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Tree Species Selection in Street Planting: It's relationship with issues in urban area

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Abstract
Trees in urban areas are an invaluable resource. Careful consideration and attention should be given to tree species selection. "Right tree at the right place" is the key to get the benefits offered by the tree. Objectives have been formulated as follows (i) to investigate the selection of tree species at selected local councils (ii) to analyse the issues related to the selection of the tree species looking at the public perspectives. A mixed method approach was undertaken in the data collection. Future considerations of the tree species as street planting based on the findings can reduce problems thus increase the quality of urban life.

Keywords: Urban tree; tree species selection; local council; public perspectives

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1.0 Introduction

Trees in urban areas are an invaluable resource. For centuries trees have played vital roles in our lives from providing food to shelter and even amenity values. A tree is a valuable commodity - they ameliorate temperature, reduce air and noise pollution, minimize soil erosion and also give the visual aesthetics and provide shade to city dwellers. Trees enhance the landscape and give significant environmental benefits thus tree planting become one of the important events on urban lands. To fully maximize the potential offered by trees, careful consideration and attention should be given to the selection of tree species - "Right tree at the right place" holds the key. Failure to consider the characteristics and requirement of tree species can cause hazards to properties, vehicles and people. Correct selection of trees can reduce issues related to maintenance cost and increase the urbanites satisfaction on tree planting. Recently, due to development such as road expansion, countless complaints by the public were received addressing problems related to street trees. Some of the complaints were directed to trees such as *Khaya senegalensis*, *Tabebuai pentaphyla*, *Acacia auriculaeformis*, *Peltophorum pterocarpum* and *Pterocarpus indicus*. Thus this study will look into tree species planted along the roadsides and how these species selection contributes to the issues related to landscape planting. Two objectives have been formulated as follows (i) to investigate the selection of tree species at selected local councils (ii) to analyse the issues related to the selection of the tree species looking at the public perspectives. Three local councils will be selected and in-depth interview will be conducted to gain information on the landscape planting and tree species selection. Field observation is also conducted to determine the tree species. 480 respondents were selected based on their knowledge in this research. The expected outcomes of this research

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will be useful in determining issues related to the species selection. Future considerations of tree species as street planting based on the findings can reduce problems thus increase the quality of urban life.

2.0 Literature Review

2.1 Issues on hazardous trees in street planting

Currently, many studies related to hazardous trees were carried out such as identification criteria and indicator (Sreetheran & Amat, 2010), tree preservation order (Hasan et al.,2016) tree heath (Norainiratna et al,2013), tree value (Metro, May 21 2014),tree inventory and risk assessment (Sreetheran et al.,2011), social factors and tree management (Hasan et al., 2017), liability for damage (Anderson and Eaton, 1986), roadside tree management (Hasan et al., 2016) and maintenance (Jess et al, 2015). Previous research revealed that problems with street trees would continue if the responsible parties do not take a proactive approach. According to Vijayakumar (2014), some local authorities enforce hazardous tree management through in-house department task force, the responsibility of private contractors and community participation. Although there are agencies concerns about the hazardous trees in Malaysia, sadly, the numbers of the public complaints are still increased every year. Most complaints received are related to fallen trees, brittle branches, prevent visibility, dead leaves and debris on the road, heavy branches obstruct traffic, matured tree, debris obstruct to drainage system, too near to residential and leaning tree trunk. Trees that always get the highest complaint are of the fabaceae family such as *Pterocarpus indicus* (Angsana), *Acacia sp* (Akasia), *Peltophorum pterocarpum* (Yellow flame), *Leucaena leucocephala* (Petai belalang). Most cases are caused by natural disasters like heavy rain and strong winds, poor pruning and lack of maintenance. In additions, the lack of actions taken from the related parties regarding the hazardous tree management causing many trees is in failure conditions. Therefore, related parties should give full attention to the management of hazardous street tree in term of planning and tree selection, tree planting, tree protection, tree assessment and tree risk and tree maintenance.

2.2 Miller's Species Selection Model

This research referred to Species Selection Model by Miller (1997) as shown in Figure 1. Based on this model, site factors, which include both cultural and environmental constraints, are the most important factor. The physical limitations of the site caused by human structural and activity are referred to cultural constraints while insects, diseases, soils, climate and microclimate are referred to environmental constraints. These adaptations were not further specified here but listed according to the environmental constraints. In contrast to the classification of environmental factors, social factors refer to community values, neighbourhood, functional utility, species aesthetics, public safety and negative social externalities. Economic factors refer to establishment, management and removal costs. However, Miller integrated economic factors into his tree selection model but did not specify these any further. Also, the cost of tree planting, tree maintenance and tree removal is a further consideration in tree selection Management at local authorities, designers and arborists need to take into account to the species selection. All factors are important during the selection of trees species at roadside planting. Consideration of These factors will minimise the hazard trees pose to the public. In this research, site factors, which are environmental and cultural constraints are highlighted and will be discussed in the findings.

