

IMPACT OF ROADSIDE LANDSCAPE TO DRIVING BEHAVIOR; A STUDY WITH REFERENCE TO SOUTHERN HIGHWAY

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Abstract

The highways, road networks, and other transportation links in cities hold an important role in connecting a network of cities but, at the same time, it had created more issues towards quality of the habitation when consider current cities.

Lack of Safety on Roads becomes a major issue in the developed and developing world due to over population of humans as well as vehicles, which lead to many fatal incidents than any other course. There are many factors which affects accidents on roads and among those factors, the 'Driving behavior' plays a crucial role in Road Safety.

Driving is an action of humans, which allows him/her motion through space from place to place. The road landscape creates the character and the spatial quality, of the space that the driver move through. The rate of information gathered from the surrounding context is vital to decide the driving safe. The accuracy of the information for a safe driving action depends on the visual perception of the driver.

'Southern Expressway', which was introduced recently, allowed people to move quickly from Western to Southern destinations of Sri Lanka and time to time accidents were also recorded. So, the spatial qualities of the existing road landscape might have impacted on the accidents happened on Southern Highway from its initiation, which was the hypothesis of the research.

The study focused on identifying the spatial characteristics of Southern Highway by Data collection and Data analysis. Data is collected by two means, then analyzed based on accidents recorded and "Black-Spots" were identified, live recording of the expressway was analyzed to understand the spatial characteristics in the identified 'Black-spots'.

In conclusion, the study focus on to analyze the significant spatial characteristics of Road Landscape in Southern highway, and reveal that there is a direct influence from the spatial characteristics in identified accident Black-spots. The study conclude to analyze only three spatial characteristics, due to the scope and time limitations and there is an opportunity to further studies in many other spatial characteristics in road landscape.

Keywords:Road safety, Road landscape, Driving behavior, spatial characteristics.

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1.0 Introduction

As a developing country, Sri Lanka recently intended to develop their transportation network up to the world standards; result of that the expressway system has introduced to the country. With the development of standards of the roads, the major issue arising is the 'road safety'. When analyzing the road accidents reported each year, considerable amount of them caused by the road environment and its landscape. So, this study is concentrated on **to study about the impact of physical environment of the roads to the driving behaviours**.

To establish road safety, should control the road accidents. Driving is a motional action, which is experiencing the landscape through different spaces. The driving behaviour is attached with the surrounding physical space of the driver. So, driver experience the space of the road landscape relative to the speed. When unable to capture the correct spatial changes in correct time, the 'Accidents' can be happen. There can identify different reasons for road accidents, issues from,

- The environment
- The road users
- The vehicle defects
- Driving behaviours.

Driving Behavior

Driving is a complex activity, which have to engage all the senses of human. It's an intellectual, cognitive and emotional experience. A driver should always balance his mental and physical states in a satisfactory level while in driving. When considering the road safety, the driving behaviour holds an important role. Driving is a multi-skilled experience which influences by both, psychological states and physiological states of the driver, as well as influenced by the internal and external factors.

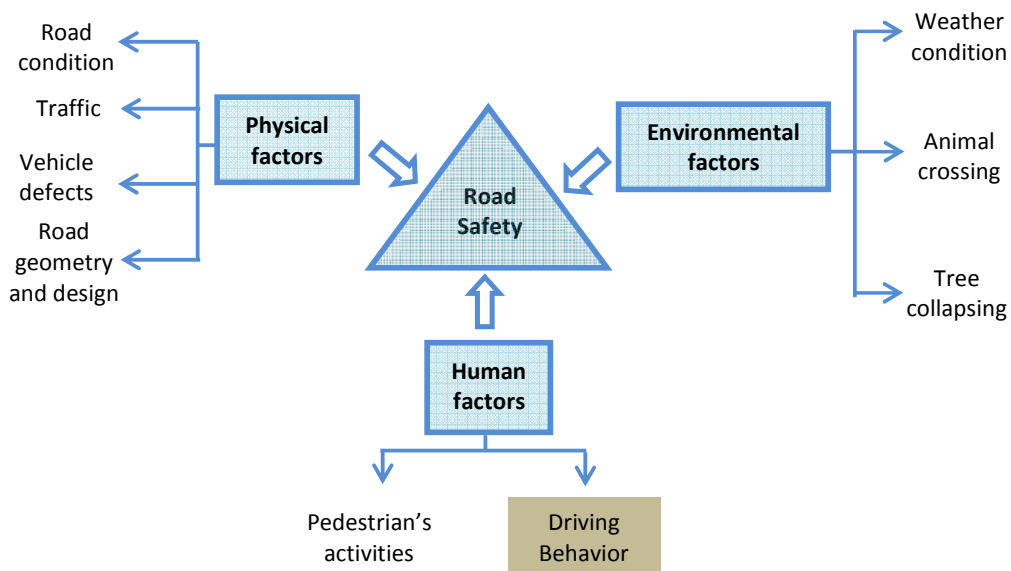


Fig 01 - Factors determine Road Safety
Source : Compiled by author

It is found that 92% of road accidents caused by human factors. (Importance of a strategic plan to prevent road accidents in Sri Lanka, 2012)

Driving behaviour and Visual Perception

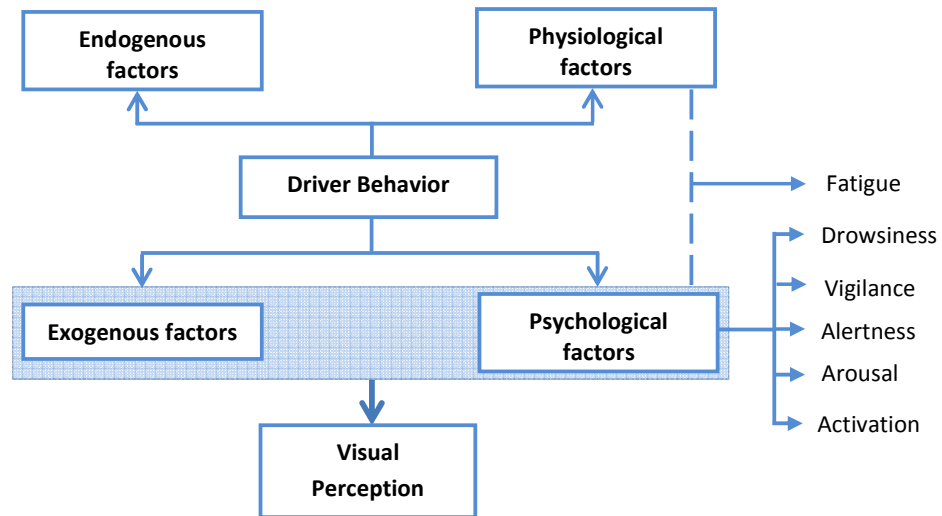


Fig 02–Driving Behaviour and Visual Perception
Source: Compiled by author

The book titled as ‘The experience of nature: a psychological perspective’ by R. Kaplan and Kaplan(as cited by in Antonson , Mårdh, Wiklund, & Blomqvist, 2009, P.494) explains that people experience and react to a landscape is based on cognition and their experiences. It is also found that most of anthropogenic activities are the results of what the human eye perceives from the surrounding landscape.

Many Researches have found that **fatigue, drowsiness, vigilance, alertness, activation** and **arousal** are the frequently occurring negative processes with the visually perceived information from the environment when performing the driving. Therefore, the effective action of driving depends on the individual’s visual perception. The exogenous factors and psychological factors determine the visual perception of drivers.

Driving behaviour and Road Landscape

“The Road Landscape is considered as a product created by a human and nature which should provide pleasure to its main users.” (Matijosaitiene, 2011)

The term ‘Road Landscape’ defines the visible road environment which includes all physical surroundings and components such as, roads, road equipment and signs, electric transmission lines, vegetation, service infrastructure and other buildings which are located not further than 3 km from the axis of a road.

