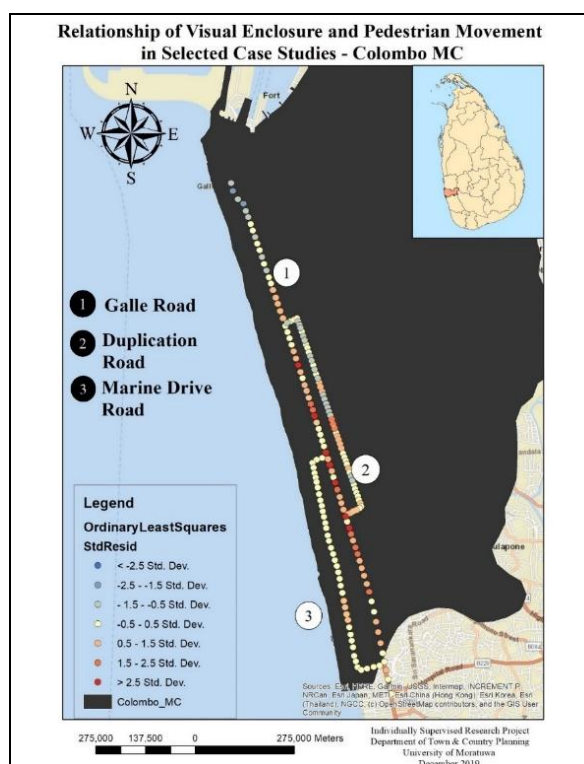


Figure 07.08,09,10 respectively shows the spatial distribution of pedestrian movement, three independent variables such as enclosed by buildings, enclosed by trees and streetscape enclosure of selected case studies. Finally, figure 11 represents the relationship of streetscape enclosure and pedestrian movement in selected case studies of Colombo MC. However, independent variables such as enclosed by trees, enclosed by buildings and streetscape enclosure have a different relationship with the depended variable of pedestrian movement.

According to Summery of OLS Results, Enclosed by trees of streetscape positively associate with pedestrian movement in selected case studies in Colombo MC. Pedestrian movement & Enclosed by trees has model fit/performance of 26%. However, it has a weak relationship and it is significant at  $p < 0.01$ . Pedestrian movement & Enclosed by buildings has model fit/performance of 74%. It has a strong relationship and it is significant at  $p < 0.01$ . Pedestrian movement & Enclosure has a model fit/performance of 52%. However, it has a strong relationship. It is significant at  $p < 0.01$ .

4.2.2 Results based on the Perception survey

Here, an equal number of participants responded from every age category which represents the different user categories, gender for the perception survey.

**Table 5 Number of Participants based on Age groups**

Age Category	Number of Participants
Children (below 18 y)	75
Young (19-35 y)	75
Middle (36-54 y)	75
Elderly (above 55 y)	75
Total	300

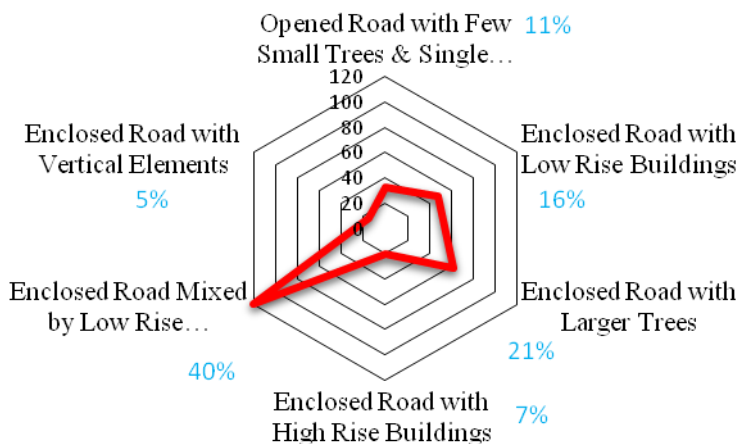
Source: Compiled by Author

4.2.2.1 Overall Preference about the Streetscape Enclosure



**Chart 1 Overall Preference about the Streetscape Enclosure**

**Overall Preference about the Streetscape Enclosure**



Source: Compiled by Author

When considering the overall preference about the streetscape enclosure *Chart 1* shows the answer for Research question number three and the sub-objective which is about the better types of the enclosure that provide a comfortable walkable environment. According to the analysis 40% of people, 120 out of 300 samples expect the enclosure by mixed of low rise buildings and medium-size trees which is a significant finding for future development.

