

# Effects of Roadside Tree Species on Malaysia Driver's Emotions Associated with Vehicle Crashes

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**Abstract.** This research aims to study the effects of roadside tree species selection on driver's emotions. The research objectives of this paper are (i) to determine the driver's emotions when passing through the roadside tree species (ii) To examine the relationship between roadside tree species and the driver's emotions. This research used a mixed-method using survey and interviews. Interviews were conducted in a public place such as at rest stops and restaurant around the side of the highway. A set of questionnaires including demographic background and illustration of seven tree shapes along the roadside shown for reference. Ten positive and negative drivers' emotions have been identified and described by the respondents when passing through the road that has different types of trees shapes. Columnar shape tree indicated the first rank for the suggestions of roadside trees species. Parameter joy displayed a very strong relationship that was statistically very high positive correlation with conical shape trees ( $\tau\text{-}b=0.89 < 0.01$ ). The research expanded the present body of knowledge in the area of the selection of appropriate roadside tree species in urban areas and taking into account the drivers' emotional factors.

## INTRODUCTION

Nowadays, trees perform many positive functions within the urban environment settings such as cooling our cities. Shade trees in roadside provide cooling effects by blocking sunlight, increased ambient air humidity and provide shade during the day. The shading effect of shade trees depends on trees characteristics and configuration. Physical aspects such as tree canopy, height, density and branching structure and color of leaves are the main components that create shade and moderate the microclimate [1-3]. Roadside tree species with spreading canopies such as *Swietenia macrophylla* (Big leaf mahogany) and *Tabebuia rosea* (Trumpet tree) provide significantly more cooling than the other species [4]. One of the benefit roadside trees can calm the traffic and reduce the drivers' stress. However, roadside tree are the most common components of urban infrastructure involved in vehicle crashes [5]. The characteristics of roadside tree such as size and density [1], canopy [6-8] are contributing to the vehicle crashes. Trees have different shapes based on natural tendencies or the environment. A tree canopy is the top portion of a tree composed of branches and leaves. Trees species are different types such as from evergreen, flowering fruit trees and a deciduous tree. Tree canopy is thought to cause increases in moisture and temperature variation and subsequently affecting the pavement's structural performance. Similarly, tree canopy alongside the roadway can affect the condition of the pavement surface raising safety concerns including reduced skid-resistance due to fallen leaves, limited direct sunlight promotes the formation of black ice and fog, and branches and fruits falling on passing vehicles or blocking

traffic lanes. Previous studies showed the tree species alongside influence the condition of the pavement, safety and maintenance [9], health effects [10], aesthetic preference and [11]. A healthy roadside tree canopy can help offset angry and aggressive reactions by keeping drivers calm and reducing stressful responses. Therefore, this study focus on tree species that influence the driver's emotions.

### TREE SPECIES IN ROADSIDE AREA

In the context of urban roadside tree management, the earliest trend in the selection of tree species can be seen in early 80s. Some of the famous tree species selected at this particular time was *Pterocarpus indicus* (Angsana), *Samanea saman* (Hujan-hujan), *Michelia sp.*(Cempaka), *Citrus sp.*(Limau) and *Heavea brasiliensis* (Getah). Initially, *Pterocarpus indicus* (Angsana) was planted in most cities in Malaysia. Now, it is widely planted at roadside, park and parking lot. Through stem cutting, Angsana is a species, capable of growing to 30-40 meters, providing shade to the areas it covers. Basically, Angsana is selected because of the fact that it is a flowering tree with subtle fragrance and yellow petals. However, after reaching maturity, this species brings a lot of trouble to people and the environment. For instance, the wilt disease of Angsana caused by *Fusarium oxysporum* was responsible for killing trees in Singapore, Malacca as well as South and West Coast of Malaysia between 1870-1880 [12,13]. This disease then spread to other areas including Penang Island, Tapah and Taiping, Perak; Kuala Kubu, and Kuala Lumpur between 1909-1910 [14]. From reports on the disease of Angsana, it can hence be seen the Angsana had been the preferred species during the 80s and 90s. The selection of this species has nonetheless slightly reduced after such problem. The images below indicate the trees species planted in urban roadside areas. The species such as *Pterocarpus indicus*, *Samanea saman*, *Peltophorum pterocarpum*, *Melaleuca cajuputi*, and *Khaya senegalensis* are the common species selected for roadside trees planting. Flowering trees are noted to add 'sense of place' to roads and provide good shade to drivers.