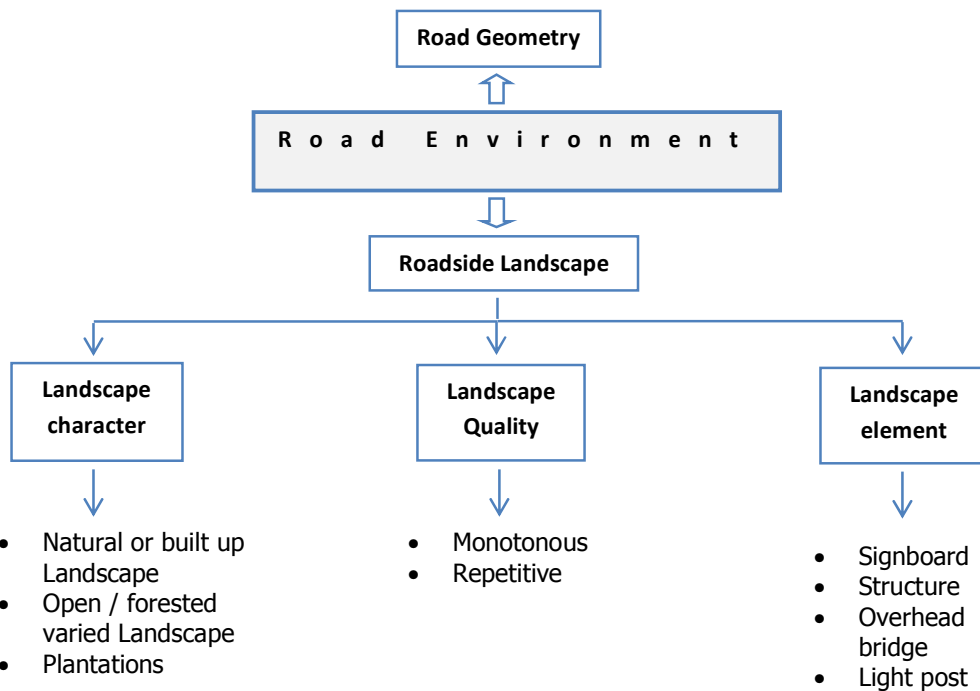


Fig. 03 - Categories of Road Environment
 Source : Compiled by author

The 'DriverBehavior' is an interactive activity by a human which is a collection of different skills and processes.

The driving skills can be divided into four broad categories,

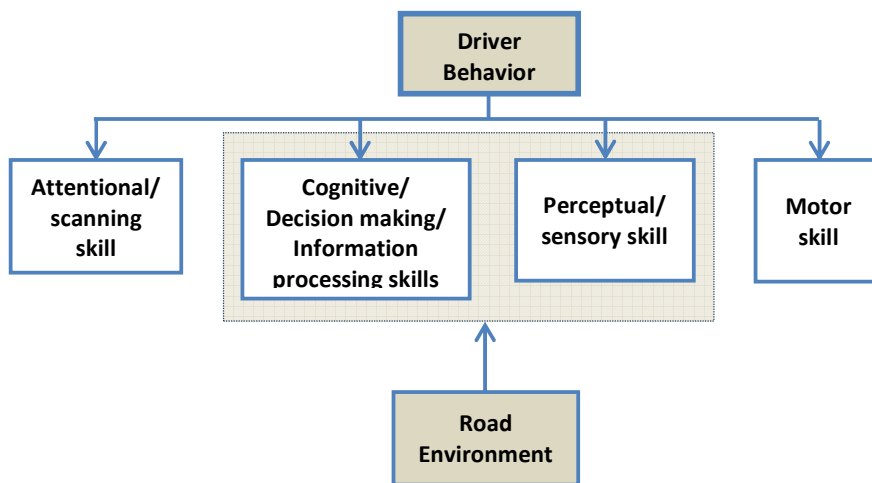


Fig. 04 - Skills of driving Behaviour
 Source: compiled by author

According to Küllers' model of the basic emotional process, "driving behavior is related to the physical environment, other road users, the driving task, the individual factors and own abilities, and to the interaction among them" (Matijošaitienė & Navickaitė, 2012). The road environment has significant impact on the driver's perceptual/sensory skills and cognitive/decision making and information processing skills.

However, driving is a visual experience of outside driving environments. The drivers limit their visual experience mainly to the larger spaces and land forms, because the drivers always focus

on the narrow band created by the road. But, drivers may interested to expose to a broader visual field even for a brief moments. But the increasing speed reduced the visual field.

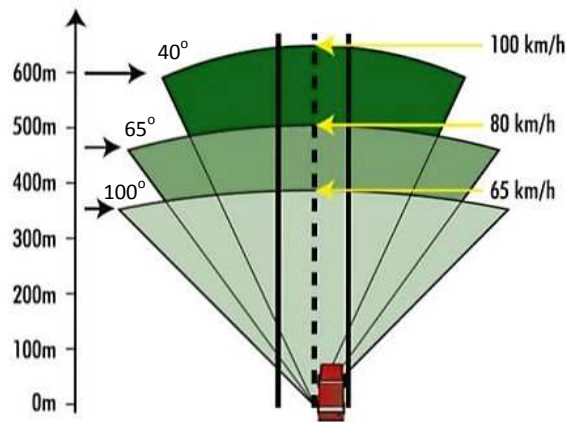


Fig. 05 - Speed and field of vision

Source: The Role of Road Engineering in Combatting Driver Distraction and Fatigue Road Safety Risks, (2015)

The fig. 05 above shows when the speed is increased the field of vision of the driver is narrowing and the driver focusing on to more distance views. Drivers pays a greater attention to what is beside the road. So, the roads and highways should have a visually pleasing environments. The landscape of roadside environment should be considered when designing roads and highways. A research done by I. Matijošaitienė and K. Navickaitė found that in Germany 68% of all the car accidents happened due to the wrong design of road and its landscape, and because of insufficient information of road and its landscape. Therefore, The Road Designers, Landscape Architects and Traffic Engineers have the potential to increase the level of visual stimulation of the roads and highways by changing the surrounding landscape, including curves to the road design and road information boards like kilometer counters; which encourage mental calculations that can enhance alertness. Many studies prove that drowsy driving can be reducing by design efforts in highway designing. The study of 'Monotony of road landscape and driver fatigue, by Thiffault & Bergeron, points out that visual stimulation can be used as countermeasures to eliminate driver fatigue.

So, the Roadside Landscape has huge impact on to the Road safety in terms of Driver behaviour.

1.1 LITERATURE REVIEW

Spatial Characteristics in Road Landscape

Road landscapes are diversifying according to its' spatial characteristics. According to the research titled as 'A new concept of Landscape design in Highway Construction' (Gong, Xie, XU, FU, & LI, 2005), identified six models to integrate into the planning, design and construction of highway landscapes; the models of highway alignment, the model of pavement and side slopes, the model of highway construction, the model of subsidiary facilities along the highway corridor, the model of highway greening and other landscape model. The following spatial characteristics in road landscape identified from those six models.

- Solidity & degree of enclosure
- Differentiate of forms
- Proportion or scale of the space
- Gradient of the slopes/embankments

These spatial characteristics in Road landscape have the potential to affect driving behaviour positively or negatively.

Solidity & degree of Enclosure

Solidity is a vital factor and can be experience as solids or voids along the roadway which are sometimes created by rocky slopes or soil berms and paddy lands or bare lands.

