EXAMINATION OF NEWLY ESTABLISHED BICYCLE LANES IN SRI LANKA WITH SPECIAL REFERENCE TO PILIYANDALA AND KATUBEDDA

Niranjala Dahanayaka, *Nayomi Kankanamge
Department of Town and Country Planning, University of Moratuwa, Sri Lanka

Abstract

With the increasing use of motorized modes and related infrastructure, different issues such as traffic congestion, environment pollution and road accidents made cities not liveable for citizens. Promoting Non-Motorized Transportation (NMT) modes is the emerging substitution against this issue. Sri Lankan government recently promote bicycle lanes following the concept of, "world bike to work day". Under this project, few bicycle lanes were promoted in several towns including Piliyandala and Malabe. Although this was meant to reduce the traffic and make cities environmentally friendly, accidents increased in the areas of Katubedda and Piliyandala, after implementing the bicycle lanes. While appreciating the initiation of promoting bicycle lanes, research findings show the requirement of promoting proper infrastructure to encourage bicycle riding. Accordingly, this research suggests a GIS based bikeability index, to evaluate the bikeability (ability to ride) of bicycle lanes, for the betterment of decision making. In order to develop the index research derived different variables through literature research and, were validated through interviews with bicycle riders of Piliyandala-Katubedda bicycle lane. The results received after applying the developed index, highlighted the areas of Piliyandala-Katubedda bicycle lane, which might lead to severe traffic issues and life losses, if the existing design exist for long.

Keywords: Bikeability Index, Bicycle lane, Safety, Accidents, Design Guidelines

*Corresponding Author: Nayomi Kankanamge; E-mail- nayomi.kankanamge26@gmail.com

1. Introduction

1.1 Research Background

Air pollution, accidents, injuries, noise pollution are some of the main issues caused by fuel driven motorized vehicles such as cars, buses, vans, etc. As a solution to this issue New York, Denmark, Germany, New Zealand and other Asian countries like Japan, China and India promote Non-Motorised Transport (NMT) modes (Sustainable Urban Transport Project Report, 2014).

'Bicycle' is one of the most popular NMT mode since centuries. Handy et al., (2004) discuss the significance of usingcycling to reduce automobile use and to create more sustainable transportation networks in cities. Seattle Community Greenhouse Gas Inventory (2008) estimated that 40% of citywide greenhouse gas emissions are caused by road transportation and Seattle residents who choose to switch from driving to bicycling as a mode of transport, even for a few trips, were helped to reduce the causes of greenhouse gas emission (Seattle Community Greenhouse Gas Inventory, 2008). Such facts show the environmentally friendly nature of the bicycles.

Within Sri Lankan context, bicycle was a popular transportation mode many years ago, especially, in Jaffna, Trincomalee, Ampara areas (Ministry of Economic Development Democratic Socialist Republic of Sri Lanka, 2011). In contrast, with the introduction of automobiles, usage of bicycles was declined rapidly. Below figure shows the increasing transport and planning issues caused by motorized transport issues in Sri Lankan cities.

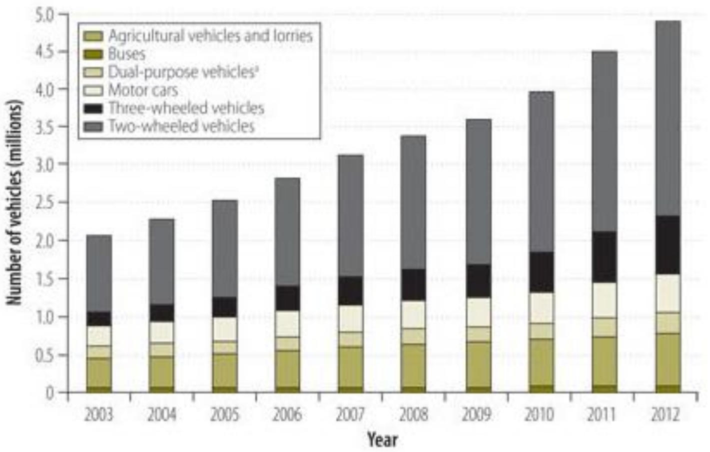

Fig 1. Registered vehicles, by type, Sri Lanka, 2003–2012 (Dharmaratne et al., 2015)

To address these issues, Road Development Authority (RDA) of Sri Lanka took an action to promote bicycles by establishing bicycle lanes in selected areas. This deserving decision was taken under the concept of "world bike to work day" which, was an initiative taken by United States and Canada. The main purpose of this attempt is to reduce traffic congestion, reduce air pollution and to gain healthy benefits (Amarasinghe Senarathna, Deputy Police of Motor Traffic, 2014). As the first attempt RDA constructed bicycle lanes in Malambe and Piliyandala areas, under the long-term vision of introducing bicycle lanes for each road in other cities.