Enclosed by vertical elements and the high rise buildings has weak responses from the participants. Which indicate enclosed by vertical elements and high rise buildings does not provide a comfortable walkable environment to the street users.

4.2.2.2 Relationship of Streetscape Enclosure & Gender

**Table 6 P-Value Chi square test**

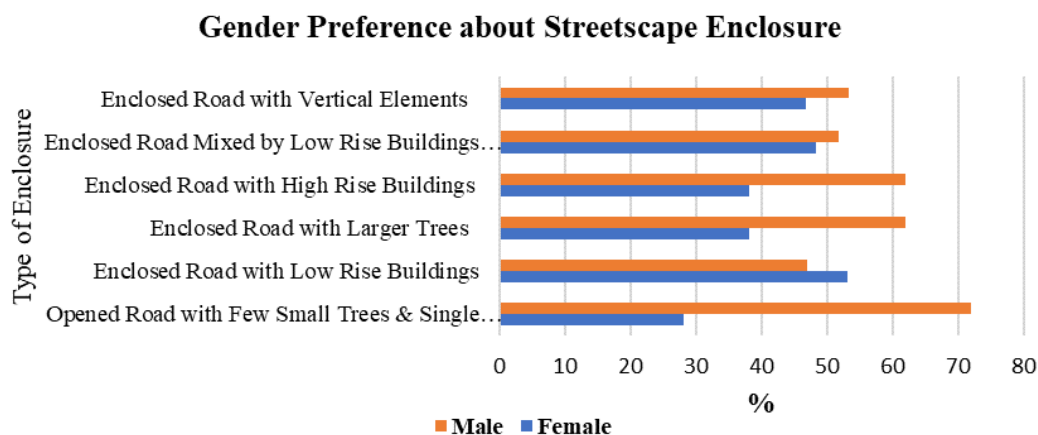
Type of enclosure	P-Value
Opened Road with Few Small Trees & Single Story Buildings	0.000
Enclosed Road with Low Rise Buildings	0.012
Enclosed Road with Larger Trees	0.000
Enclosed Road with High Rise Buildings	0.082
Enclosed Road Mixed by Low Rise Buildings and Medium Size Trees	0.000
Enclosed Road with Vertical Elements	0.036

Source: Results based on P-value – Chi square test (Descriptive statistics)

According to the results based on the Chi-square test, there are association between different type of enclosure and gender preferences (multi choice). Here P-Value explains the significance of the relationships.



**Chart 2 Overall Gender Preference about Streetscape**



**Enclosure**

Source: Compiled by Author

However, according to chart 2, there is significant variation of gender preference and the streetscape enclosure. Based on the responses female have a low preference (28%) than the Male (72%) about opened road with few small trees and single-story buildings. Enclosed road with larger trees where the female prefer 38% which is lower than male (62%). According to people’s opinions, especially the majority of females does not like to walk or use the road enclosed by larger trees. Discussions with females highlighted that Opened road with few small trees and few single-story buildings, they feel they alone at the space.

4.2.2.3 Relationship of Streetscape Enclosure & Age Category

**Table 7 Correlation Table**

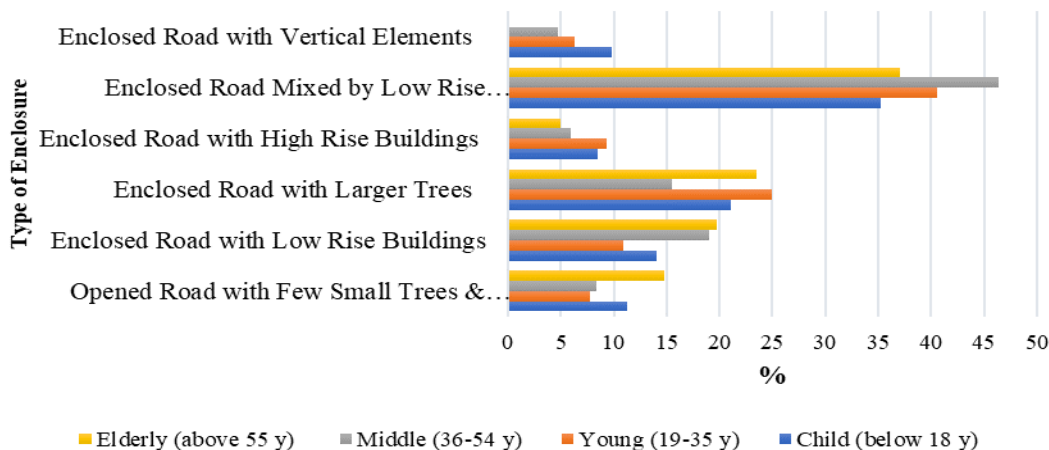
Type of enclosure	Correlation	Sig. (2-tailed)
Opened Road with Few Small Trees & Single Story Buildings	.481**	.000
Enclosed Road with Low Rise Buildings	.277*	.016
Enclosed Road with Larger Trees	.592*	.000
Enclosed Road with High Rise Buildings	-.660**	.000
Enclosed Road Mixed by Low Rise Buildings and Medium Size Trees	.692*	.012
Enclosed Road with Vertical Elements	-.581**	.000