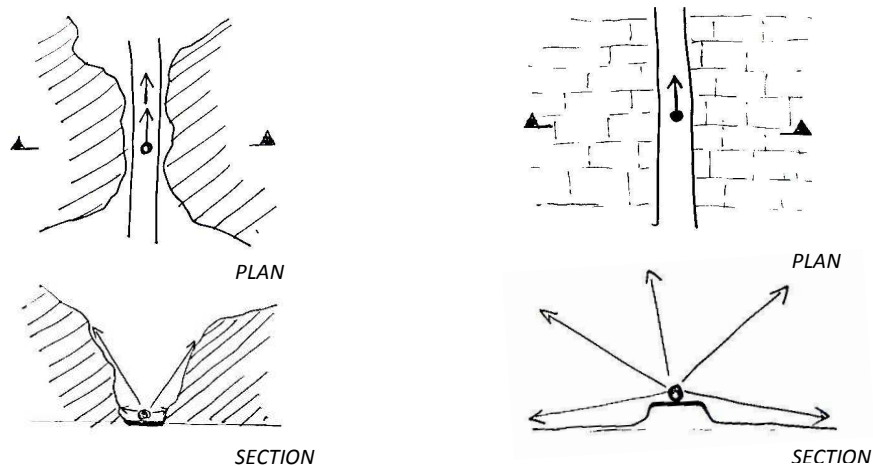


Fig. 06 - Solidity & degree of enclosure

Source: drawn by author

When approaching from void to solid or solid to void affects differently to the observer. Actually, it psychologically affects to the driver's mind. As per the finding of Brude & Wretling in their study, (as cited in Antonson et al., 2009) the 'accident risk has been shown to be higher in open terrain with a monotonous road experience and regular geometry than in closed forested terrain'.

When someone moves through a narrow solid space, it feels very uncomfortable and constricts the mind. So, it induce the mind to escape and move fast. The speed will increase in this kind of

spaces. When move through open lands it relax the mind of the driver with spreading the views of the landscape. Therefore, in these spaces the speed will automatically reduce.

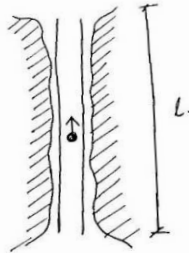


Fig. 07 - Distance of a solid/void matters a lot
Source: drawn by author

When moves through solid or void spaces the distance matters a lot. If the solid /void distance increases, the road landscape turns into a monotonous space. It depends on the relative speed of the vehicle. So, when designing the roadways it is important to have a composition of solid & void spaces.

Differentiate of forms

Human always identified 'forms' first when they expose to a scenery, then identify the details such as colors, lines etc. So, the forms in the road landscape helps to legibility of the roadway. The lack of variations in the forms creates a monotonous roadscape, which draws the drivers to fatigue, drowsiness and hypo-vigilance.

The study of Vagverket (as cited in Antonson et al., 2009) mention that the spatial form of a road or street should give clear visual guidance and signals to drivers regarding suitable speed and driving behaviour.

Drivers limit their visual experience mainly to larger landforms and spaces, since they have limits their focus on to a narrow band with the speed. (Appleyard, Lynch, & Myer, 1965) So, they are more concentrate about the immediate verge of the road. The driving behaviour changes accordingly to the landscape form of the immediate verge of the road.

Proportion or scale of the space

According to the research on 'A new concept of Landscape design in highway construction'(Gong, Xie, XU, FU, & LI, 2005)it is highlighted that the cross section of the highway and the organization of its space is a crucial factor to consider in planning, designing and construction phase of the highway landscapes. Proportion or scale of the space creates a huge psychological impact to the driving in a highway. When a roadway falls through a landscape, it creates different spaces in different proportions.

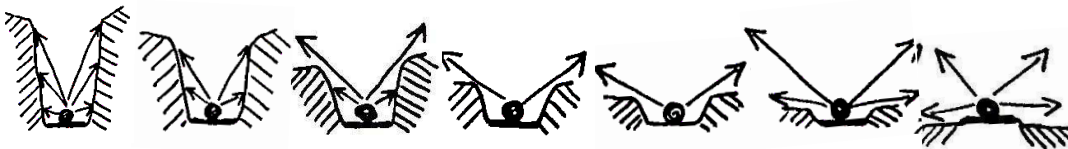


Fig. 08 - Proportion or scale of the space
Source: drawn by author

According to the above diagramme, in a space, where the proportion is much larger than the observer it is more uncomfortable to drive through. It psychologically congested mind of the driver. When subsequently reduce the proportion it seems psychologically more comfortable to the driver, the mind expand and positively affected.

Gradient of the slopes/ Embankments

Gradient of the slopes/embankments is also impact to the driving behaviour, as fig. 09 indicates that, when larger the gradient its' difficult to drive through the space. So, there are standard gradients to final slopes when constructing the highways.

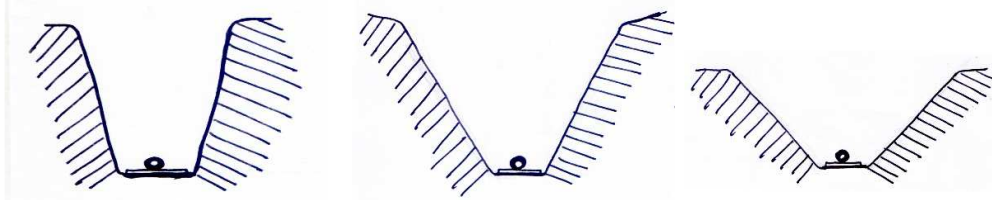


Fig. 09 - Gradient of the slopes/embankments
Source: drawn by author

As Zhiyong's study (as cited in (Gong, Xie, XU, FU, & LI, 2005) mentioned that the road users are less able to have head movement, as vehicle speeds up in a certain direction. So, their attention would be directed to the lane and side slopes. So, road lane and side slope view can ensure the safety of road users and give them better views.

The side slope view, especially in cuttings and embankments, is highly visible to the road users in highways, so, the form and the angles of the slopes decides the visual quality of the scenery of highways. So, the form of the side slopes should be changed as often as possible, the vegetation can be used in upper slopes to change the views with time, to absorb the noise and lessen driver fatigue.

Experience of Road Landscape in Highways

There are many characteristics in highway landscape affects the experience of driving in highways. The different stages of highway experience is processed with the spatial sequences made up of many elements in landscape.

The study done by (Appleyard et al., 1965)found that two-third of all elements experienced by the driver in highway, are straight ahead and only one-third of elements are either in the right and left sides. And, almost all things seen to the side of the road were obliquely forward to the driving direction rather than perpendicular or backward.

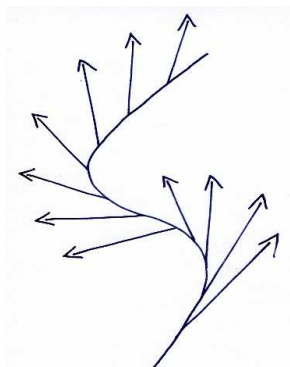


Fig. 10 – Change of visual focus in highway driving
Source: drawn by author

Also, the focus of attention is regularly switched from side to side. As mention above, the speed increases, the driver's attention is confined to a narrow forward angle. The attention may shift

to more distant and relatively stable elements. The landmarks are seen in clusters rather than single objects, a larger landforms and spaces make commands to the driver and the scenes are changes from detail to generality. (Appleyard et al., 1965)

Sense of motion in highways

The drivers aware about the speed they are moving by interpreting the apparent motion of surrounding objects, which they know already the objects, are fixed. In a highway, drivers always moving with visual clues and illusions, such as the outward radiation of details and textures from the point of dead (fig. 11A), the apparent rotation of near objects around far objects (fig. 11B), the growth of objects from the point of dead (fig. 11C) etc.