1.2 Research Problem and the questions

While appreciating the initiation taken by RDA, the research argues that the proposed bicycle lanes are causing issues rather solving the problems in urban areas. For instance, after constructing the bicycle lanes, 12 accidents were reported (Traffic police - Piliyandala, 2017). Further, anyone who visits these areas could simply observe how automobiles use bicycle lanes to park their vehicles and bypass the traffic. Against, this backdrop this research raise the question, 'How dedicated bicycle lanes proposed in Piliyandala contribute to increase bikeability?' The new measure for bikeability introduced in this paper is a novel modification to the commonly used equations.

1.3 Research objectives

- To critically evaluate the design parameters considered in designing the bicycle lanes.
- To develop effective method to establish proper bicycle infrastructure

2. Research Methodology

2.1 Conceptual framework

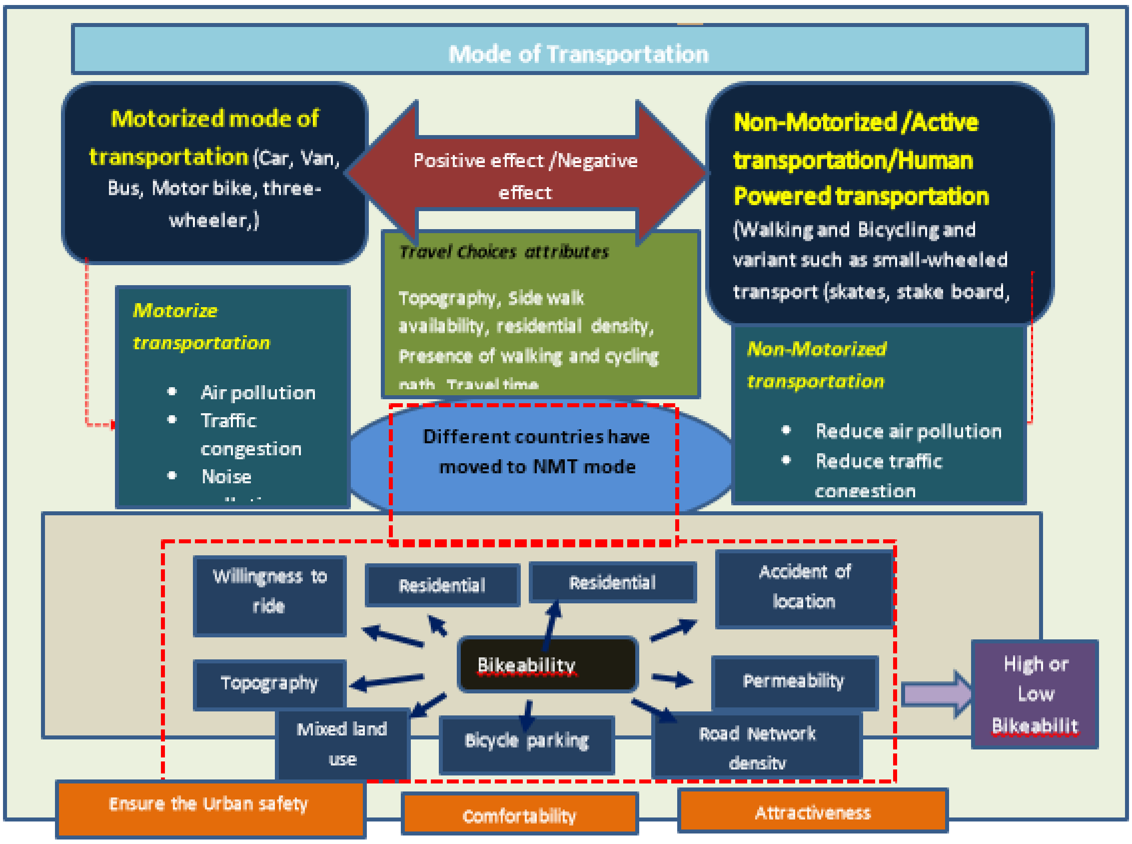

Fig 1: Conceptual Framework
Source: Compiled by author

3. Literature review

3.1 Bicycle infrastructure

Bicycle infrastructures are found to be an important factor influencing the motivation and quality of cycling. (Browne et al., 2005; Heinen, van Wee & Maat, 2010; Tirachini & Hensher, 2012; Asadi-Shekari et al, 2013). Stinson and Bhat (2005) found that bicyclists, -'those who ride the bicycles'- are sensitive to different kinds of cycling routes. Thus, to encourage people to use bicycles, bicycle infrastructure should be more attractive and convenient to the riders. According to Dill and Antos et al., (2013) infrastructure may encourage cycling by raising visibility, enhancing convenience, improving safety, and reducing conflict points with automobiles (Carr,
2003; Buehler and Pucher, 2011). Below quote further justifies the aforesaid arguments;

> "The negative consequences of automobile dependency have become widely recognized in recent decades, prompting cities across the globe to invest in transportation alternatives with the potential to improve public health, reduce air pollution and carbon emissions, and relieve traffic congestion".