### CHARACTERISTICS OF ROADSIDE TREE PROBLEMS

Structural defects are visible signs of defects on parts of trees. Structural defects can be dead wood, cracks, weak branch attachment, decay, root problems and poor tree architecture. Structural defects occur as the consequences of poor arboriculture practices, such as improper pruning method and poor tree species selection. Figure 1 shows the types of tree problems and their effects on public safety and its property. Branch defect refer to dry and fragile branch, which usually does not bear any healthy leaves that only dead leaves are present [15]. However, it is to be pointed out that some species like *Delonix regia* (Semarak api) and *Peltophorum pterocarpum* (Yellow flame) shed their leaves during dry season.

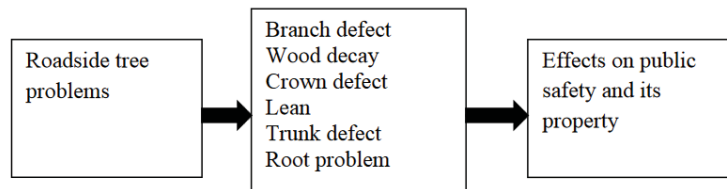


FIGURE 1. The Types of Tree Problems

### TREE SPECIES INFLUENCES DRIVER'S EMOTIONS

Few studies have specifically examined the influence of plants characteristics on people's emotional and physiological behavior. Previous research have showed that passive interaction with plants has been associated with many beneficial responses including reduce stress, improvements in health and restoration from mental fatigue [16]. The savanna hypothesis by Orians [17] had predicted human aesthetic responses to tree canopy with spreading forms have been associated with productive human habitats. Previous studied [18] examines the emotional and physiological responses to scenes with trees of different forms are the same as the aesthetic responses predicted by savanna hypothesis. Furthermore, a spreading tree form elicited more positive and fewer negative emotions than a conical and columnar tree or an inanimate object. Drivers in negative emotions such as anger or sadness are prone to perform badly at driving and decreasing the road safety for all road users. Some of the research carried out has stressed

the importance that roadside elements such as vegetation, trees characteristics, tree canopy and guardrail barriers play in our perception of the road edge, driver speed and the driver's perception of safety [20].

## **EFFECTS OF ROADSIDE TREE SPECIES SELECTION ON VEHICLE CRASHES**

Nowadays, the widespread of roadside tree problems is proven by public complaints made to local authorities and reported by newspapers. Malaysia city councils are unaware of the consequences of tree failure, such as property damage and personal injury [21]. In Malaysia, the case related to hazardous trees is found to increase each year. Tree failure has even been reported to cause casualty. For instance, a fallen tree incident in Taman Sentosa, Gemas, Negeri Sembilan has caused the death of a 35-year-old named Muhammad Ridduan Abdul Karim and the minor injury of the other two passengers of the truck (Sinar Harian, April 9th, 2015). In another case reported by Sinar Harian on September 2<sup>nd</sup> 2014, fallen roadside trees were once again cited to have caused two casualties after the teenagers were crushed dead at Pintasan road, Kuantan. The sudden roadside tree fall was found not to be caused by rain or strong wind as the weather was good. Fire-fighters had to remove the bodies from the tree branches before they were sent to the hospital. Public Relations Officer of the Fire and Rescue Department took about half an hour to cut the branches and clean the areas to avoid traffic jam. On July 10th, 2015, seven cars were damaged by fallen trees at Sultan Abdul Halim and Sultan Badlishah road in Alor Setar, Kedah. Sinar Harian reported the incident to occur due to heavy rain with strong wind. Berita Harian on Mei 8th 2015 reported four vehicles were crushed by a big fallen tree at Landai road, Pudu Plaza, Kuala Lumpur. As a result, eight members from the Fire and Rescue Department were deployed to the scene and Kuala Lumpur City Hall management had to cut and remove the tree. Similar case occurred in Kuantan, Pahang where one vehicle was crushed by a tree (Berita Harian, June 4th, 2014). Kuantan Municipal Council verified that the tree falling was not due to bad weather, but the fact that the central trunk was rotten. On 5 August 14, 2012, a matured *Fragrea fragrance* (Tembusu) was reported by Sinar Harian to have crushed nine cars parked in Taman Tasek Seremban. Seremban Municipal Council had to clean up the branches of the fallen trees.

## **METHODOLOGY**

This research used mix method using survey and interviews. Qualitative rely quite extensively on in-depth interview. Unstructured interview provide absolute flexibility in structure, content and interview questions, while flexibility is not provided in a structured interview. In this research, in depth interview was preferred whereby a set of questions was asked. A total of two hundred drivers were randomly selected as a respondents in this research. The respondents consisted of those who regularly used the road that have trees on the side of the road. Interviews was conducted in public place such as at rest stops and restaurant around the side of highway. A set of questionnaires including demographic background and illustration of seven tree shapes along the roadside shown for reference. This questionnaires is to identify the types of the emotions of the driver when driving through the seven types of tree shapes. This survey took two months and was conducted around Klang Valley. For interview data was analysed using ATLAS.Ti version 8 software and statistics data was analysed using Statistical Package for the Social Sciences (SPSS) version 7.