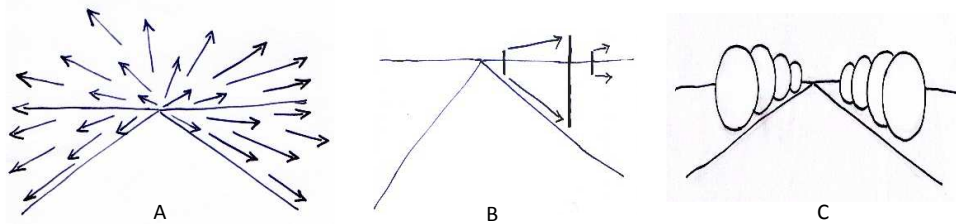


Fig. 11 – Visual experience of highway driving
Source: The view from the road, drawn by author

The sense of motion in highways is mainly can experience as visual sequences. A proper continuity of the visual sequences is much important when performing a safe driving. The road alignment, the road landscape, the form of the space and many other factors contribute to the continuity of visual sequences.

The visual field of the driver, not only be interpreted as a series of distant views, or a collection of objects in motion, but also as a space with solids and voids. Therefore, the sensation of driving through highways different from spatial form, it can be confined spaces or flat terrains.

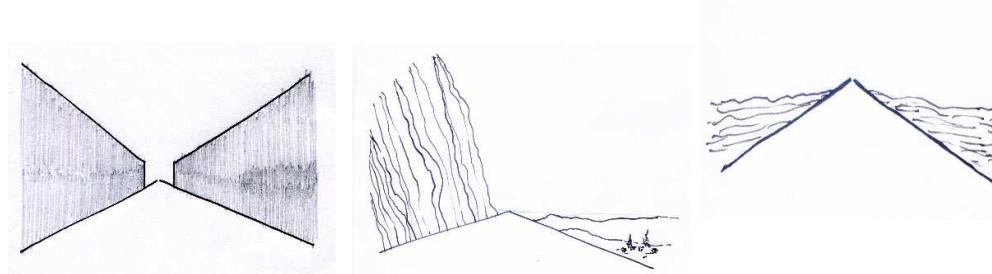


Fig. 12 – Variation of spatial form in highway driving
Source: The view from the road, drawn by author

1.2 Theoretical Framework

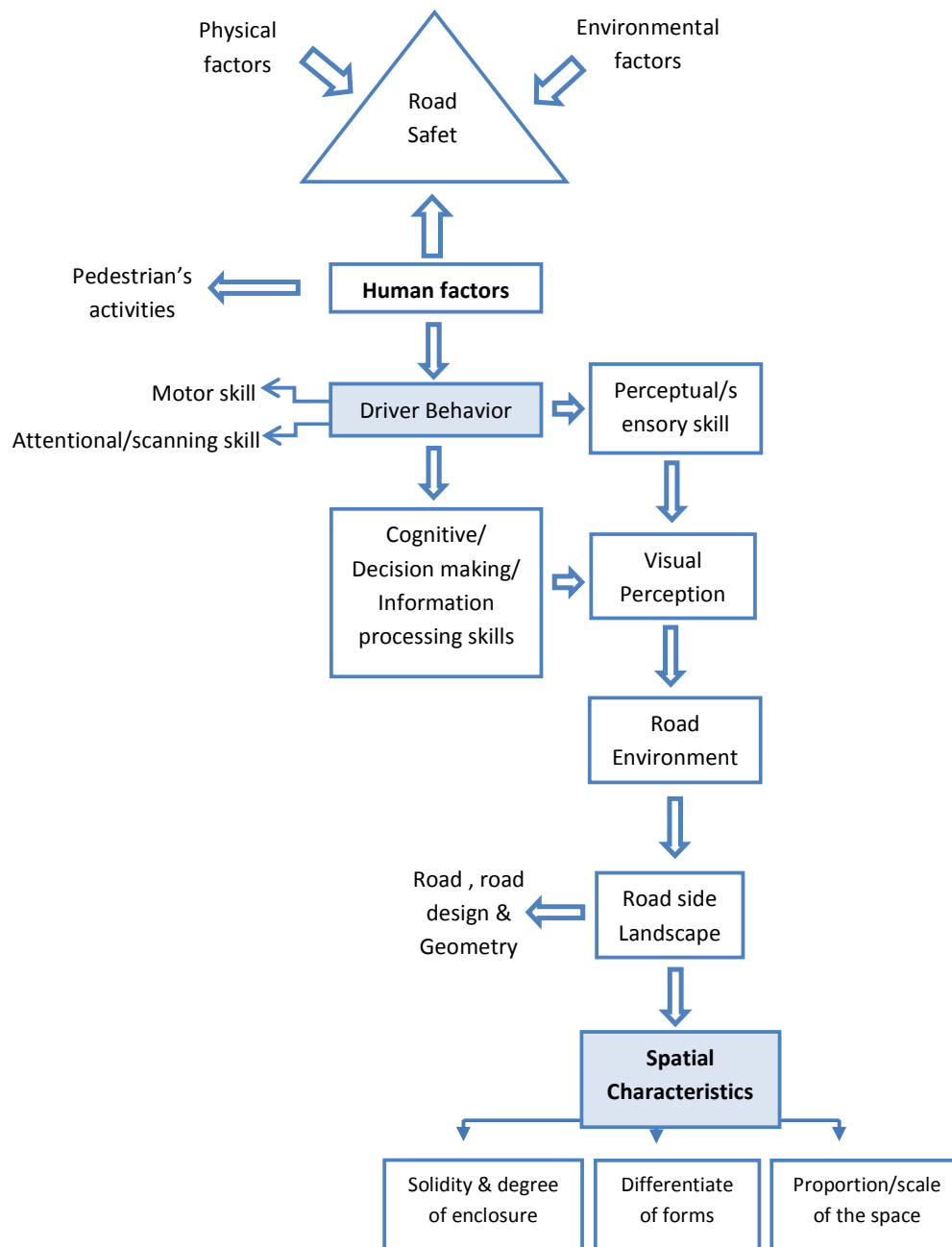


Fig. 13 - Theoretical Framework
Source: compiled by Author

1.3 Research Methodology

Southern Expressway is selected a case study , considering its' highest Average Data Traffic(ADT) with comparing other two expressways in Sri Lanka.

The study formed with three stages.

Stage 01	- Literature Review to form theoretical Framework
Stage 02 (Data Collection)	- Phase 01 – Accident data collection - Phase 02 – Field Data collection
Stage 03 (Data Analysis)	- Phase 01 – Identification of 'Black-Spots' by analyzing accident data - Phase 02 – Use of Photographic Analysis method to analyze the Road Landscape of identified Black-Spots.

From the collected data in Stage 02 has been analyzed and categorize by 'Accident causes' and 'Locations'. Then identified the accident 'Black- Spots' (high risk accident locations) in terms of driving behaviours. The spatial characteristics of road landscape mention below, have been analyzed from the identified two black spots from both directions. The study is confined to analyze only major three spatial characteristics due to the time limitations and scope of work.

1. **Solidity & degree of enclosure**
2. **Differentiate of forms**
3. **Proportion-scale of the space with respect to the observer**

The above mentioned spatial characteristics analyzed within 7km stretch, 4km before & 2km after from the identified 'Black-Spot'.

1.4 Data Collection and Analysis

The Southern Expressway runs up to 126km from Kottawa to Matara with 11 interchanges. From the date of opening 2011 November upto 2016 February, there were **2602 accidents** recorded in both directions which was the highest among other expressways in Sri Lanka.

The recorded accident data were collected by the Expressway Operation Maintenance and Management Division.(EOM & M Division) and then sort them according to the accident location. Then, identified the most accident prone areas in Southern highway by both direction. Then arranged them according to the accident cause, under main three factors to identify the percentage of driving behaviour related accidents. Again sorted the driving behaviour related accidents according to the location in both direction, to identify the accident prone areas of driving behaviour related accidents. Then use 'dot density measure' to the identified accident prone areas to recognize the specific locations ('Black-Spots') of driving behaviour related accidents. Those identified Black-Spots used to study the Spatial Characteristics of Road Landscape.

When analyzing the recorded accidents happened in Southern Highway, can identify some specific areas in both directions, recorded most number of accidents.