Deakin, 2001; Pucher et al., 2010; de Nazelle et al., 2011;

Transport services of Scotland has included different bicycle lanes and considered dedicated cycle lane design aspects under the bicycle infrastructure to attract bicyclists in 2010. Main objectives behind proposing dedicated cycle lanesas given in the literature are summarized below;

- Increase drivers' awareness of bicyclists (Johnson et al., 2010; Pringle, 2016).
- Encourage other drivers to leave space for bicyclists (Jones, 2005; Walker, 2007; Hamilton-Baillie, 2008).
- Give people greater confidence to cycle on the road network (Daley, 2007)
- Improve 'perceived' and 'actual' safety (Timperio et al., 2004; Johnson et al., 2010)
- Assist bicyclists to pass queuing traffic (Zealand, 2008; Pringle, 2016).
- Encourage lane discipline by bicyclists and motor vehicle drivers (Hamilton-Baillie, 2008).
- Help to confirm a route for bicyclists (Walker, 2007).

3.2 Bicycle facility in Sri Lankan context

There are bicyclists within all the cities in Sri Lanka at a significant amount. With the intention of facilitating them, bicycle lanes were implemented along Malambe to Kaduwela and Piliyandala to Katubedda roads with the long-term objective of expanding them further. Below diagrams show the Piliyandala to Katubedda bicycle land and its structure (see Figure 3 & 4).

Fig.3: Bicycle lane in Piliyandala
Source: Compiled by author

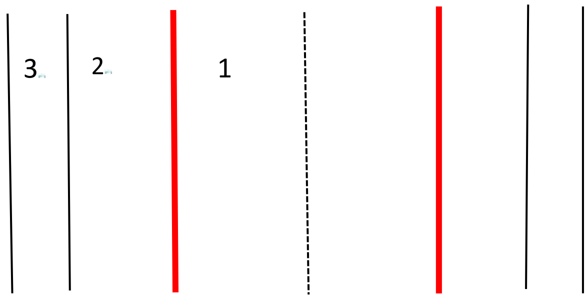

Fig.2: Existing Bicycle lane structure proposed by RDA
Source: Compiled by author 2017

As per the Figure 4, number 2 denotes the bicycle lane which is located in between the motorway and pedestrian way. Although, it was the theoretical demarcation in practice, most of automobile drivers park their vehicles in the bicycle lane (see Figure 12). This demotivates the bicyclists. It forms the main argument of this research, challenging the existing bicycle lane design parameters. According to the Transport Services of Scotland, (2010) bicycle lanes should have a proper design for encourage bicyclists. Accordingly, they encourage the authorities to adhere below five core principles in designing a bicycle lane;

1. Safety - Infrastructure should address safety of bicyclist, particularly at junctions, high slope areas and high bend areas.
2. Directness – Bicycle routes should be as direct as possible, whilst being logical, and avoiding unnecessary obstacles and delays to a journey. Planning routes as part of a network is key.
3. Comfort - Surfaces should be fit for purpose, enable smooth surface riding and should maintained.
4. Coherence - Infrastructure should be easy to understand and follow for all users.
5. Attractiveness – Infrastructure should add to the attractiveness of the public without unnecessary street clutter.

Transport Scotland, 2010

The existence of above five principles is really questionable within Piliyandala to Katubedda bicycle lane, which is the case study of the research. Opposite to the Sri Lankan context, Netherlands, Denmark and Germany have made bicycling safe, convenient to the rider (PucherJ., Buehler R. 2008). Safety of non-motorized users including bicyclists are a responsibility of other vehicle users (Facility design (AASHTO, 2010; Metroplan, 2010). The way the bicycle lanes are designed are remembering all the vehicle riders about their mutual responsibility and discipline in driving (Dufour, 2010).

3.3 Bikeability

“Bikeability” does not have a concise, universal definition. Different scholars express different idiosyncratic definitions for bikeability. Some of them and the main attributes emphasized in through their definitions are listed below in Table 1.

Table 1 – Definitions of 'Bikeability'

No	Author	Definition	Attribute
1	Wahlgren&Schantz. (2012).	'… whether the route environment is perceived as stimulating or hindering active commuting is an integrative environmental category of potential importance'	Integrative environmental, Active commuting
2	Lowry et al., (2012)	'…an assessment of an entire bikeway network for perceived comfort and convenience and access to important destinations'	Assessment, bikeway network, comfort and convenience, access to important destinations
3	McNeil (2011).	A methodology for assessing a neighbourhood's bicycle accessibility	Bicycle accessibility,Neighbourhood.
4	Winters and Cooper, 2008	"The bikeability index is a tool that can support local planner in the decision making to increase the use of bicycle through an expansion of the bicycle network, since it highlights areas more conducive and less conducive for cycling thus, where cycling condition need to be improved".	Decision making, Conducive
5	Krykewycz (n.d)	Making field measurements to create a complete area wide bicycle comfort	field measurements, bicycle comfort

The attributes highlighted through above definitions show that, bicyclists have separate unique behavior and thus it should fit to the environment, irrespectively of optimal preferred environment conditions. As per Wahlgren (2011) people use bicycle for different purposes such as, transport, recreation, exercise as well as for competition etc. Therefore, designing bicycle lanes requires to have an analytical perspective. Evaluation of bikeability, was the main method adopted to assess its effectiveness. Besides, there are many methods that have been adopted to evaluate the bikeability of bicycle lanes (see Table 2).