## **RESULTS AND DISSUSSIONS**

### *Frequency of The Respondents*

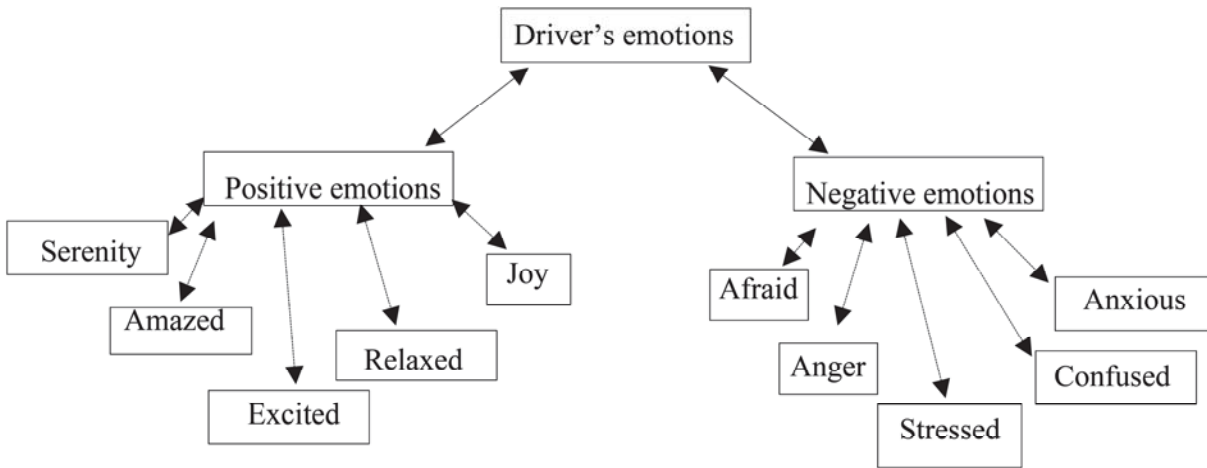
Table 1 shows the response rate of the research. The selection of the respondents was based on their voluntary response and knowledge in the field of the research. The distribution of the actual questionnaires form was conducted for two months, involving two hundred of respondents who are male 50% and female 50%. In term of race, 48.5% are Malay, 28.5% are Indian and 23% are Chinese. Majority of the respondents fall under ages group 41-50 years. The differentiation of socio demographic characteristics in this research are important to determine the variety of driver's emotions when passing the road and focusing on tree canopy shapes. Few study [22, 23, 24] stated that gender, race and age showed emotional differences in while driving.

**TABLE 1:** Selected socio demographic characteristics of the respondents

Socio Demographic Characteristics		Frequency, F	Percent, %
Gender	Male	100	50
	Female	100	50
Race	Malay	97	48.5
	Chinese	46	23
	Indian	57	28.5
Age	30 and less	33	16.5
	31-40	42	21
	41-50	72	36
	51-60	32	16
	60 and above	21	10.5

*Interviews Results*

Figure 2 shows the analysis of the driver’s emotions regarding the tree canopy in the roadside areas. From the interviews results, ten emotions have been identified and described by the respondents when passing through the road that has different types of trees shapes. It can be divided into two categories of emotions such as positive emotions and negative emotions. 132 of respondents’ response to negative emotions when passing the roadside trees. Some reasons are given such as angry when tree canopy blocking the road signage’s, afraid if a tree branch falls under the car and stress in case fell trees in the road and have to wait for the tree cleaning process. There are some of the respondent’s shows confusing when passing different roads with the same tree species are planted. Their emotions will be anxious when passing through a tree with many branches especially during heavy rain. 68 of the respondents showed positive emotions when passing the roadside trees with different shapes of canopies. They feel joyful, relaxed and excited to see the uniqueness of the tree characters. The driver will feel such as serenity, amazed and excited when passing through flowering trees. Famous roadside trees that produce beautiful flowers such as *Tabebuia rosea* (Trumpet tree) (spreading shape), *Pelthophorum pterocarpum* (Yellow flame) (spreading shape) and *Pterocarpus indicus* (Angsana) (spreading shape). A study was conducted by previous research stated that [24] state that flowering trees along the roadside will reduce the stress emotions of drivers.