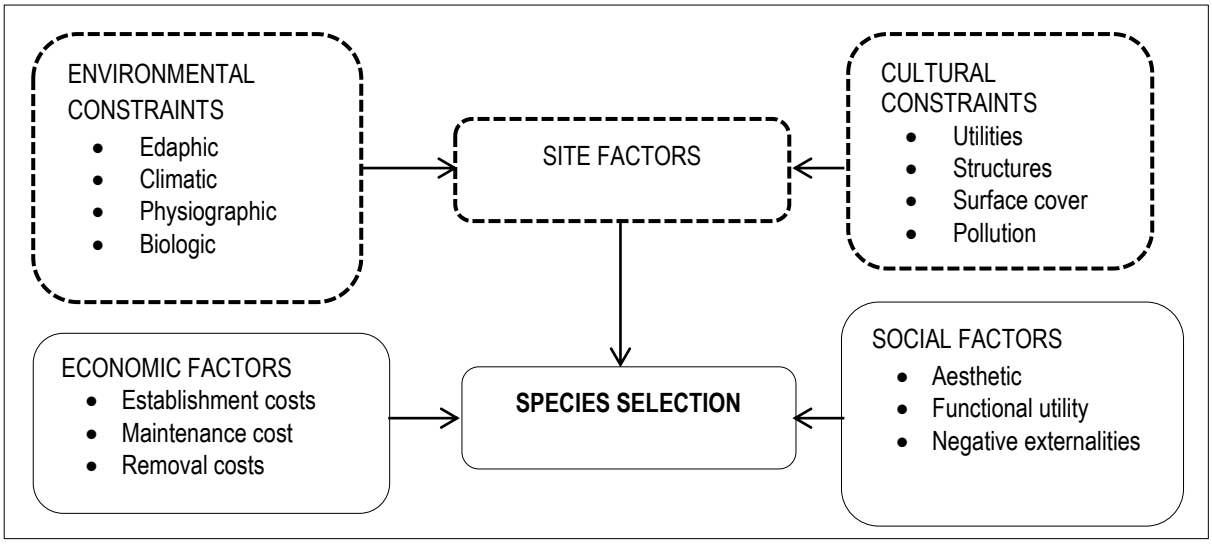


Figure 1: Species Selection Model
(Source: Miller 1997)

2.3 'Right tree at the right place' to increase the quality of urban life

Urban trees, in particular trees planted along city streets, are increasingly used as part of green infrastructure programs to reduce stormwater runoff. Trees hold onto rainwater in their roots and surrounding soil and then liberate water vapour to the atmosphere

through trans-evaporation. A tree's root zone also absorbs water and enhances the penetration of surface water into the soil to further mitigate surface runoff. It is clear that urban trees improve our quality of life and that planting a single tree in an urban setting will yield a significant return on the investment. Expanding our urban tree populations and greening our cities will improve our quality of life.

2.4 Public awareness regarding tree species selection

Nowadays due to the rapid development in urban areas, increase in public awareness on street planting can be seen from the report and complaints at the local authority. Because of that, the local authority has introduced online systems for public convenience when making a complaint. These online systems are different according to the administration of local authorities such as *Sistem Talian Aduan Rakyat Selangor* (STARS) in Shah Alam City Council, *e – Aduan* in Ipoh City Council, *Sistem Pengurusan Aduan Awam* (SISPAA) in Malacca City Council and Iresponz in Subang Jaya City Council. The capacity of data storage is also different according to the management. Therefore, the public can easily make a complaint should there be any occurrence fallen trees or other related problems. The proactive steps from the local authorities by creating this system will increase the quality of life especially in urban areas.

3.0 Research Methodology

A literature review was conducted to outline the factors and issues related to the research. As explained by Merriam (1998); and Gregory et al., (2007), the literature review will help to identify the major studies and factors affecting this research. A mixed method approach was applied in the data collection. The distribution of questionnaire is purposive selected. 480 of the respondents are the expert in this research. Four local authorities which are Petaling Jaya City Council, Selayang Municipal Council, Ampang Jaya Municipal Council and Subang Jaya Municipal Council were selected and in-depth interviews were conducted to gain the information on the landscape planting and selection of tree species. This selection is based on their knowledge and experience regarding the research conducted. Also, primary data was collected from each selected local authorities through documentation, reports and online public complaint systems (STARS) and (Iresponz).

4.0 Results and Discussions

4.1 Ranking of hazardous street trees from 2014 until 2016 at selected local authority

Table 1 shows the total number of tree species based on public complaint in Petaling Jaya City Council, Subang Jaya Municipal Council, Ampang Jaya municipal Council and Selayang Municipal Council. The tree species complaints are from different family backgrounds which are Fabaceae, Meliaceae, Bignoniaceae, Combretaceae, Lauraceae, Casuarinaceae, Moraceae, Anacardiaceae, Myrtaceae, Sapindaceae, Sapotaceae, Calophyllaceae, Dipterocarpaceae, Gentianaceae, Tiliaceae, Apocynaceae, Euphorbiaceae and Salicaceae. From the data analysis, the highest ranking 1 to 13 gets above hundred complaints from the public from 2014 until 2016. The species are *Peltophorum pterocarpum* (673 complaints), *Pterocarpus indicu*s (619 complaints), *Acacia sp.* (539 complaints), *Khaya senegalensis* (489 complaints), *Tabebuai rosea* (464 complaints), *Terminalia mantaly* (201 complaints), *Cinnamomum iners* (160 complaints), *Samanea saman* and *Casuarina sp.* (140 complaints), *Pithecellobium dulce* (126 complaints), and *Ficus benjamina* (110 complaints).

Table 1. Trees species based on public complaint from 2014 until 2016

Rank	Botanical name	Common name	Family	Total
1.	*Peltophorum pterocarpum*	Batai laut	Fabaceae	673
2.	*Pterocarpus indicus*	Angsana	Fabaceae	619
3.	*Acacia sp.*	Akasia	Fabaceae	539
4.	*Khaya senegalensis*	Khaya	Meliaceae	489
5.	*Tabebuai rosea*	Tecoma	Bignoniaceae	464
6.	*Termanalia mentaly*	Bucida	Combretaceae	201
7.	*Cinnamomum iners*	Kulit Kayu Manis	Lauraceae	160
8.	*Casuarina sp.*	Rhu	Casuarinaceae	140
9.	*Samanea saman*	Hujan-hujan	Fabaceae	140
10.	*Pithecellobium dulce*	Madras thorn	Fabaceae	126
11.	*Ficus benjamina*	Beringin	Moraceae	110
12.	*Azadirachta indica*	Semambu	Meliaceae	79
13.	*Eugenia grandis*	Jambu laut	Myrtaceae	63
14.	*Dalbergia oliveri*	Burmese Rosewood	Fabaceae	62
15.	*Syzygium myrtifolium*	Kelat paya	Myrtaceae	55
16.	*Koompassia malaccensis*	Kempas	Fabaceae	49
17.	*Cassia fistula*	Golden Shower Tree	Fabaceae	45
18.	*Swietenia macrophylla*	Mahogany	Meliaceae	44
19.	*Pongamia pinnata*	Mempari	Fabaceae	43
20.	*Filicium decepiens*	Fern leaf	Sapindaceae	39
21.	*Millettia pinnata*	Mempari	Fabaceae	36
22.	*Mimosops elengi*	Tanjung	Sapotaceae	34
23.	*Gliricidia sepium*	Pokok baja	Fabaceae	34