Table 2: Bikeability measuring methods

Method	**References**
Bicycle stress level	Sorton & Walsh (1994)
Road condition Index	Epperson
Interaction Hazard Score	Landis (1994)
Bicycle suitability Rating	Davis (1995)
Bicycle suitability Assessment	Emery and Crump (2003)
Bicycle suitability score	Turner et al (1997)
Bicycle Level of service score	Lowry et al (2012)
Bikeability index	Mesa and Barajas (2013); Krenn et al. (2015)
Bicycle Level of service	Botma (1995); Dixon (1996); Jensen (2007); Petritsch et al, (2007); The highway capacity manual (2011)

Source: Compiled by author

Such indices acknowledged the use of proper bicycle lane designs to assure the user friendliness and, motivate people to use bicycles. Table 3 summarizes different design guidelines adopted in designing bicycle lanes.

Table 1: Bicycle infrastructure designs features

Facility	Type of design
Bicycle facilities	Off-street pathways, Multi-use pathways Separated pedestrian and bicycle facilities
Cycle tracks	One-way cycle tracks, Two-way cycle tracks Curb/median protected cycle tracks, Elevated cycle tracks Parking protected cycle tracks, Bollard protected cycle tracks
Bicycle lanes	Painted bicycle lanes, No on-street, Buffered bicycle lanes, Shoulder bikeways, Contraflow bicycle lanes
Shared Use Facilities	Local street bikeways, Shared use lanes
Intersection and Crossing Treatments	Intersection Approaches, mixing zones, turning zones, at intersections, Advance stop lines, Bike boxes, Two-stage left turn boxes. Median refuges, Traffic circles, Roundabouts, Protected intersections, Intersection crossing markings, Coloured pavement markings
Signals	Bicycle activated signals, Signal Timing Leading bicycle intervals Separate signal phase Bicycle specific signal heads, Intersection restrictions
Other	Retrofitting streets for bicycle lanes, Signage, Pavement markings Maintenance, Way finding

Source: National Association of city transportation officials, 2011

Adhering the design guidelines discussed in Table 3 is worth considering to make to demarcate bicycle lanes with the motor ways and passenger ways or to design shared zones where automobiles and bicycles ride harmoniously.

3.4 Bikeability Index

Bickeability Index was used to find the level of bikeability of bicycle lanes, but without considering the environment besides the bicycle lane, it is difficult to evaluate the bikeability. Below section discusses the variables considered to develop the bikeability index.

3.4.1 Variables of the bikeability index

Bikeability indices have been used in different countries. Variables in each index represent the identical characteristics of a particular city or a region. Therefore, there is a practical deficiency in applying such indices as universal tools. For example, Mesa and Barajas (2013) have developed a bikeability index for Cali, a city in Colombia, which has only considered four factors, -'Infrastructure', 'Environment quality', 'Topography' and 'Security' (*see* Equation 1).Developing an index and visualize them through GIS, is the most common approach followed so far (Winters and Cooper, 2008; Winters and Teschke, 2010; Winters et al, 2010). Using ArcGIS to visualize the results of the bikeability index could be accredited as a powerful visual aid and a quantitative metric which, can be used to design user friendly and safer bicycle lanes.

$$BI = \alpha x_1 + \beta x_2 + \gamma x_3 + \delta x_4$$

BI = **Bikeability index**
x_1 = Infrastrucure factor
x_2 = Topografical factor
x_3 = Security factor
x_4 = Environmental quality factor
α = Weighted infrastructure coefficient
β = Weighted topographical coefficient
γ = Weighted security coefficient
δ = Weighted environmental quality coefficient

Equation 1 : Bikeability Index (Meghan Winters Michael Brauer Eleanor M Setton Kay Teschke, 2011)

4. Research design

4.1 Case study

As the research problem argues, that recently proposed two bicycle lanes, -'Malambe and Piliyandala bicycle lanes'-, are not functioning properly. During the pilot surveys, it was noted that Piliyandala-Katubedda bicycle lane is still attracting more bicyclists than Malabe bicycle lane. Therefore, Piliyandala-Katubedda bicycle lane was selected as the case study. It covers 12 Grama Niladhari Divisions (GNDs) from both Kesbewa Urban Council and Moratuwa Municipal Council.

