Visual Tree Analysis of Rain Trees (*Samanea saman*) in Universiti Sains Malaysia, Main Campus

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Abstract. *Samanea saman* is an urban tree usually planted in an urban landscape for its important role providing numerous environmental, social and economic benefits to the people. These trees provide excellent protective shading tree and its wood were widely used as commercial timber. Although these trees had numerous potentials in agroforestry, there were limited specific research on *Samanea saman* recently. Given all the above benefits, a study with an objective to evaluate tree risk assessment of *Samanea saman* health in three different sites within USM main campus was conducted. In this study, health assessment of *Samanea saman* were inspected based on crown class, tree shape, leaf density and tree health including root system, trunk and branch structure. Each assessed trees were categorised in tree health ranking namely excellent, good, fair and poor based on their physical condition. Results shown that trees planted in wider lawn area and less polluted area exhibited the highest number in excellent condition compared to trees planted along sloped and paved area. Overall, *Samanea saman* were in good condition. This type of analysis approach will aid USM management to monitor the trees time to time to help the trees to grow well and serve sustainable environment in USM campus.

1. Introduction

*Samanea saman* (Jacq.) Merr or commonly known as rain trees belong to the family of Leguminosae. It is believed to be native in northern South America (Colombia, the Caribbean slope and the Orinoco drainage of Venezuela), and in Central America [1]. This species was brought to Singapore in 1876 from where it spread throughout Peninsular Malaysia [2]. Rain tree has a distinctive form which the crown shaped broad and domed. This tree has many benefits and plays a vital role in the environment and ecosystem. In Malaysia, rain trees were commonly planted during the colonial period as avenue trees to provide much-needed shade for pedestrians [3].

This tree is easily recognised by its characteristics umbrella-shaped crown. During dry periods, trees lose their leaves and become semi-deciduous. The fruit is a sausage-shaped pod 6-20 cm long with thickened seams [4].

Inspection towards tree health is vital to achieve a sustainable environment. The first step to assess the general condition of the tree is to perform a detailed inspection of the tree’s health using the visual tree assessment method [5]. According to [6], Visual Tree Assessment (VTA) was initially published by [7] and more thoroughly examined in [8], encouraged experienced arborists to note signs of abnormal growth defects and relate them to failure criteria.

Tree health can be affected by many factors. The three components of tree risk assessment proposed by [9] are the tree’s failure potential, an environment conducive to tree failure, and a target. Target is
anything nearby tree that could be harmed if tree failure occurred. A tree is considered hazardous if it
possesses some type of structural defect associated with a target, such as buildings, vehicles, pavements,
or picnic areas where people and property are present [2].

Therefore, it is important to assess tree health status for sustainable development in an urban area. *Samanea saman* are species of tree used in this project, focusing the following goals to evaluate tree risk assessment of *Samanea saman* in USM campus.

2. Material and Method

2.1 Study species and area

Universiti Sains Malaysia (USM) main campus was the place to conduct for this project. Thirty rain
trees in the USM campus were assessed and divided into 3 different sites where the data were collected
for visual tree assessment analysis of rain trees. Each 10 trees were located at Fajar Harapan, Padang
Kawad and Minden site respectively. These sites were chosen due to each site had most number of rain
trees compared to other sites in USM and the planted sites of the trees were nearby to the property and
driveway which were suitable to evaluate tree risk assessment of the rain trees.

2.2 Visual Tree Assessment (VTA)

A total of 30 rain trees in USM campus were assessed during the study. The assessment procedure began
with identifying the rain trees. Diameter breast height (DBH) of rain trees were measured using DBH
tape. The measurement was taken by using a diameter tape at 1.4 meters from the ground. The DBH
data was measured in centimeter (cm) unit.

The height of the trees was measured using Arboreal application using IOS mobile operating
software. This application requires the user to walk close to the trees and mark the base. It will mark the
base and the user is required to walk away from the trees until the user can see the top of the tree. The
reading of height of the trees in meter was taken and recorded in VTA form.

Crown class, trees shape, and leaf density were inspected and the health and structural condition of
leaf condition, root system, trunk and branch structure were evaluated. Lastly, surrounding targets near
the tree were identified. Targets include facilities, people, and property which were exposed to harm
when tree failure occur. All the tree assessment data will be observed and recorded in the visual tree
assessment form.