24.	*Mesua ferrea*	Penaga lilin	Calophyllaceae	20
25.	*Bauhinia kockiana*	Tapak Kuda	Fabaceae	19
26.	*Hopea odorata*	Merawan siput jantan	Dipterocarpaceae	19
27.	*Fagrea fragrans*	Tembusu	Gentianaceae	18
28.	*Muntingia calabura*	Ceri	Tiliaceae	17
29.	*Adenanthera pavonina*	Pokok saga	Fabaceae	16
30.	*Alstonia angustiloba*	Pokok pulai	Apocynaceae	15
31.	*Artocarpus indicus*	Terap	Moraceae	14
32.	*Delonix regia*	Semarak api	Fabaceae	14
33.	*Erythina glauca*	Dedap merah	Fabaceae	13
34.	*Hura crepitans*	Payung indonesia	Euphorbiaceae	12
35.	*Terminalia catappa*	Ketapang	Combretaceae	10
36.	*Salix babylonica*	Weeping willow	Salicaceae	7

(Source: *Sistem Aduan Rakyat*)

Landscape architects in local authorities are authorised in the selection of tree species in order to create greener cities, and will produce better quality of human life. The right selection of trees with sufficient space during planting will create the sense of place and provide a sense of direction to the drivers. The beautiful shape of *Termanalia mentaly*, the floweryness of *Tabebuai rosea,* shadiness of *Samanea saman* can make people and places alive. However, a tree will also become hazardous and can cause death, accidents and result in properties damage if not properly chosen. Thus, the selection of tree species is a very important factor for creating a safe city.

4.2 Total number of hazardous street trees at Petaling Jaya district

Figure 2 shows the total number of public complaint related to tree species at Petaling Jaya City Council. These complaints were taken from 2014 until 2016. 19 tree species have been identified as hazardous trees in Petaling Jaya district. The analysis shows *Pterocarpus indicus* receives the highest complaint which is 221 complaints, followed by *Tabebuai rosea* 177 complaints and *Peltophorum pterocarpum* 174 complaints. Next is *Acacia sp.*, fourth-ranking, with 123 complaints followed by *Khaya senegalensis* 98 complaints, *Pithecellobium dulce* 52 complaints, *Koompasia malaccensis* 49 complaints and *Milletia atropurpurea* 36 complaints. *Ficus benjamina* received 28 complaints, *Cinnamomum iners* 25 complaints, *Filicium decipiens* 23 complaints, *Azadiractha indica* 21 complaints, *Bauhinia kockiana* 19 complaints, *and casuarina sp.* 18 complaints. Next is *Hura crepitans* 12 complaints, *Hopea odorata* 7 complaints, *Terminalia catappa* 6 complaints and lastly is *Fagraea fragrans* with only 3 complaints.

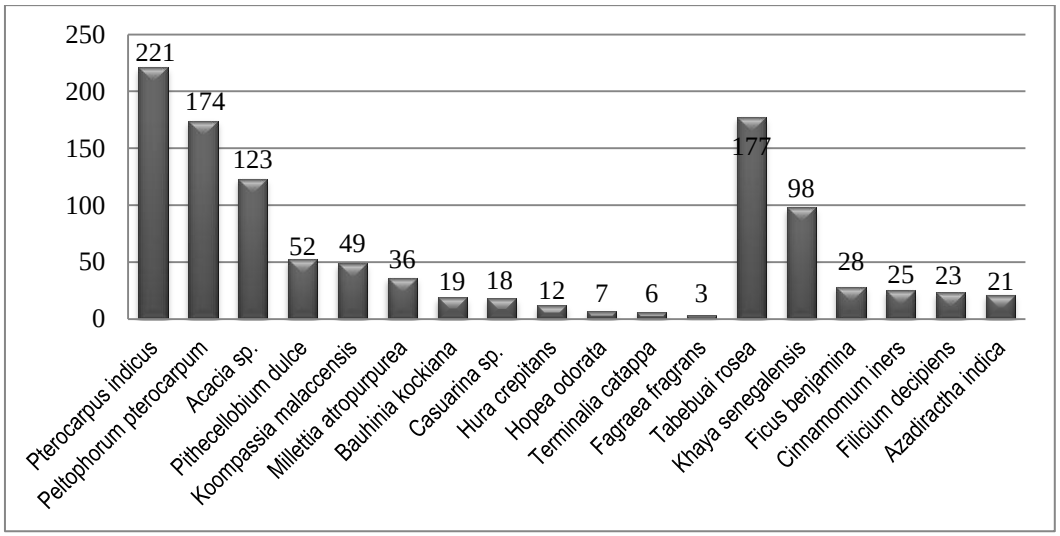


Figure 2: Trees species based on public complaint from 2014 until 2016
(Source: Petaling Jaya City Council)

According to the interview with a landscape architect in the Petaling Jaya City Council, tree species selection will be approved if the client or landscape consultant followed the basic guidelines produced by the Landscape department. Based on the self-observation in the street planting at the primary road in Petaling Jaya district, the majority of the trees are classified as matured trees. Three famous species planted are *Pterocarpus indicus, Tabebuai rosea* and *Peltophorum pterocarpum*. The selection of these species was highly recommended during the 1990's because these species provide instant shade, produce beautiful flower and leaf and provides aesthetical value to the place. Nowadays, the public are increasingly aware of *Pterocarpus indicus* that have brittle stems which cause damages to vehicles and properties due to fallen tree. Because of that, the landscape department in this authority takes the initiative to cut down any potential *Pterocarpus indicus* trees that may cause problems to the public and properties.