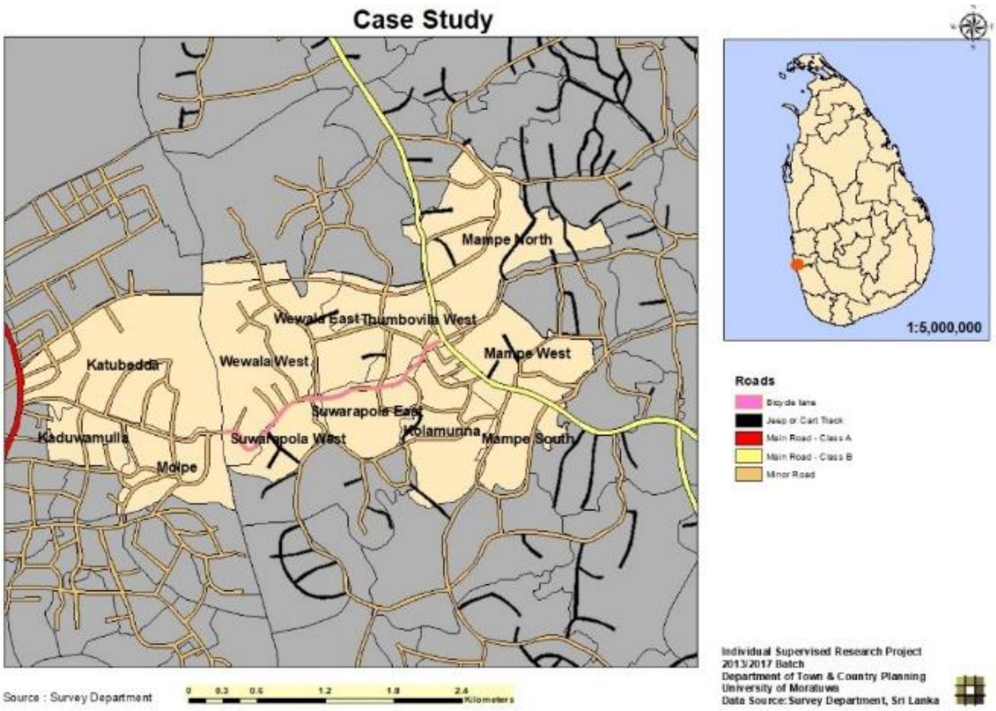

Fig.5: case study map

Research methodology was initially conducted on two stages. Stage one was to conduct a comprehensive literature review, identify variables to develop the model. The second stage is to validate and prioritize the identified variables through questionnaire surveys with the bicycle riders.

4.2 Methodology

4.2.1 Stage 1 – identification of variables to develop the bikeability index

Selecting variables to develop a bikeability index was done based on a comprehensive literature review. Accordingly, research reviewed more than 50 journal articles, conference proceedings and, derived **11** variables such as bicycle facility availability; bicycle facility quality; street connectivity; topography. Michael Brauer (2011), emphasized that, any bikeability index should use widely available data types and, thus should facilitate easy application in other cities. Therefore, he suggests to use flexible variables and weighting schemes to enable users elsewhere to tailor it to evidence about local preferences and conditions.

Characteristics of bikeability variables derived through literature review

Variable 1 – Safety (Jones, 2005; Chen, 2012; Pringle, 2016)

'Safety' should be given the first priority in designing bicycle lanes (Chen, 2012). Bicycle infrastructure designs features such as painted bicycle lanes, marking shared zones are listed in the Table 3 shows how the countries across the world use design principles to assure the safety of the bicycle lanes.
Bikeability map shows the accidents happened on the bicycle lane, reported after implementing the bicycle lane. It shows the appropriateness of selecting 'safety' as one of the key variables to evaluate the case.

Variable 2 - Topography (Daley et al., 2007**;** Zealand, 2008**;** Sandberg, 2015).

It is better to design bicycle lanes in flat terrain with low slope, unless the cycling is used for adventure rides (Sandberg, 2015). Steep slopes gradually increase the speed of the bicycles and in oppose it made riders exhausted. Rider energy consumption will increase with all these facts. The negative aftermaths of bicycle riding in steep slopes will become severe when the bicycle lanes are located adjacent to motorways or compact area.

Variable 3 - Environment condition (Timperio et al., 2004; Peiffer&Abbiss 2011; Caulfield, 2012).
Bicyclist exposure to sunlight directly will make day to day bicycle riders for their work space a severe barrier. Unlike European countries, Asian countries have high temperature. Designing bicycle lanes next to rivers and shady areas will make cyclist attractive and motivate them to use bicycles (Pucher et al., 2011). Thus, environmental condition has been one of the key facts, where mostly the scholars brought into consideration in designing bicycle lanes (Peiffer & Abbiss 2011).