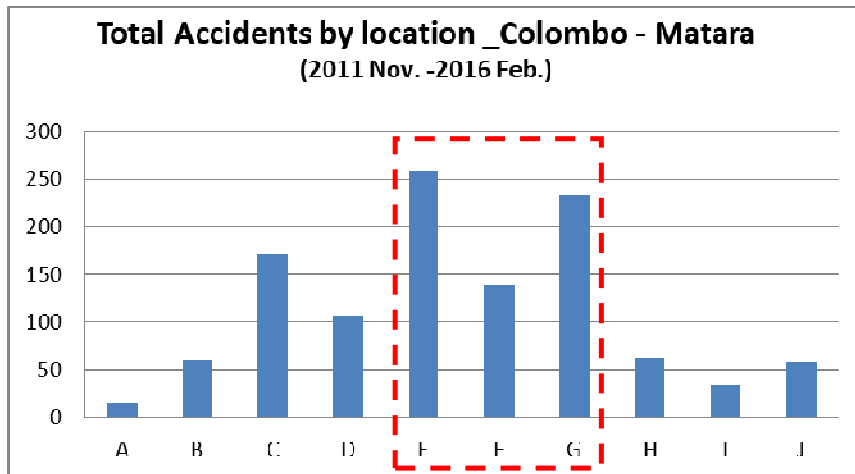


Fig.14 -Total Accidents by location_Colombo – Matara direction
 Source: Database-EOM & M division, compiled by author

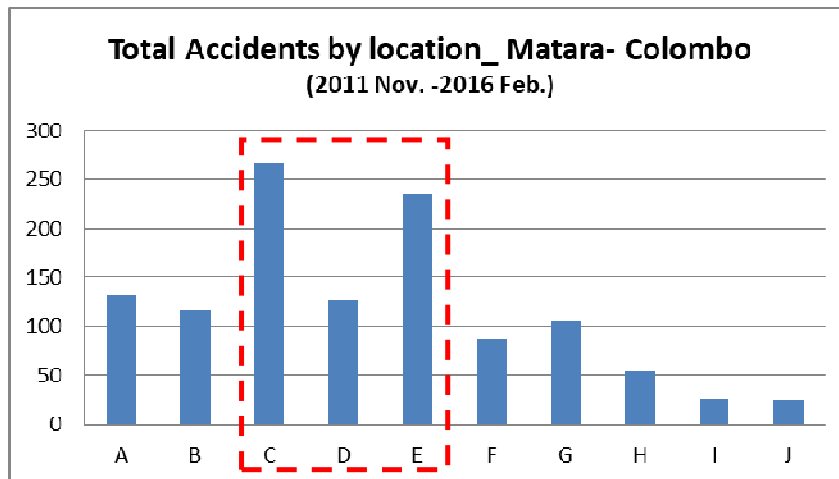


Fig. 15 -Total Accidents by location_Matara- Colombo direction
 Source: Database-EOM & M division, compiled by author

Table 9- Highway Interchanges and distances

	DISTANCE	INTERCHANGE		DISTANCE	INTERCHANGE
A	0-6 km	Kottawa-Kahathuduwa	F	68-80 km	Kurundugaha-Baddegama
B	6-14 km	Kahathuduwa-Gelanigama	G	80-96 km	Baddegama-Pinnaduwa
C	14-35 km	Gelanigama-Dodangoda	H	96-108.4 km	Pinnaduwa-Imaduwa
D	35-46 km	Dodangoda-Welipenna	I	108.4-116.3km	Imaduwa-Kokmaduwa
E	46-68 km	Welipenna-Kurungugaha	J	116.3-126 km	Kokmaduwa-Godagama

Source: compiled by author

So, when carefully analyzing above charts, most number of accidents happened in same areas in both directions. So, there may have a contribution from road landscape to those accidents.

The study is conducted in the day time, because two third of all accidents in Southern Highway happened in day time.(Source: Database-EOM & M division, Southern Highway)

According to the accident data collected from the Southern highway EOM & M division, the road accidents mainly happened according to three factors.

1. Human Factors
2. Physical Factors
3. Environmental Factors

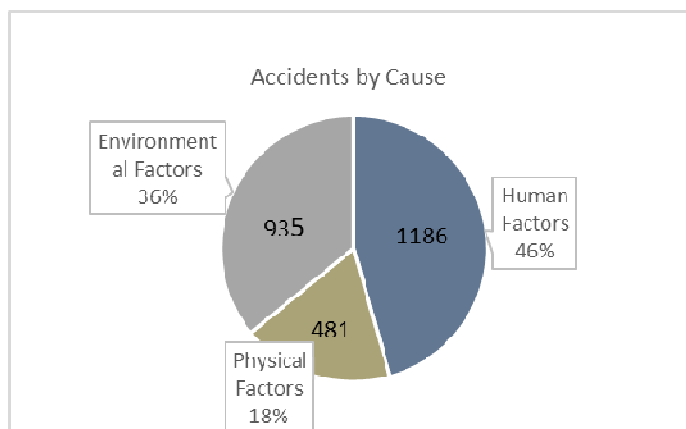
The 'human factors' include all the errors from the drivers' side which were caused to accidents in Southern Highway. 'Physical factors' include all the issues from external environment and the vehicle. The 'Environmental factors' include all the accidents happened due to the issues from the environment. The accidents related to the Driving Behaviour include in the human factor's column.

These are the causes of accidents which were recorded in the Southern Highway from 2011 November – 2016 February. The data were collected from the Expressway Operation Maintenance and Management Division.(EOM & M Division)

Table 10–Accidents by cause in southern highway

	Human Factors	Physical Factors	Environmental Factors
Driving Behaviour	Alcohol - 15	Vehicle defects - 293	Bad Weather - 527
	Bad Driving - 396	Electrical Problems - 30	Animal crossing - 408
	Fatigue - 316	Stone throw/hit - 127	
	Negligence - 146	Other objects - 7	
	Overtaking - 168	Road slippery - 14	
	Sudden Stopping - 29	Fire - 1	
	Speed - 113	Others - 9	
	Reverse - 3		

Source: Expressway Operation Maintenance and Management Division



Bad Driving - 396
Fatigue - 316
Negligence - 146
<u>858</u>

Driving Behaviour causes 32% of total accidents.

Fig. 16 – Percentage of accidents by cause- Southern Highway
 Source- compiled by author

According to the above analysis, human factors contribute 46% of accidents happened in Southern highway, Environmental factors contribute 36% of accidents and Physical factors holds 18% of accidents in Southern Highway.

Driving behavior related accidents (accidents caused by Bad Driving, Fatigue, Negligence) contributed 32% of all accidents happened in Southern Highway. So, to further analyze, the study focused on to the driving behaviour related accidents (accidents caused by Bad Driving, Fatigue, and Negligence).

When analyzing the driving behaviour related accidents, the most accidents recorded between Kurundugahahetekma – Baddegama from Colombo to Matara direction. Then, a dot density measure has been used to identify the specific Black-spot between 70km – 90km. From that, it can be concluded that the most number of accidents happened between 89km and 90km.