Source: Compiled by Author based on SPSS Results (Bivariate correlation)

Age category and streetscape enclosure have a significant relationship. According to the correlation chart when age and the opened road with a few small trees and single-story buildings has a moderate positive relationship.

Age and the enclosed road with low rise buildings have a significant positive relationship. It indicates that when age is a growing preference for the enclosed road with larger trees also increasing. It has a moderate positive relationship. Enclosed road high rise buildings and age has a negative moderate relationship. It indicates that when age is a growing preference for enclosed by preference for high rise building is decreasing. Enclosed road with vertical elements also has the same type of relationship. However, enclosed road mixed by medium-size trees and low rise building has a significant positive relationship at 0.01 level.

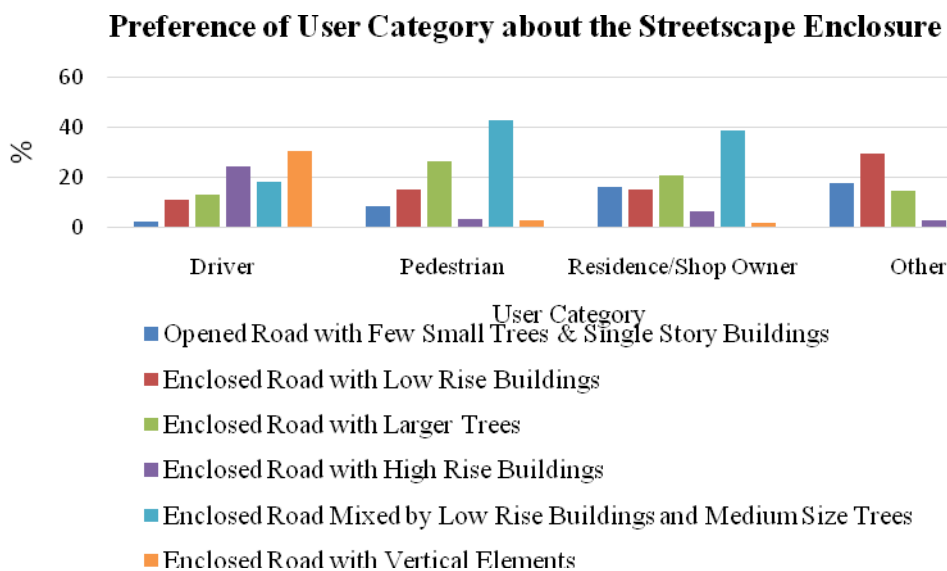
**Chart 3 Preference of Age Category about the Streetscape Enclosure**  
**Preference of Age Category about the Streetscape Enclosure**