Variable 4 - Mixed land use rate (Frank et al, 2005; Bruno Guasti Motta, 2017).
Mixed land use rate defined by Frank et al, (2005), denotes the rate between the number of different types of establishment and its corresponding area. This variable is measured the activity cluster of the area mixed of activity positively related to the high bikeability. Mixed of use reduce the distances within the activities. These characters are increase the bikeability. Measure the mixed land use using a formula.

$$= \left[\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ 1}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right) x\ ln\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ 1}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right)\right] + \left[\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ 2}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right) x\ ln\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ 2}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right)\right] + \cdot + \left[\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ n}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right) x\ ln\left(\frac{m^2 of\ land\text{-}use\ activity\ type\ n}{total\ m^2 of\ respective\ land\text{-}use\ zone}\right)\right]$$

According to the Bruno Guasti Motta, (2017), this formula was considering different land use activities distribution according to the respective land area. Where land use objective type 1 land use objective type 2, and Land use objective type 3 land use objective type 'n' represents the different type of activities existent in the case study (residential activities, commercial activities, and industrial activities)

Source: Bruno Guasti Motta, (2017)

Variable 5 - Residential Density (RD) (Forsyth et al., 2007; Wang et al., 2016).

High density housing has been identified in many researches as an opportunity to increase cycling (Forsyth et al., 2007; Wang et al., 2016). Accordingly, below equation was used to identify the residential density.
RD = Number of residences in one sector /Area (in km^2) of respective sector -> Equation 2
In calculating the RD one GND was considers as one sector. Higher RD levels were considered as a positive while, where the lower RD values considered to be the negatives.
Variable 6 - Bicycle infrastructure (Garrard et al., 2008; Caulfield et al., 2012; Monsere et al., 2012)

Table xx shows a list of bicycle infrastructure designs features. The research evaluated the existence of such design features along the case study area. The places having at least 2 of such features were considered as the places with high bikeability level.

Variable 7- Road Network density (Muhs& Clifton, 2016)
Road density was considered for the selected 12 GNDs using ArcGIS software. High road density areas were considered as a positive fact for bikeability (Muhs& Clifton, 2016)

Variable 8 - Importance of destination
Important destinations are grocery stores, banks, and restaurants, school etc. An assessment of an entire bikeway-network in terms of the ability and perceived comfort and convenience to access such destinations will be considered through this variable.

Variable 9 - Destination density (Krizek, 2003; Forsyth et al., 2007)

According to Forsyth et al (2007) and Krizek (2003) heterogeneity of land uses ate lead to create the destination density.

Variable 10 - Generalized cost (Rietveld& Daniel., 2004)

Rietveld and Daniel (2004) state that the monetary costs, travel time, physical needs, risk of injury, risk of theft, comfort and personal security are among the factors that impact the generalized costs of cycling.

Variable 11 - Impedance function for the travel time (Börjesson & Eliasson, 2012; Hunt & Abraham, 2007; Wardman et al., 2007)

Impedance function for the travel timeis one of the essential attributes of a trip and influences mode and route choice in different ways (Börjesson & Eliasson, 2012; Hunt & Abraham, 2007; Wardman et al., 2007).Travel can be broken down in-vehicle time, waiting time, walking time and transfer time (Ortúzar & Willumsen, 2002).

4.2.2. Stage 2 – Validating the variables through on-ground interviews.

50 bicyclist and 100 non-bicyclists were interviewed and they were asked to prioritize the above ten variables. The questionnaire survey was based on bicyclists' perceptions and non-bicyclists' (automobile drivers, pedestrians and, vendors beside the bicycle lane) perceptions about bicycling in the newly introduced bicycle lanes. Main objective of this survey was identifying their perceptions towardsusing the bicycle lane.

After considering the perceptions of the interviewees the selected **11** variables were reduced to **6**, Finalized variables and proposed evaluation criteria are listed in Table 4.

Table 2: variables

Variables	Analysis	Output	Rank
Residential Density	Calculate Number of residences using Equation RD= Number of residences in one sector /Area (in km2) of respective sector With result of equation Raster map create, raster map 10 different classes, then using reclass tool obtain raster map in 1 to 10 scales. Lower density = 1(low bikeability) Higher density = 10(high bikeability)	Density of residences	4
Topography	Ratio of bicycle lanes with low slope percentage 1 step – Using "Topo to raster" tool in the original contour lines map made the interpolation from the different elevation values of the shapefile this will generate raster map 2 step- using slope tool calculate the gradient between the different areas of the city 3 steps – using natural break, classify the map 4 step- Using reclass tool to transform the output values of the slope calculation into 1-10 scale. Areas with higher slope differences assign an index of 1 Higher slope = 10(low bikeability) Lower slope assign index 10 Low slope = 1 (high bikeability)	Slope pattern of the area	1
Mixed Land use	Mixed land use rate is comparison between the number of different activities performed in the same land use zone and its respective areas. Different type of activities existent in the city (residential activity, commercial activity, Industrial activity, etc.)	Mixed land use ratio More homogeneous activity (less diversity = 1: Low	3