4.3 Total number of hazardous street trees at Subang Jaya district

Figure 3 shows the total number of public complaint related to tree species at Subang Jaya Municipal Council. The complaint is taken from 2014 until 2016. 24 tree species have been identified as hazardous trees in Subang Jaya district. From the analysis, *Terminalia mentaly* is the highest rank with 193 complaints followed by *Khaya senegenesis* 185 complaints and the third highest is *Pterocarpus indicus* with 156 complaints. Next is Acacia sp. 128 complaints, *Tabebuai rosea* 117 complaints, *Peltophorum pterocarpum* 103 complaints, and *Samanea saman* 77 complaints. The next ranking is *Pithecellobium dulce* 74 complaints, *Eugenia grandis* 63 complaints, *Dalbergia oliveri* 62 complaints and followed by *Casuarina sp.* 53 complaints. Next is *Azadirachta indica* 51 complaints, *Cassia fistula* 45 complaints, *Swietenia macrophylla* 44 complaints, *Pongamia pinnata* 43 complaints, *Cinnamomum iners* 40 complaints, *Mesua ferrea* 20 complaints. Then the *Filicium decepiens* 16 complaints, followed by *Artocarpus indicus* 14 complaints, *Mimusops elengi* 13 complaints and lastly is *Salix babylonica* 7 complaints. Compared with other local authorities, the species of *Terminalia mentaly* and *Khaya senegelensis* received the highest complaints in this authority. Self-observation indicates the majority of tree species planted in roadside at Subang Jaya district is *Terminalia mentaly*, *Khaya senegelensis*, *Tabebuai rosea* and *Peltophorum pterocarpum*. According to the interview with the landscape architect in Subang Jaya Municipal Council stated that the beautiful shape of *Terminalia mentaly* with small leaf become trending in the selection of tree species around 2009.Sadly, ther roots from this species pose problem to buildings, pavements and drainages when the root break the concrete and pipeline. Up to one stage, the leaf will fall thus increasing maintenance costs.

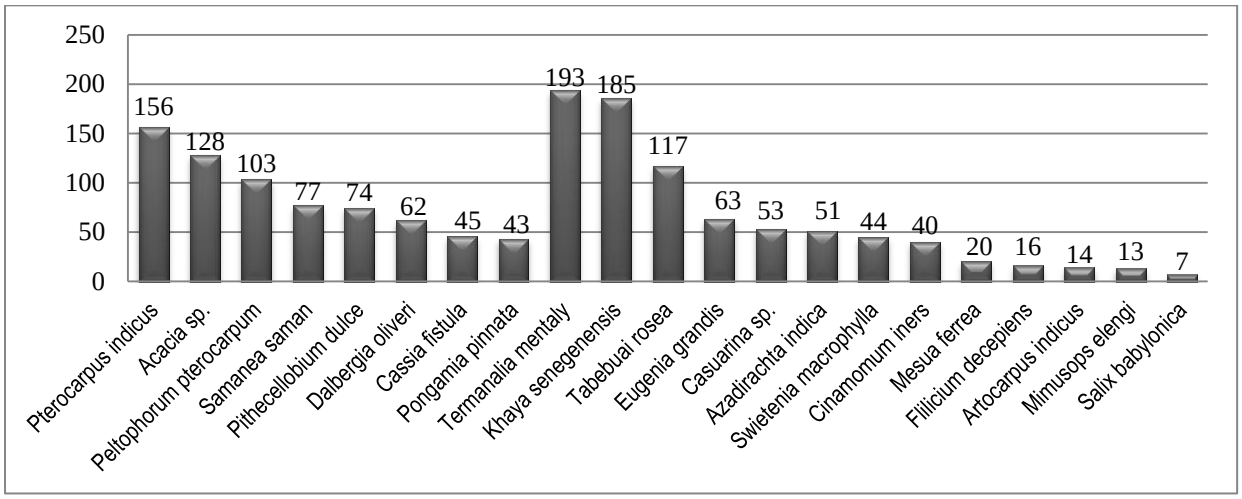


Figure 3: Trees species based on public complaint by 2014 until 2016
(Source: Subang Jaya Municipal Council)

4.4 Total number of hazardous street trees at Ampang Jaya district

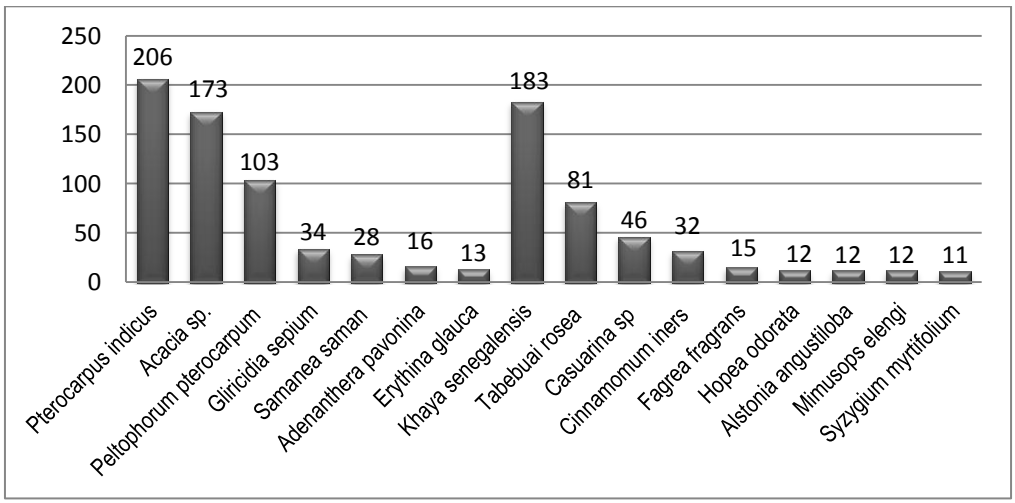


Figure 4: Trees species based on public complaint by 2014 until 2016
(Source: Ampang Jaya Municipal Council)

Figure 4 shows the total number of public complaint related to tree species at Ampang Jaya Municipal Council. The complaint is taken from 2014 until 2016. 17 tree species have been identified as hazardous trees in Ampang Jaya district. The analysis shows the majority of the tree species problem is *Pterocarpus indicus* with 206 complaints, followed by *Khaya senegalensis* 183 complaints,

Acacia sp. 173 complaints, *Peltophorum pterocarpum* 103 complaints. Another tree species such as *Tabebuai rosea* 81 complaints, *Casuarina sp.* 46 complaints, *Gliricidia sepium* 34 complaints, *Cinnamomum iners* 32 complaints, Samanea saman 28 complaints, *Adenanthera pavonina* 16 complaints. Next is *Fagraea fragrans* with 15 complaints, *Erythrina glauca* 13 complaints and *Syzygium myrtifolium* 11 complaints. For *Hopea odorata, Alstonia angustiloba* and *Mimusops elengi* are the same numbers which are 12 complaints. According to the person in charge of public complaint in Ampang Jaya district state that species of *Pterocarpus indicus* was planted around the 1890s. The reason for the selection of this species is to obtain fast shading. Through analysis of the stem cuttings, this species is categorised as fast growth tree. A deciduous evergreen tree such as *Khaya senegelensis* will fall when the roots are infected by diseases.