**Enclosure**  
 Source: Compiled by Author

4.2.2.4 Relationship of Streetscape Enclosure & User Category

**Chart 4 Preference of User Category about the Streetscape Enclosure**

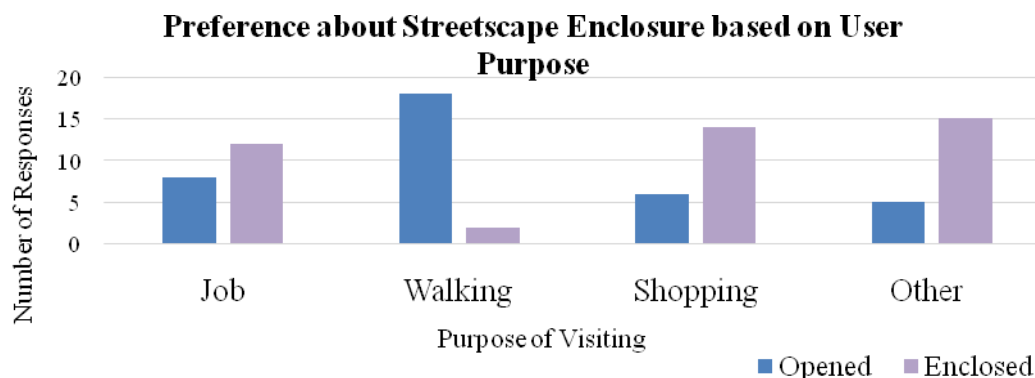


Source: Compiled by Author

When considering the user category and their preference for the streetscape enclosure majority (30%) of Drivers are prefer to have enclosed road with vertical elements such as signboards, advertisement boards, etc. According to the discussion they highlighted that place identity is the reason for that. Majority of the pedestrians (43%), shop owners and residence (38%) are preferred to have enclosed road mixed by low rise buildings and medium-sized buildings. Majority of other category prefer to have enclosed road with low rise buildings (29%) and enclosed road mixed by low rise buildings and medium-size trees (29%). However, enclosed by high rise buildings has a weak preference by every user category.

Colombo is the largest urbanized area in Sri Lanka and which has varied enclosed streets by street canyons. However, frequency of visit to Colombo has a significant negative correlation with impact from the enclosure for the root choice.

**Chart 5 Preference about Streetscape Enclosure based on Purpose of Visiting**



Source: Compiled by Author

**Figure 8 P-Value**

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.471 <sup>a</sup>	3	.000
Likelihood Ratio	23.601	3	.000
Linear-by-Linear Association	4.380	1	.036
N of Valid Cases	80		

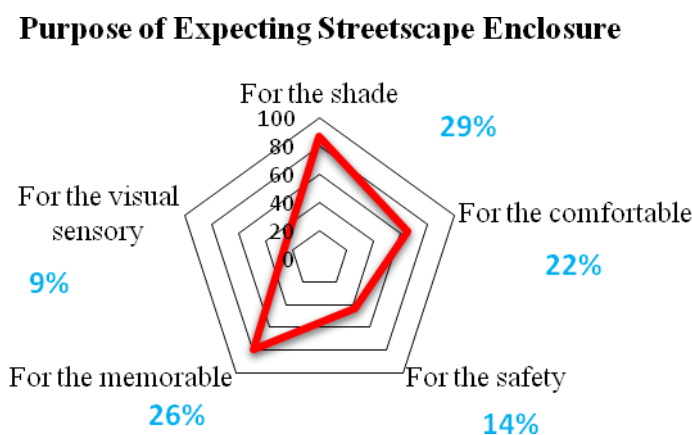
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.25.

Source: Results based on P-value – Chi square test (Descriptive statistics)

There is an association between the Purpose of visiting (Different users) and preference about streetscape. It accepts the hypothesis of streetscape variation (opened/enclosed) depend on the user category. For this analysis responded 20 participants per each category. It has a significant finding which is about opened and enclosed streets. When people use streets for walking/jogging majority (18) of them prefer opened streets with small/medium size trees. When people use streets for visiting shopping, jobs and another majority (14,12,15) of people prefer enclosed streets.

4.2.2.5 Relationship of Individual Reaction and Streetscape Enclosure

**Chart 6 Purpose of expecting Streetscape Enclosure**



**Enclosure**  
Compiled by Author

Source:

The literature explains that people expecting the streetscape enclosure because of the shade, comfortable, safety, etc. However, in Sri Lankan context 29% of the majority of people are expecting streetscape enclosure for the shade. As a tropical country which is a possible answer. Another 26% of people expecting the streetscape enclosure for the memorable. As explained by Kevin Lynch variation of the streetscape and its enclosure level is

useful for keep memory about the places. Pedestrian comfortable and safety are important elements of walkability. According to the results in the Sri Lankan context also people expecting safety and comfortable by streetscape.