	Step 1- get the value using equation. Step 2- With that result raster map created in 100m*100m grid. Step 3- Result grouped I ten different classes by flowing natural break classification and obtain 1 to 10 scales. Step 4- Using reclass tool reclassify map, higher mix of activities of area =10 (high bikeability Lower values =1 (homogeneous activities and less diversity: low bikeability)	bikeability) High mix activities=10: High bikeability)	
Safety	This map generates based on traffic-related accident involving cyclists in the area. All the accident input manually Mark the accident places in the map High accident places are low Bikeability Less accident places are low bikeability (Larsen and El-Geneidy, 2010) (Montreal)	To determine optimal location for new facilities	1
Bicycle infrastructure	Considered the availability of bicycle infrastructure (Bicycle lane) Note: Here get the assumption available bicycle lane in Piliyandala – Moratuwa road is the one available bicycle lane infrastructure according to that give the high weight for bicycle lane	Availability of bicycle infrastructure	5
Environmental Features	Availability of green corridors and, shadow effect, existence of water bodies beside the bicycle lane. Using GIS tools marking vegetation and water bodies as layers overlay with other raster maps	Availability of Shaded line and Water bodies	2

Source: Compiled by author

5. Analysis and results

Analysis and results of the paper are presented under two sections. First section delivers a comprehensive descriptive picture about the case study derived through the interviews conducted with bicyclists and non-bicyclists. The second section analyses the results derived by applying the developed bikeability index.

5.1 Results – Perceptions of bicyclists.

The results of the interviews conducted show that, most of the people ride bicycles to avoid traffic and to assure their health. These two aspects show the emerging motivation fact behind the riders, which is a prospective aspect. It further elucidates a promising future, where many bicycles could be seen in roads, instead of automobiles.

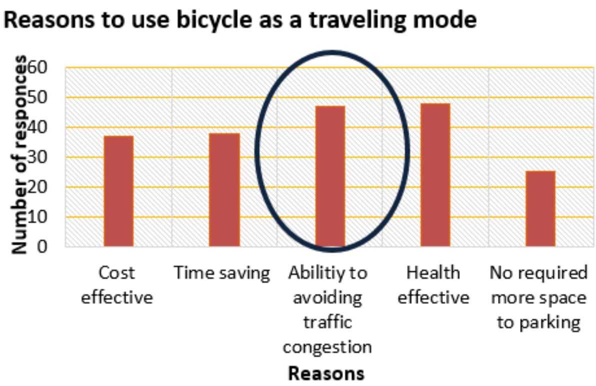

Fig. 6: Reasons to use bicycle

Nevertheless, all the riders emphasized few facts which withdraw their motivation of bicycling. The most common issue highlighted was, the bicycle lanes been blocked by other vehicles and, 86% of riders told, the vehicles parked on bicycle lanes demotivate them to ride bicycles. These facts call for proper bicycle lane infrastructure designs features. Another 50% of responders highlighted that except for the bicyclists, the automobile drivers also use this lane for driving, making cycling unsafe for them.

Even this, has caused to increase accident making bicycle lane an issue for both riders and pedestrians. According to the Piliyandala traffic police, from 2016 -2017, 19 bicyclists' accidents were recorded (see Figure 7). Parking of other vehicle on the bicycle lane and existence of bends is some of the main causes for such accidents highlighted by the responders.

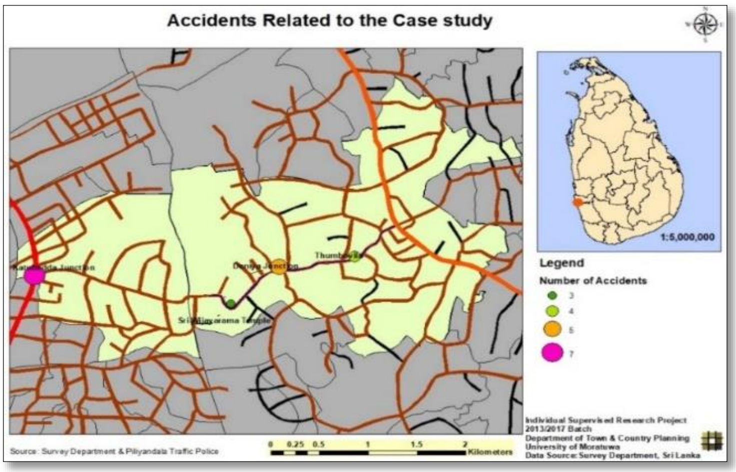

Fig. 7: Accidents map (Source: Piliyandala Traffic police)

Bicycle lane starts from Piliyandala junction and end from the Kospalana Bridge. After the exit of bicycle lane, bicyclists have to use motorways to travel the rest of their journey. Automobile in the motorways seem not welcoming the bicycles to motorways. Instead, automobiles are trying to use bicycle lane to bypass the traffics in bicycle lanes.