4.5 Total number of hazardous street trees at Selayang district

Figure 5 shows the total number of public complaint related to tree species at Selayang Municipal Council. The complaint is taken from 2014 until 2016. 20 tree species have been identified as hazardous trees in Selayang district. The analysis shows the *Peltophorum pterocarpum* get the highest complaint with 119 complaints from the public. Secondly is *Acacia sp.* 115 complaints, followed by *Tabebuai rosea* 89 complaints, *Ficus benjamina* 82 complaints, wild trees 72 complaints and *Cinnamomum iners* 63 complaints. Next is *Syzygium myrtifolium* and *Pterocarpus indicus* get the same complaints 36 complaints, *Samanea saman* gets 35 complaints and *Casuarina equisetifolia* 23 complaints. Another tree species is *Khaya senegalensis* 21 complaints, *Muntingia calabura* 17 complaints, *Delonix regia* 14 complaints, *Millettia pinnata* 10 complaints, *Mimosops elengi* 9 complaints, *Terminalia mantaly* 8 complaints, *Azadirachta indica* 7 complaints and lastly is *Alstonia angustiloba* 3 complaints. According to self-observation conducted 2017 14, April, the majority of trees species was planted in roadside is *Peltophorum ptrerocarpum*, *Pterocarpus indicus* and *Acacia auriculiformis*. The management of the landscape department in Selayang Municipal Council takes the proactive actions to cut down the hazardous tree such as *Acacia sp* .In addition, they will improve the schedule of street maintenance such as pruning period and complete the inventory of existing street trees, especially in main roads.

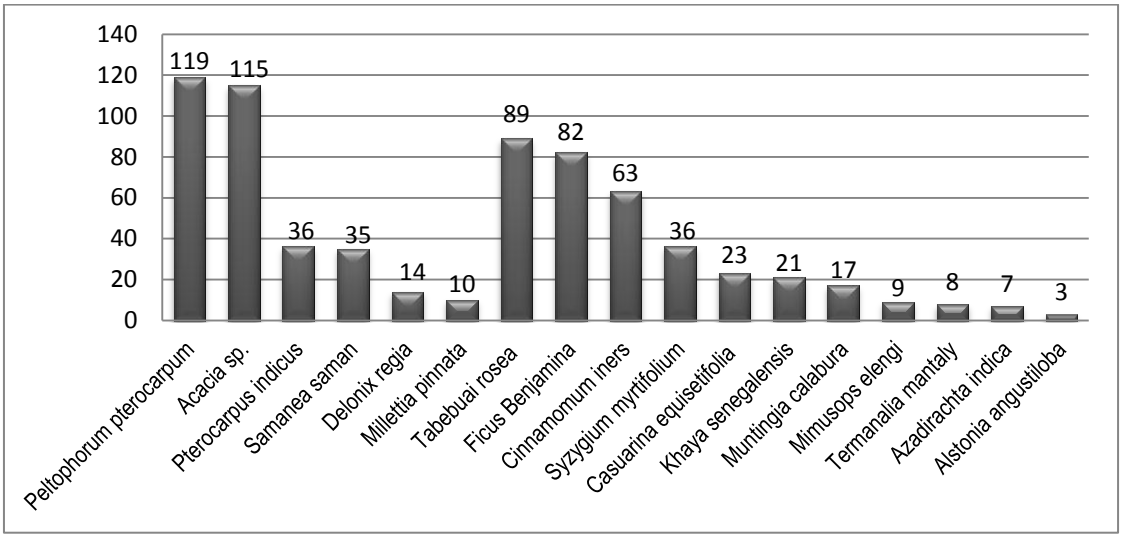


Figure 5: Trees species based on public complaint by 2014 until 2016
(Source: Selayang Municipal Council)

4.6 Ranking of total public complaints related to tree characteristics at street planting

Figure 6 shows the ranking of total public complaints from 2014 year until 2016 year at nine's City Council in Malaysia which is Kuala Lumpur City Hall, Kuala Terengganu City Council, Shah Alam City Council, Malacca City Council, Alor Setar City Council, Penang Island City Council, Johor Bahru City Council, Ipoh City Council, Petaling Jaya City Council. Based on public complaints, there are nine main problems identified in this research. Brittle branches recorded the highest number of complaints (4168) (rank 1). This is followed by fallen trees recording 4072 complaints (rank 2), debris obstructs drainage system recorded 3694 complaints (rank 3), old and dead trees recorded 3584 complaints (rank 4). Next, dead leaves and debris on the road recorded 3502 complaints (rank 5), heavy branches obstruct traffic recorded 3335 complaints (rank 6), and leaning tree trunk recorded 3147 complaints (rank 7). Next, obstructing visibility recorded 3022 complaints (rank 8) and lastly, proximity to houses recorded 639 complaints (rank 9). Based on the complaints, it can be concluded that tree characteristics with brittle branches are *Pterocarpus indicus, Acacia auriculiformis, Bauhinia purpurea, Cassia fistula, Delonix regia, Muntingia calabura.* Fallen trees can occur during heavy rain and storms - where strong winds blow and natural disasters such as flood and landslide may occur. Lack of maintenance efforts such as pruning will cause heavy branches to obstruct traffic flow and lead to road accidents. Additionally, mature trees require more serious care compared to small trees to avoid fallen trees. In addition, wrong planting distance between trees will reduce driver visibility when driving.