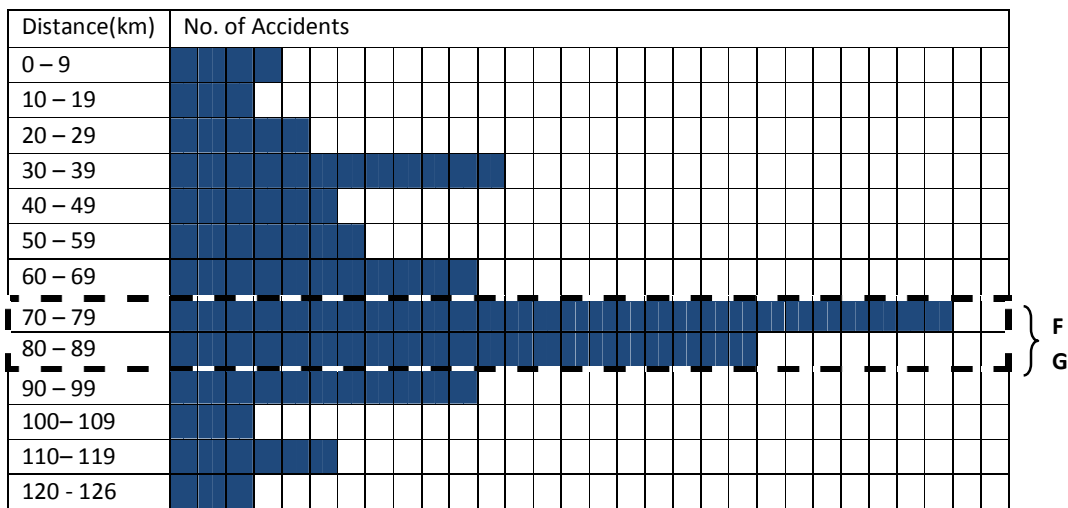


Fig. 17 -Black- spot identification chart, most accidents in Colombo to Matara direction
 Source: compiled by author

F – Kurundugahahetekma- Baddegama Interchange (68-80 km)
 G- Baddegama- Pinnaduwa Interchange (80-96 km)

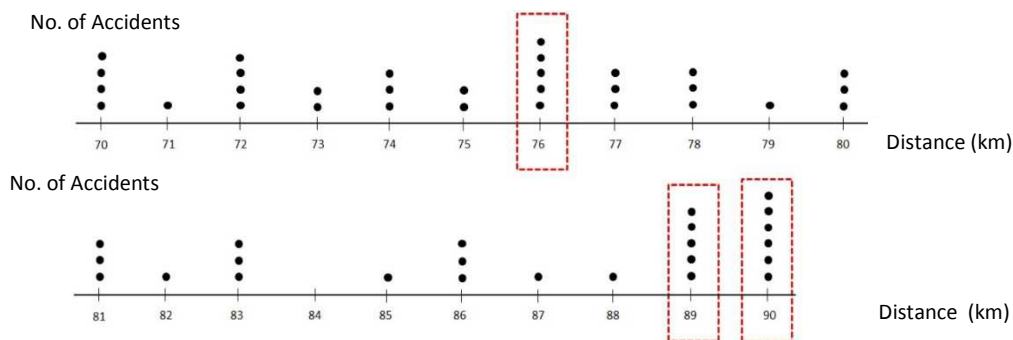


Fig. 18 - Dot-Density measure to identify black spots, Colombo to Matara direction
 Source: compiled by author

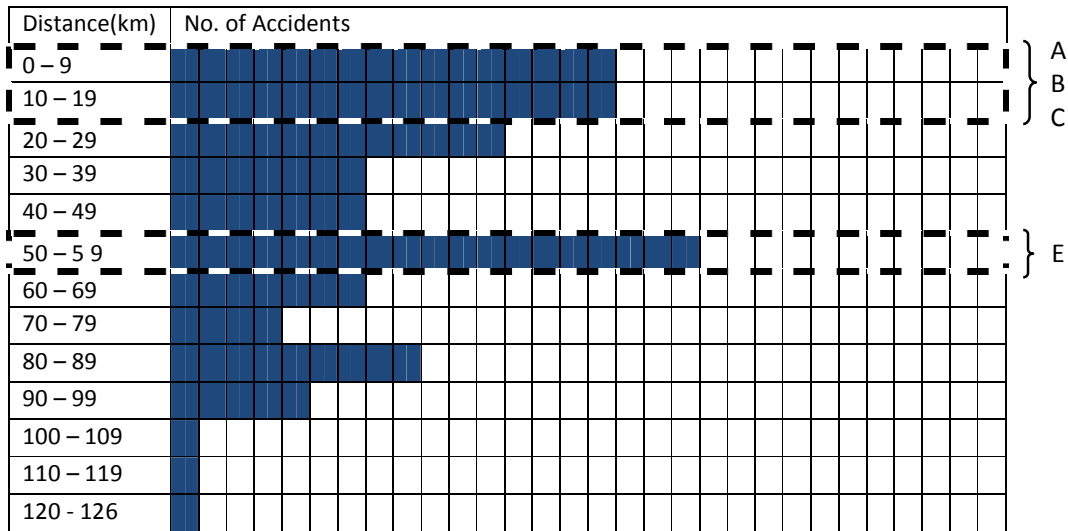


Fig.19 -Black- spot identification chart, most accidents in Matara to Colombo direction
 Source: compiled by author

- A – Kottawa – Kahathududwa Interchange (0-6 km)
- B – Kahathuduwa- Gelanigama Interchange (6- 14 km)
- C – Gelanigama- Dodangoda Interchange (14- 35km)
- E – Welipenna - Kurundugahahetekma Interchange (46-68 km)

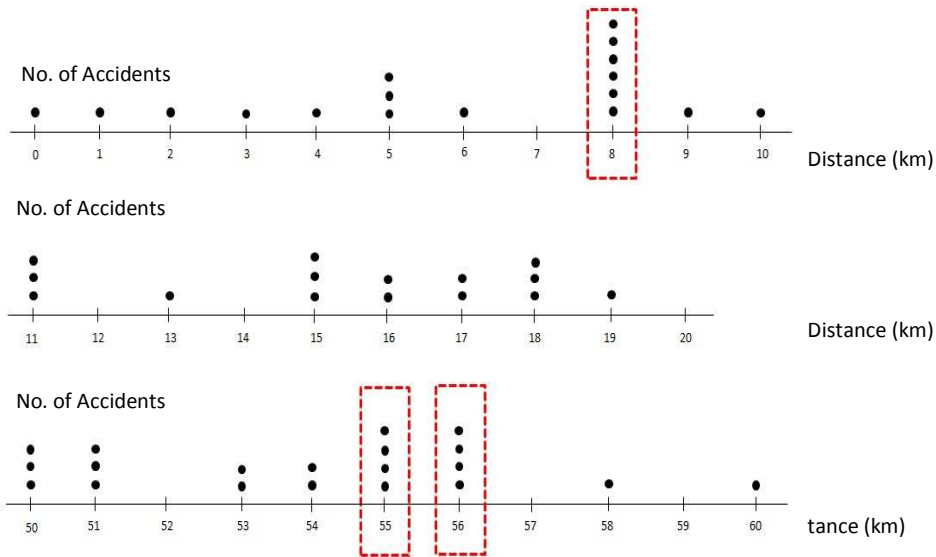


Fig. 20 -Dot-Density measure to identify black spots, Matara to Colombo direction
 Source: compiled by author

In Matara- Colombo direction, it is identified that the Black-spots are located between Welipenna - Kurundugahahetekma Interchanges and Dodangoda to Kottawa interchanges. Then, a dot density measure has done to identify the specific Black-spot which is in between 55km – 56km.

According to the above analysis, particular two points have identified to analyze the spatial characteristics of Road Landscape.

**Point A - 89 km-90 km, Between Baddegama- Pinnaduwa Interchanges–
 Colombo – Matara direction**

**Point B -55 km- 56 km, Between Welipenna-Kurundugahahetekma Interchanges -
 Matara – Colombo direction**

The selected three spatial characteristics have analyzed by using scaled plans, sectional diagrammes, photographic analysis and video recording. This paper indicate only a summarized version of data analysis.