This shows the infancy in considering the bicycle lane design features, which has caused to make accidents for bicyclists, and pedestrians ultimately. Except for the white thin line there is no significant buffer to avoid entering other vehicles to the bicycle lane. According to NACTO (2011), bicycle lanes should be segregated from traffic lanes with a proper buffer line for safe riding. Above facts are further elaborated through the field observations conducted in and around the case study area (see Figure 8).

Fig. 8: Blocked the bicycle lane by other vehicles: Piliyandala Bicycle lane

5.2 Development of a 'Bikeability Index'

Bikeability index will be introduced as an ArcGIS tool, thus will show the less bikeable areas spatially.

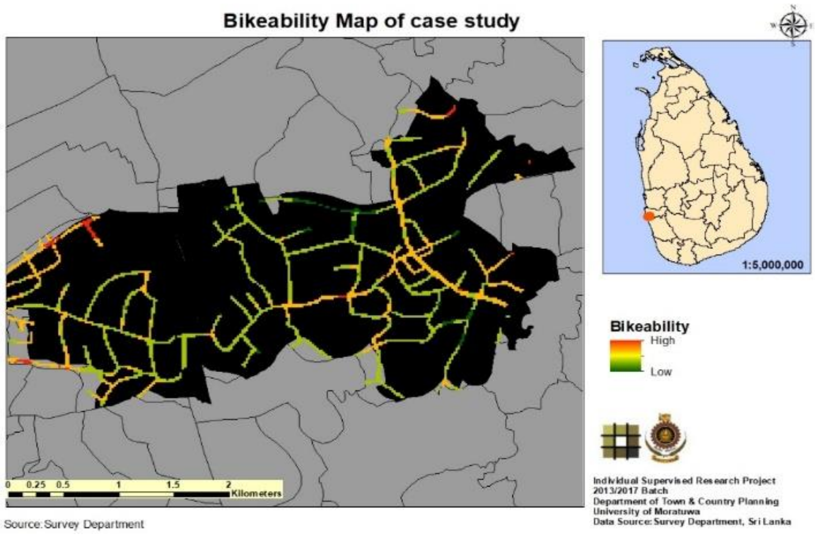

Fig 9: Bikeability map -Piliyandala

Each variable was evaluated through separate raster maps developed as described in the Table 4. According to the bikeability map existing bicycle lane is located on high elevation area and, due to thatsteep slopes could be observed. These are the most vulnerable areas for bicycle accidents (see Figure 7).

Piliyandala and surrounding areas are consisting with residential, commercial, agricultural, religious, etc. activities. Angulana, Thelawala, Moratuwa, Katubedda are the trip generating areas, where labors, students, businessmen and other employers with residential areas, but still these areas are having low bikeability since such areas are not meeting the other conditions. Further, from Katubedda junction to Piliyandala road network density is high. The researcher couldnot observe any special bicycle lane infrastructure except for the while line to demarcate the bicycle lanes with the motorway. On the other end the existing case is not getting the benefits of canopy shadow effect. Therefore, after considering all the facts, the composite bikeability map shows that Piliyandala-Katubedda bicycle lane is a failure and need to be considered the above variables to harvest the best results.

6. Conclusion

Newly initiated bicycle lane implementing project was evaluated through this research, considering Piliyandala-Katubedda bicycle lane as a case study. Research attempted to critically evaluate the design approach and facts considered to design the Piliyandala-Katubedda bicycle lanes interviewing bicycle riders and, through a bikeability index. As a non-motorized transportation mode bicycles fulfil the major task in transport aspects. For instance, to travel short distances, other countries use bicycles i.e., Denmark, Norway, India and Japan.

In contrast, Sri Lankan citizens are moving from bicycles to automobiles. Enough studies have shown the significance of moving automobiles to bicycles. RDA has initiated to implement separate bicycle lanes as a solution for this, but the research findings show that the established bicycle lanes needs more background studies such as its physical design, relevant variables and standard design guidelines, level of bikeability, prior implementing the bicycle lanes. Piliyandala-Katubedda bicycle lane neither satisfy the authorities to meet their goals nor the riders to enjoy a safer ride. Further, the case study does not consist with the attributes mentioned at the bikeability definitions expressed by different authors (see Table 1). Therefore, research emphasize the need of considering the bikeability level of a bicycle lane prior implementing. Since ‘world bike for work today’ project is a fresh study which, is at its initial stage of expanding their project of introducing bicycle lanes to the Sri Lankan cities, this research could be useful document for RDA, to look back the project prior expanding the same model further.

7. Recommendations

This research was considered few variables develop bikeability index to find the bikeability of case study due to limited time period and lack of data availability.

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