**FIGURE 2.** Driver’s emotions on roadside area

Table 2 shows the mean analysis of the suggestions tree canopy shapes by respondents. Based on experiences and supportive images related to tree canopy provided when answering the survey, respondents preferred columnar shape (mean=4.01,rank 1), vase shape (mean=3.56,rank 2) and round shape (mean=3.36,rank 3). The last four like spreading shape (mean=3.13, rank 4), conical shape (mean=3.11, rank 5), graded shape (mean=3.02, rank 6) and weeping shape (mean=2.98, rank 7). Columnar shape trees are tall and thin with a very narrow, upright and upright branches. This analysis supported by previous research [16], columnar shapes trees are eco –friendly trees and their right placement

in urban environment to overcome the driver's stressed and the pollution problems. Other researchers argued that *Polyalthia longifolia var pendula* with its columnar shaped crown can be used to frame the view and the structure of a landscape [17, 18]. In others views, the cool rate data showed that columnar and vase crown shapes provided higher cooling compared to others tree shapes [19]. Therefore, the driver's emotions will feel more joy, relaxed and serenity when passing the shaded and cool road.

### Survey Results

**TABLE 2:** The suggestions of tree canopy shapes by respondents

Tree image							
<b>Example tree species</b>	<i>Polyalthia longifolia</i> (Asoka tree)	<i>Arfeuillea arborescens</i> (Hop tree)	<i>Filicium decipiens</i> (Ferntree)	<i>Pterocarpus indicus</i> (Angsana)	<i>Juniperus chinensis</i> (Juniper)	<i>Terminalia mantaly</i> (Umbrella tree)	<i>Salix babylonica</i> (Weeping willow)
<b>Tree shape</b>	Columnar shaped	Vase shaped	Round shape	Spreading shape	Conical shape	Graded shaped	Weeping shape
<b>Mean</b>	4.01	3.56	3.36	3.13	3.11	3.02	2.98
<b>Std. deviation</b>	0.86	0.76	0.79	0.89	0.92	0.97	1.04
<b>Rank</b>	1	2	3	4	5	6	7

Note: Likert Rating Scale: 1-Strong disagree, 2-Disagree, 3-Moderate, 4-Agree, 5-Strongly agree

Table 3 displays the correlation coefficient matrix of the driver's emotions and tree canopy shapes. The correlation is highly significant at the 0.01 level (2-tailed) and significant at the 0.05 (2-tailed). A Kendall's Tau-b correlation was run to determine the relationship between parameter amongst two hundred respondents. High correlation with the marked relationship was observed between parameter amazed with round shape tree ( $\tau\text{-}b=0.85 < 0.01$ ). Parameter joy displayed a very strong relationship that was statistically very high positive correlation with conical shape trees ( $\tau\text{-}b=0.89 < 0.01$ ). For parameter amazed, the same correlation displayed a positive relationship with spreading and graded shape trees. Low correlation with the weak relationship was observed between parameter relaxed with weeping shape trees ( $\tau\text{-}b=0.21 < 0.01$ ).

**TABLE 3:** The Correlation Coefficient between the driver's emotions and tree canopy shapes

Parameter	Round shape	Conical shape	Spreading shape	Weeping shape	Columnar shape	Vase shape	Graded shape
Joy	0.57**	0.89**	0.67**	0.27	0.67**	0.66**	0.82**
Amazed	0.85**	0.75**	0.85**	0.55**	0.88**	0.75**	0.85**
Excited	0.68**	0.64**	0.48	0.45**	0.78**	0.64*	0.48
Relaxed	0.56**	0.76**	0.56**	0.21	0.56**	0.76**	0.56**
Serenity	0.65**	0.87**	0.87**	0.57**	0.77**	0.87**	0.62**
Anxious	0.82*	0.59**	0.42	0.55**	0.82**	0.59	0.62*
Afraid	0.31	0.54**	0.51**	0.64**	0.51**	0.54**	0.57**
Confused	0.42**	0.52**	0.25	0.52**	0.62**	0.52**	0.65**
Stressed	0.55*	0.68**	0.52**	0.38	0.52	0.68**	0.52*
Anger	0.68**	0.69**	0.64**	0.59**	0.65**	0.69**	0.64**

Note: Correlation coefficient is calculated using Kendall's Tau-b (tb)

\*\*Correlation is highly significant at the 0.01 level (2-tailed)

\*Correlation is highly significant at the 0.05 level (2-tailed)

## CONCLUSIONS

In conclusion, ten drivers' emotions were derived from in-depth interviews with two hundred of the public. The emotions include joy, amazed, excited, relaxed, serenity, anxious, afraid, confused, stressed and angry. The selection of right tree species at the roadside is one of the factors that need to be considered to avoid vehicle crashes. Drivers' emotions regarding the selection of trees species should be taken into account to reduce vehicle crashes. The methodology applied in this research was based on the standard procedures of scientific research to ensure the validity and reliability of the results.

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