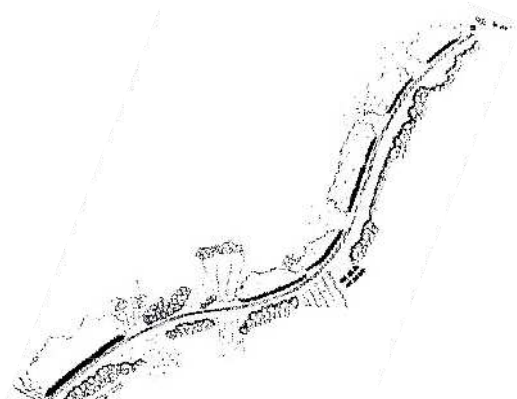
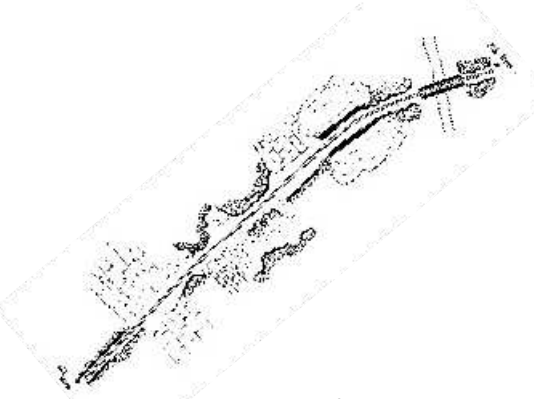
❖ **Solidity & degree of Enclosure**

In this parameter, 'Solidity' and 'Degree of Enclosure' have analyzed separately.

Solidity

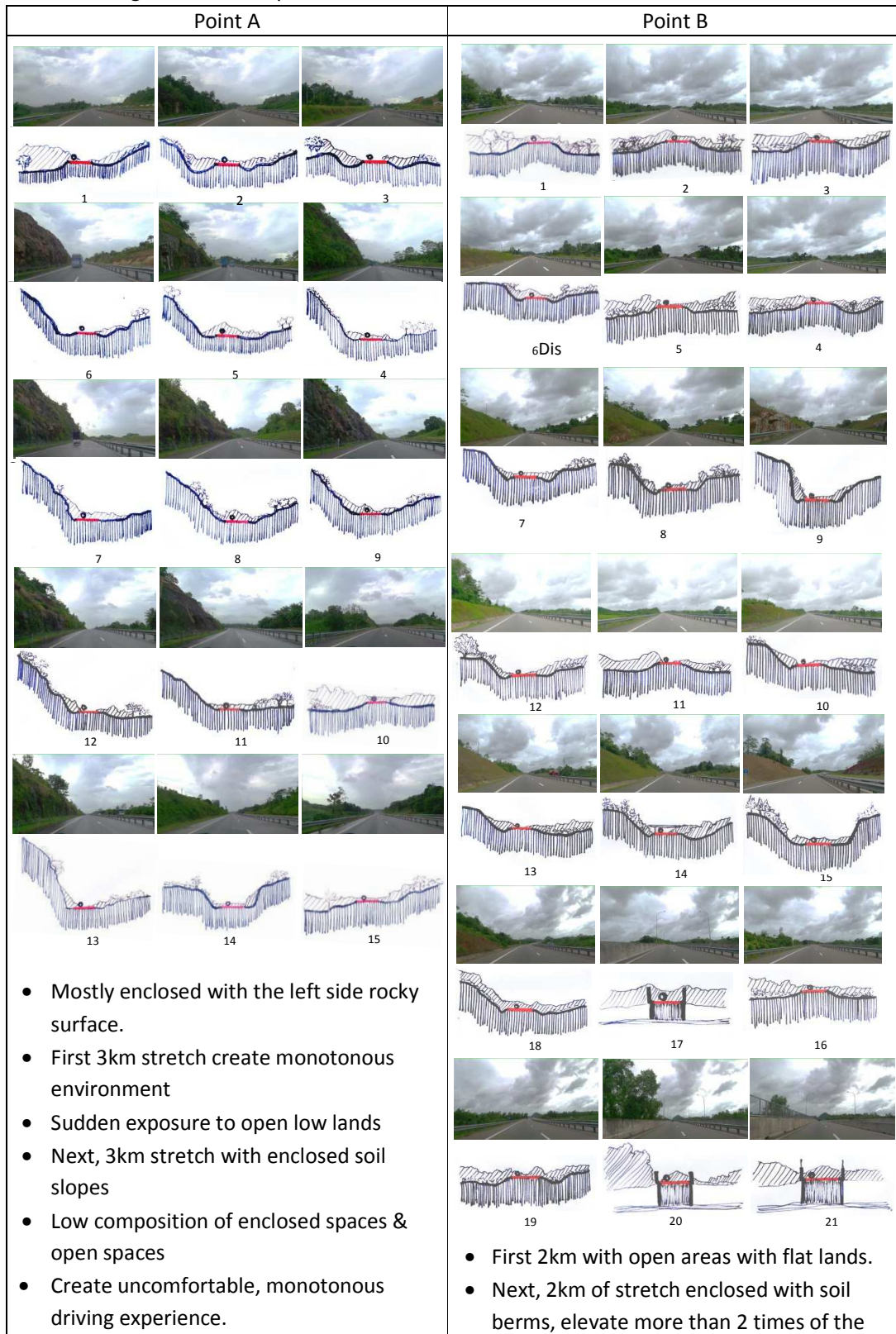
The solid & void spaces and its composition analyzed in Point A and Point B. The experience of driving through solid and void spaces is different. It varies according to the surface material of solid spaces, the distance from road, the length of the solid/void stretch and the composition of solid/void spaces.

Solidity along the stretch identified by using scaled spatial plans of Southern Highway.

Point A	Point B
 <p>Fig. 21 -Experience of solidity, Colombo to Matara direction Source: drawn by author</p> <ul style="list-style-type: none"> ● Road mostly goes through hard solid rock surfaces ● Very few void spaces ● Low variation of Solids- Voids ● Solid walls on left side of the road act as a visually backing elements. ● Create monotonous driving experience 	 <p>Fig. 22 -Experience of solidity, Matara to Colombo direction Source: drawn by author</p> <ul style="list-style-type: none"> ● Mostly road goes through open lands, vegetation patches ● Mostly a straight road ● No eye catching elements along the straight road ● No visually backing elements ● No variation of solid-void spaces ● Create monotonous driving experience.

Degree of Enclosure

The degree of enclosure has analyzed by using diagrammes of sectional elevations of road section along the identified points.



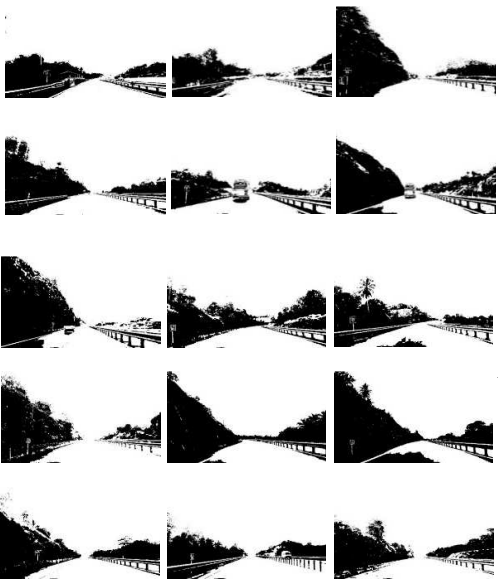
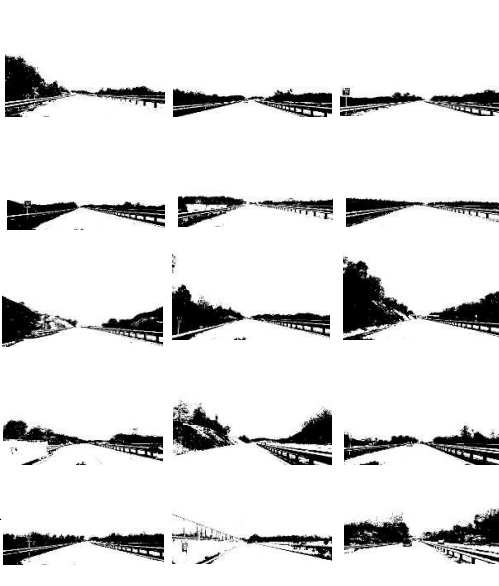
	<p>observer.</p> <ul style="list-style-type: none"> • No any stimuli to the drivers mind, create monotonous driving spaces. • Sudden exposure to open lands, enclosed area with soil berms & vegetation patches. • Composition of enclosed & open spaces are poor, leading the way to monotonous driving experience.
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Both, having long stretches of enclosed areas or open areas to a highway driving create uncomfortable driving experience to the users. Both situations create monotonous environments which can leads drivers to fatigue, negligence or hypo vigilance. So, there should be a better composition of enclosure effect in road landscape of highways.