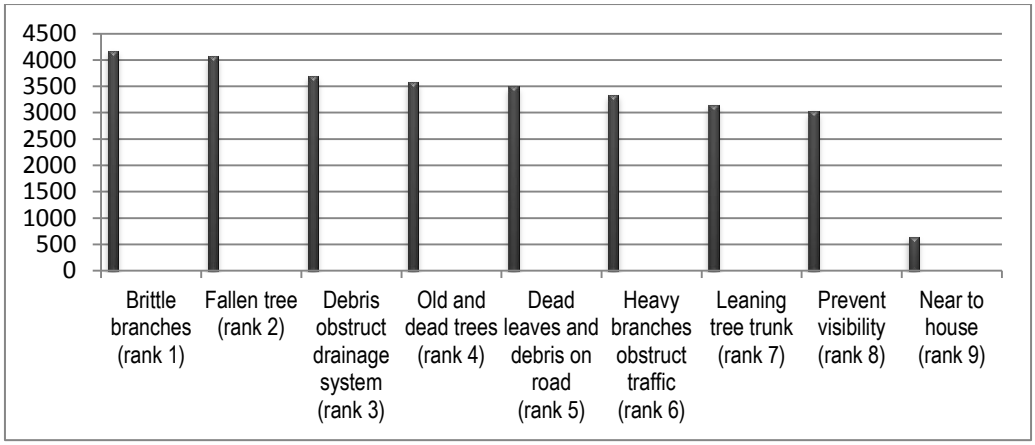
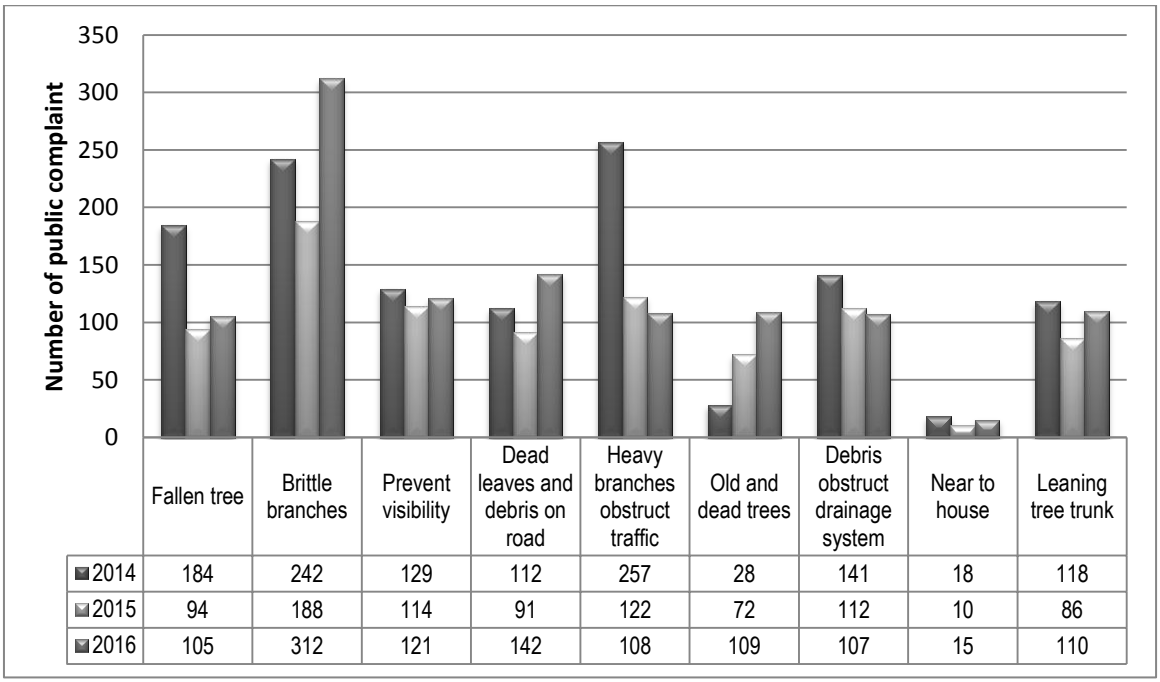


Figure 6: Total number and ranking of problems related to tree characteristics at street planting
(Source: Selayang Municipal Council)

4.7 Number of public complaints related to tree characteristics at street planting at Petaling Jaya district

Figure 7 shows the problems of street planting in Petaling Jaya district. In 2014, the highest complaints received is due to heavy branches obstructing traffic (257 cases) followed by brittle branches (242 cases) and fallen tree (184 cases). Next is debris clogging up drainage systems (141 cases), prevent visibility (129 cases), leaning trunks (118 cases), dead leaves and debris on the road (112 cases), old and dead trees (28 cases) and lastly near to house (18 cases). In 2015, the top three cases were brittle branches (188 cases), followed by heavy branches obstructing traffic (122 cases) and debris clogging up drainage systems (112 cases). In 2016, the highest cases were brittle branches (312 cases), prevent visibility (121 cases) and leaning tree trunks (110 cases). From the interviews with landscape architect and person in charge in Landscape Department at Petaling Jaya City Council, they state that *Pterocarpus indicus* (Angsana) is famous for brittle branches and cause car damage, *Khaya senegalensis* (Khaya) will fall in certain time due to root problems, flower and leaf fall from *Peltophorum pterocarpum* (Batai laut) and *Tabebuai rosea* (Tecoma) will clog the drainage system thus increasing maintenance costs. They now avoid these species for planting selection in certain areas at Petaling Jaya district especially at roadside areas. Another important problem identified is the issue of limited space for planting street trees. Based on the street tree inventory, most of the trees are unhealthy and in stress conditions due to limited space.