**Table 8 Correlation Table**

Dependent variables	Correlations	Sig (2-tailed)	N
Feel interest	-.223*	.035	300
Feel comfortable	-.850**	.000	300
Feel safety	.600**	.000	300

*Source:* Compiled by Author based on SPSS Results (Bivariate correlation)

Because according to the *correlation table* which shows that streetscape enclosure has a significant positive correlation with feel safety. The enclosure and feel comfortable has a strong negative correlation and it significant at two-tailed. Feel interested also has a weak negative correlation with the streetscape enclosure. According to the model summary of above variables using linear regression tool feel comfortable, feel interest and feel safety have 0.850, 0.223, 0.577 model fit with level of streetscape enclosure. As explained by the concept of walkability individual reactions such as interest, safety and comfortable have significant correlations with the urban design quality of streetscape enclosure.

## 5. Conclusion and Recommendations

This study investigates the influence of physical characteristics in the streetscape visual enclosure on pedestrian movement/Walkability. Findings indicate that it has significant interaction with the street users and the pedestrian movement. Therefore, to create more walkable cities and the healthy environment, planners and designers have a responsibility for the streetscape enclosure.

The study conducted in three different case studies in Colombo MC area which includes Galle road, Marine Drive road and the Duplication road. As methodology study used the Arc GIS software and SPSS to find the relationship. The study used the Arc GIS image classification tool for classification of google street view images for visually measure the objectives of view. However, it has limitations with objectively measure the images. Significant findings under analysis indicate that enclosed road mixed by low rise buildings and medium-size trees is the most preferable enclosure type of the people. It is a common preference for all age categories also.

Especially, people not interested in high rise buildings/towers along the main arteries, as age category and enclosed road by high rise building model has a negative significant relationship. According to the discussion with people, it creates less comfortable feelings about the streets and the places with the interaction of enclosure and the human scale. However, according to that streetscape enclosure and the human scale has an enormous interrelationship. Findings show that there is a significant positive relationship between streetscape enclosure and the pedestrian movement. It has a different correlation based on age category, users and individual reactions. As a tropical country, the purpose of expecting enclosure is also significant. Because, the streetscape enclosure causes to provide shade also. It is an important fact to arrange human thermal comfort. Correlation according to the OLS regression had a weak positive relationship between enclosed by trees and pedestrian movement. Some similar case studies also argued that people interest to walk that enclosed by buildings than the trees (Li, et al., 2018). However, results and the discussion with people indicate that enclosed by trees can provide comfortable walkable environment than enclosed by buildings. Especially, people, who prefer to walking/jogging they expect street that enclosed by medium-size trees due to comfortable and shade. Therefore, preferences about streetscape enclosure different based on the purpose of visiting.

However, results indicate that visual enclosure has a significant relationship with individual reactions such as comfort interest and safety. According to the results, more enclosed roads provide less comfortable and high safety. According to Stamps (2005) the streetscape enclosure and perceived safety and comfort have a linear relationship. Majdi(2015) argued that streetscape enclosure and perceived safety and comfort have a U-Shape relationship. However, according to this study both variable have a linear relationship. Finally, according to the results streetscape enclosure promote the physical activity or walkability of the streets. Therefore, consideration of arguments and the preference by the study is important for provide more walkable cities. However, as recommendations, Street canyons better to consisting of mixed trees and the buildings, because only trees or only buildings feel less comfortable for the walkability. Building heights need to control along the streets between single story to low rise buildings, because high rise buildings along the streets provide less interest and the comfortable to the people.

Especially, for the planning of open space and jogging/walking places larger trees are not suitable. Because, trees need to arrange according to the requirement of land uses such as shopping, recreational, etc., since larger trees also can feel less safe for the walkability. Vertical elements such as advertisement boards, signboards need to arrange with the regular method as it provides less interest in walking. On the other hand, it is an essential element for place identity. However, streetscape needs to arrange with a variation. It cannot be similar along the long distance at the streets as it is also important to place identity and memory.

On the other hand, the study further explains that walkability has an association with D-Variables. Because building height have direct relations with Density. However, Big data such as Google Street View images provide reliable and recent information about urban designs on the streets. That has avoided the traditional small sample size and it provides an opportunity to study larger study areas also.

## 5.2 Future Research

In different land-use types and urban-rural, both environments may have a different experience about streetscape enclosure. To investigate the relationship of streetscape enclosure in different land-use type and urban-rural environment between pedestrian movement and user opinion is recommending for future study.

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