❖ **Differentiate of forms**

Human always try to understand the 'form' first of any object. The information processing skills while driving decided the safety of the driving. Always the road landscape impact to the decision making stage of the driving performances. Therefore, the forms of the road landscape very much important when ensuring the safety on roads.

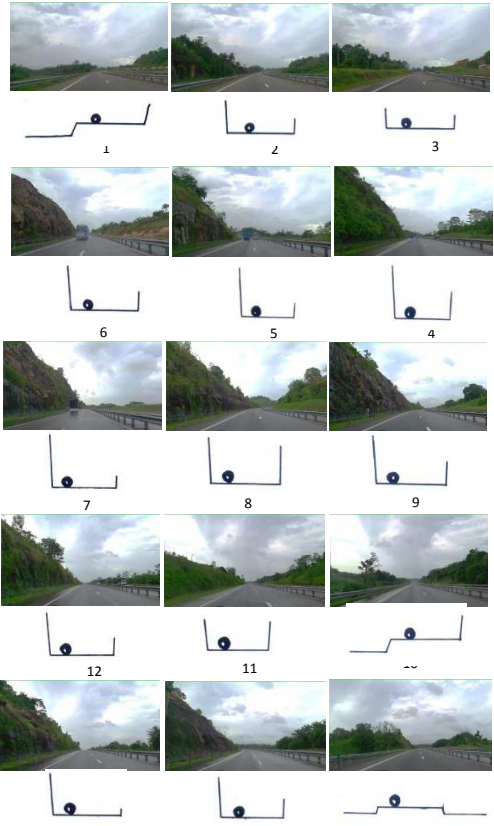
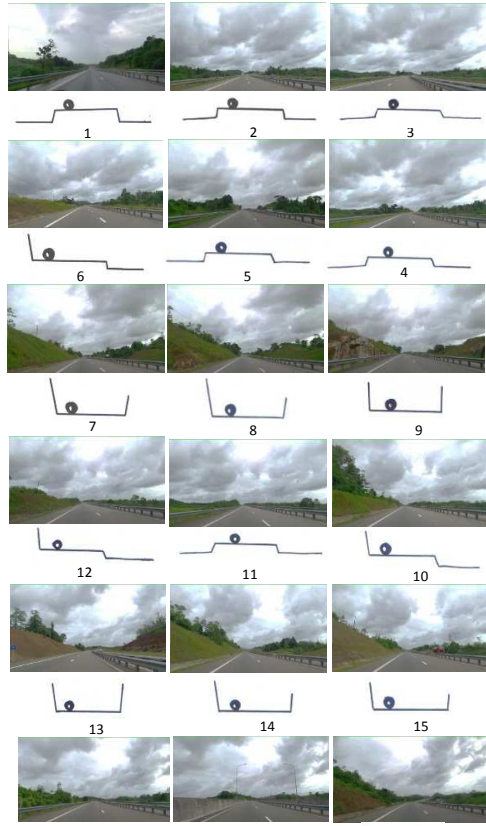
Drivers always read the front view of the road to identify the form of the landscape. Then realize the detail of the road section. The differentiate of forms analyzed with the Photographs Analysis Method, the photographs of the road landscape taken within every 500m intervals.

Point A	Point B
	
<ul style="list-style-type: none"> • Variation of forms very less • Create monotonous visual forms in the landscape • Causes to fatigue & hypo-vigilance. 	<ul style="list-style-type: none"> • First half of the stretch is through more open lands, eye reads the landscape horizontally. • It has very low range of variations & not sequentially changing forms.

The Point A has mostly vertically variate forms & Point B has mostly horizontally variate forms. Both point have low variation of forms, leads to driver fatigue with monotonous driving experience.

❖ **Proportion / Scale of the space with respect to the observer**

Proportion of the space with respect to the observer/ driver is one of the most important characteristics in road landscape which directly affect to change the driving behaviour. This characteristic has been analyzed by using scale diagrammes of road sections in both points.

Point A	Point B
	
<ul style="list-style-type: none"> • First, 2km stretch, falls through a narrow spaces confined with two walls. • Higher proportion to the observer can identify this stretch with soil/ rock surfaces. • Not a sequential flow of proportion. • Create uncomfortable driving space 	<ul style="list-style-type: none"> • Falls through more open spaces & paddy lands, create more relax for drivers. • But, here several kilometers of driving without any stimulation create monotonous experience. • Then, space getting narrow & margined with soil berms. • At the end of the stretch driver moves with

	two rigid walls of bridges, create more stressful environment.
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Driving is sequential experience to the driver. It should have correct combination of proportion of the space to the driver, otherwise it create more stressful environment to the driving behaviour. Point A has higher proportioned spaces than Point B. Side walls with higher proportions create an uncomfortable driving environment which reduce driving performances. Point B has very low proportion (mostly flat areas) and sudden rigid walls, both situations create again stressful driving environments caused to poor driving performances.

1.5 Conclusion

Through the literature review, major three spatial characteristics, '**solidity and degree of enclosure**', '**differentiate of forms**' and '**proportion/scale of the space with respect to the observer**' are identified to analyze the roadside landscape in Southern Expressway.

The two 'Black-Spots', accident-prone areas, were identified to assess the spatial characteristics in road landscape. The 'solidity and degree of enclosure' is analyzed by variations through solid and void spaces and variation of enclosure effect. The variation of solid and void spaces are minimum in two identified spaces, which creates a monotonous visual environment. It pulled drivers into a very lethargic form of driving, eventually, it causes to driver fatigue and hypovigilance. The degree of enclosure effect is different in two black-spot areas, one with a high profile of enclosure effect and another area has a low profile of enclosure. But, in both situations, the driver move through a monotonous road environment, cause to driver fatigue and drowsy driving. The roadside landscape form variation have analyzed by the second characteristic, 'differentiate of forms'. It is found that monotonous landscape formations are continued in both areas, reduces driving performances. The 'proportion/scale of the space' is another identified spatial character along the highway, which makes troublesome for the drivers. In one area, driver mostly moves through very confined space, and in other area, the space is more open. Both situations make influences to driver's psychological imbalance; finally cause to reduce driving performances.

Generally, the road safety researches are conducting as simulator studies in laboratories, because of its' difficult to replicate and control the real-world situations. But, non availability of resources, the study confined to a qualitative analysis of spatial factors. And, also, the study concentrated to analyze only the selected important spatial characteristics of the roadside landscape; but there are many other spatial characteristics in road landscape to be analyzed. This study has formed a discussion to analyze the spatial characteristics in road landscape and there are many characteristics not mentioned here, are recommended for future studies. In addition, there is a need to develop an equitable method of analyzing the human perception of live experience, which cannot be replicate.

The study emphasizes an evaded part of most of the major road construction projects in Sri Lanka, 'the evaluation of roadside landscape'. As per the study, the driving is an activity of experiencing landscape when the human in motion. The drivers need to attach to their driving space to gain information for ensuring the safety. So, the spatial characteristics in road landscape contribute to shape-up the driving space. Therefore, when planning and constructing the roads, it should consider not only, the engineering aspects of road construction, but also, the spatial characteristics of road landscape. The study is highlighted the spatial characteristics in roadside landscape and their impacts on driving behaviour.

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