	Fallen tree	Brittle branches	Prevent visibility	Dead leaves and debris on road	Heavy branches obstruct traffic	Old and dead trees	Debris obstruct drainage system	Near to house	Leaning tree trunk
2014	184	242	129	112	257	28	141	18	118
2015	94	188	114	91	122	72	112	10	86
2016	105	312	121	142	108	109	107	15	110

Figure 7: Total number of complaints received by landscape department at Petaling Jaya City council
(Source: Landscape department)

4.8 Mean comparison results for environmental factor influencing hazardous street trees and type of respondents (One way ANOVA)

Figure 8 shows the mean comparison between environmental factor and type of respondents. There are two elements of environmental factors that show highly significant differences ($p<0.01$) in term of preferences for environmental factors are the slope

and hilly areas and natural disaster. Furthermore, when ANOVA testing was conducted, it depicted that the mean rating factors on a slope and hilly area for the private group are highly and significantly different (mean = 3.75) from other groups (local authority, mean=4.47; government, mean=4.53; student, mean=4.74). Also, the element of natural disaster for local authority also show highly significant differences (mean=3.21) compare to other groups (government, mean=4.75); private, mean=4.70; student, mean=4.11). However, other elements such as climatic change, pests and diseases, wind direction and soil structure are not of significant difference in terms of preferences.

Element Environmental factor	Type of respondents: Local authority (Expert) (N=45)	Government (Public) (N=139)	Private (Public) (N=241)	Student (Public) (N=60)	F	*Sig.*
Climatic change	4.11	4.00	4.63	4.21	1.01	0.04*
Pests and diseases	3.98	3.83	3.75	0.94	0.98	0.40
Wind direction	4.22	4.27	4.02	4.23	2.28	0.07
Slope and hilly area	4.47	4.53	3.84	4.13	4.74	0.00**
Soil structure	4.22	4.24	4.13	4.16	0.65	0.57
Natural disaster	3.21	4.75	4.70	4.11	13.75	0.00**

Figure 8: Mean comparison between environmental factor and type of respondents

Note: 1=Strongly disagree; 2=Disagree; 3=Moderate; 4=Agree; 5=Strongly agree

* Significant differences at p<0.05

**Highly significant differences at p <0.01

4.9 Mean comparison results for cultural factor influencing hazardous street trees and type of respondents (One way ANOVA)

Element Cultural factor	Type of respondents: Local authority (Expert) (N=45)	Government (Public) (N=139)	Private (Public) (N=241)	Student (Public) (N=60)	F	*Sig.*
Chemical pollution	4.41	4.29	4.45	4.46	2.05	0.42
Location of facilities close to tree	4.08	3.75	4.70	4.71	8.31	0.00**
Location of utilities close to tree	3.98	3.84	3.75	3.65	0.98	0.40
Location of building close to tree	4.22	4.27	4.02	4.23	2.28	0.07
Location of walkway close to tree	4.47	4.53	4.45	4.13	4.75	0.00**
Concrete blocking the root movement	4.22	4.24	4.14	4.17	0.65	0.57
Limited space for tree planting	4.08	4.31	4.50	4.43	5.93	0.00**
Tree as place of worship	4.28	4.14	4.02	4.08	1.99	0.39

Figure 9: Mean comparison between cultural factor and type of respondents

Note: 1=Strongly disagree; 2=Disagree; 3=Moderate; 4=Agree; 5=Strongly agree

* Significant differences at p<0.05

**Highly significant differences at p <0.01

Figure 9 elaborates on the mean comparison between an element of cultural factors and type of respondents. This section covers the four groups of type of respondents which are local authority, government, private and student. This mean comparison compares the preferences of groups. Three elements of cultural factor showed highly significant different (p<0.01) in term of preferences of cultural factors. Furthermore, when ANOVA testing was conducted on the data, the elements such as location of facilities close to trees, the location of walkway close to the tree and limited space for tree planting are significantly different (p<0.01). For the location of facilities, the preference from a group of government (mean =3.75) are highly significant compared to other groups (local authority, mean=4.08; private, mean =4.70; student, mean=4.71). The element of location walkway close to a tree for the student group (mean=4.17) are significantly different from the other groups (local authority, mean =4.47; government, mean =4.53; private, mean=4.45). Finally, the limited space for tree planting are significantly different for a group of local authority (mean=4.08) compared to other groups (government, mean = 4.31; private, mean = 4.50; student, mean = 4.43).

5.0 Relationship between species selection with issues related street planting at urban areas

From the analysis (Figure 10 There are relationships between tree species selection and hazardous trees in street areas. All approval for landscape planning especially the selection of tree species is the responsibility of local authority. This research found that 13 tree species receiev a hundred and above complaints from the public due to 9 types of tree damage such as brittle branches, fallen tree, debris obstruct drainage systems, old and dead trees, dead leaves and debris on road, heavy branches obstructing traffic, leaning tree trunks, reducing visibility and near to houses. 'Wrong tree species in wrong places' will give negative effects to public safety and property damage. Many cases are reported on fallen trees which cause human death, vehicle damage and house damage due to wrong tree species selection. Some people plant the tree based on aesthetic values such as beautiful flowers, fragrant flowers,

beautiful shapes, colourful leaf shapes but they forgot that the trees are threatening their life and property. Factors such as tree species, planting distance and space suitability need to be considered before planting a tree. Selection of tree species such as *Pelthophorum pterocarpum* and *Tabebuai rosea* has become trending nowadays because of the flower and the character looks beautiful when the flowers fall to the ground. Species *Tabebuai rosea* labeled as 'Sakura Malaysia' by the public when these species are blooming over a month and decorate the main street (Mohamad Fakhri, 2015). However, there is also a disadvantage if authorities do not control the planting of these trees. It is because the leaf and flower will obstruct the road and clog the drainage system, this will increase maintenance costs. The brittle branches of *Pterocarpum indicus* cause the branches to fall on the vehicle. Furthermore, fruit tree species such as *Mangifera indica* are not suitable for street planting because this tree is easily attacked by insects and diseases, stem quickly decomposed, brittle branches, prevent visibility, dead leaves and debris on the road and are likely to fall. The matured species such as *Termanalia mentaly, Pithecellobium dulce, Samanea saman* have surface roots that will damage the drain, pavement, building and piping system. Furthermore, the small leaf will obstruct the drainage system and pollute the road area. However, the character of this tree is brittle branches, leaning tree trunk and heavy branches obstruct the traffic. Selecting species such as *Acacia sp., Khaya senegalensis, Cinnamomum iners, Casuarina sp.* and *Ficus benjamina* will cause problems like root problems, leaning trees, dead trees, prevent visibility and at the same time will cause the fallen trees. This entire species can be categorized as hazardous street trees because of the highest public complaint and the characteristics of the trees.

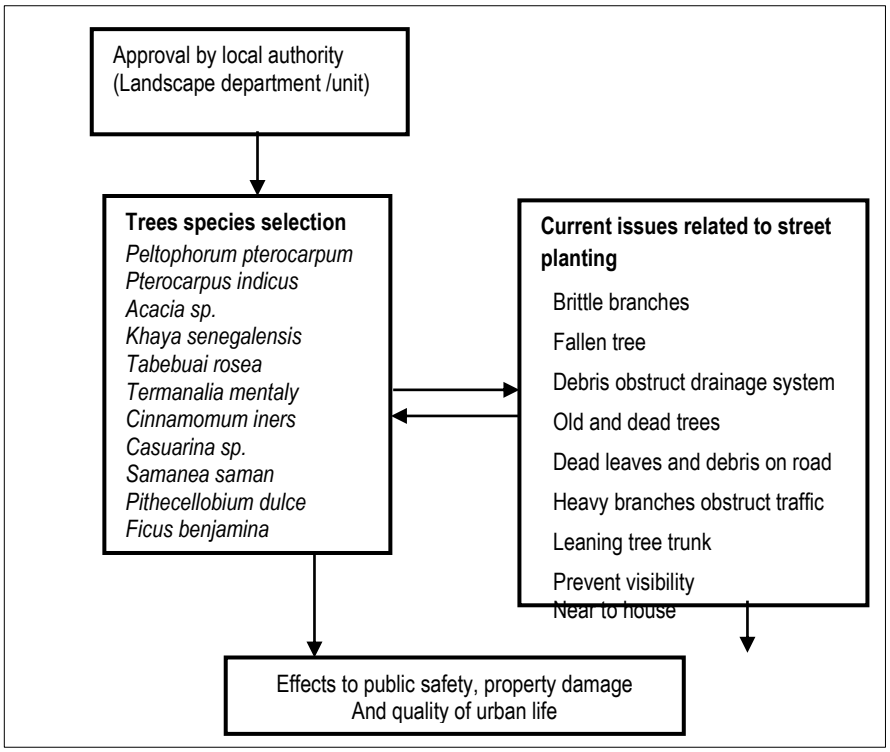


Figure 10: Relationship between tree species selection with hazardous street trees
(Source: Author)

6.0 Recommendation

The local authority needs to give more considerations in term of tree species selection. They should provide a proper guideline for tree species selection based on the feedback from the public with a proper hazardous tree management plan. The aspects consideration such as space distance, maintenance costs, tree health should be taken into account in the tree species selection. The trees were selected based on their adaptability to our climate, attractiveness, the range of size, and suitability to growing along the streets. Also, the person who is responsible for selecting of tree species should be knowledgeable and experienced. Site evaluation is another important aspect as is one of the most important step in the selection of tree species for a planting site. Landscape architects should consider both attributes – those which are above ground and below ground during the evaluation. Some contractors skip the site evaluation process, which explains why tree species planted in urban areas become hazardous to the public and public property and are often short-lived. Community programs should be introduced to enhance the quality of urban life by promoting the planting, protection and care of street trees. It is because street trees contribute to energy conservation, soil stabilisation, improve air quality, provide aesthetic value and enable enhancement of property values.

7.0 Conclusions

The findings show that the total number of public complaint on hazardous street tree has become a major issue that needs to be addressed in Malaysia. The tree to be planted along the urban streets should be appropriately hardy, deep rooting, safe and have inherently strong branching. Certain trees should not be planted because of the following undesirable characteristics such as inherently weak branching and high susceptibility to wind, to disease, view obstruction, fallen trees, leaning tree trunks and root problems. The 'right tree in the right place' needs to be considered to prevent the occurrence of hazardous street trees and hopefully increase the quality of urban life.

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References

Anderson and Thomas A. Eaton. (1986). Liability for Damage Caused By Hazardous Trees. Journal of Arboriculture, vol. 12, No. 6.

Hasan, R., Othman, N., & Ismail, F. (2016). Roadside Tree Management in Selected Local Authorities for Public Safety. *Procedia- Social and Behavioral Sciences*, *234*, 218-227.

Hasan, R., Othman, N., & Ismail, F. (2017). Social Factors Influencing Hazardous Street Trees at Selected City Council in Malaysia. *Environment-Behaviour Proceedings Journal*, *2*(5), 215-222.

Hasan, R., Othman, N., & Ahmad, R. (2016). Tree Preservation Order and its Role in Enhancing the Quality of Life. *Procedia-Social and Behavioral Sciences*, *222*, 493-501.

Lemaire, F., & Rossignol, J. (1997, September). Stress factors related to urban soils. In *International Symposium on Urban Tree Health 496* (pp. 347-352).

Miller, Robert W. 1988. Urban Forestry: Planning and Managing Urban Greenspaces. Prentice-Hall, Inc.:Englewood Cliffs, New Jersey.

Maruthaveeran, S., & Yaman, A. R. (2010). The identification of criteria and indicators to evaluate hazardous street trees of Kuala Lumpur, Malaysia: a Delphi study. *Journal of Forestry*, *108*(7), 360-364.

Metro. Nilai pokok di Tepian Jalan ,retrieved on May 21 2014

Norainiratna (2013). Health Of Trees In Titiwangsa Recreational Park, Kuala Lumpur, Malaysia. *Journal of Sustainability Science and Management*, *8*(2), 191-196.

Sreetheran, M., Adnan, M., & Khairil Azuar, A. K. (2011). Street tree inventory and tree risk assessment of selected major roads in Kuala Lumpur, Malaysia. *Arboriculture and Urban Forestry*, *37*(5), 226.