2.3 Tree Health Status

The condition of rain trees that had been evaluated in VTA form act as an indicator to determine tree
health status. The assessed conditions of the rain trees were categorised into several classes of ranking
system based on their physical conditions [10] as shown in Table 1.

| Ranking of Tree Health | Conditions |
|------------------------|------------|
| Excellent              | - Mature specimen  
- Well balanced grand or outstanding appearance and structure  
- No evidence of insect or parasitic attack or disease, epicormic growth or dead wood physical damage |
| Good                   | - Mature specimen  
- Tree structure, appearance form and balance are considered typical.  
- Little evidence of insect or parasitic attack, epicormic growth or dead wood |
| Fair                   | - Mature specimen  
- Sparse or pale colored foliage  
- Epicormic growth or deadwood throughout the crown |

Table 1. Ranking system of tree health status
Ranking of Tree Health Conditions

| Poor | - Evidence of some branch fall  
|      | - Limited life expectancy (less than 5-10 years)  
|      | - Limited habitat value  
|      | - Poor form, health and condition, significant die back or sparse canopy.  
|      | - Physical damage, disease, decay, susceptible to large limb drop included bark forks. |

Furthermore, pie chart of tree health status in Fajar Harapan, Padang Kawad and Minden has been illustrated to show the percentage of trees categorised as excellent, good, fair and poor in each site.

3. Result and Discussion
The ranking of rain tree health as shown in pie chart each in for Fajar Harapan, Padang Kawad and Minden. Based on Figure 1, out of 10 trees sampled in Fajar Harapan, the highest number of trees was in good condition whereas the lowest number of trees in poor condition (Figure 1). There were 30% trees was in excellent condition and there are no none trees in poor condition.

![Figure 1. Tree Health Status in Fajar Harapan](image)

Figure 2 showed that in Padang Kawad, the highest percentage of trees were categorized in fair condition which is 40% whereas the lowest was in excellent condition which is 10%. Based on Figure 3, the highest number of trees was in good condition which is 60%. The lowest number of trees was in poor condition which is 10%. Fajar Harapan and Minden had none trees categorised in poor and excellent, respectively.
In this study, based on the result obtained the ranking of rain tree health in Fajar Harapan, most of the rain trees were considered as good. This is due to the trees had a living crown, dense leaf density, total alive trunk and normal leaf colour with an exposed root. The exposed root had extensive surface root system. The root system may compete too well for moisture and nutrients in agroforestry systems with small trees or shrubs underneath [1]. There was one tree classified as good condition but had swelling on the main trunk. However, the tree structure and appearance form of the trees were in good condition (Figure 4).

Most of the rain trees had epiphytic ferns on the branches. The abundance of epiphytic ferns on avenue rain trees, as observed in Peninsular Malaysia, is a striking phenomenon [11]. There were trees that had a tree pruning mark on the branches and had strangler on trunk of the trees (Figure 5). Seedlings of strangler figs establish as epiphytes on living trees, but once a fig seedling attains a rooting connection with the soil, it surrounds the host with roots that fuse and thicken, eventually forming a restricting expansion of the host trunk [12]. This strangler will be detrimental towards the host tree by strangles it to death and finally stands on its own as independent tree.
The excellent trees in Fajar Harapan shown that the trees had a balance tree shape and no evidence of insect or parasitic attacked or disease infections and any physical damage. There were no trees were classified as poor condition in Fajar Harapan because the planting site of trees in Fajar Harapan had wider lawn area as compared to trees planted in Padang Kawad and Minden. This allow trees in Fajar Harapan to avoid decreases competition among them and had enough space for the crown spread. Furthermore, trees in wider lawn areas would have had more availability in soil volume available for root exploitation and ones without paving blocks would enjoy better soil aeration [13]. These factors would allow the trees to gain more efficient water and nutrients.

In Hawaii, rain tree adapts well to trade winds, although lopsided crowns may develop in exposed situations [1]. Storm winds may uproot the rain tree, as it is shallow rooted. Rain trees planted in wider lawn area allow deep rooting, make it resistant to hurricane force winds. Pavement, foundations, or shallow bedrock restrict root growth and make the species vulnerable to windthrow [14].

Rain tree fixes nitrogen through an association with gram-negative strains of rhizobia bacteria known as *Bradyrhizobium* [1]. In pasture systems, rain tree enhances growth of grasses below and near the tree canopy through nitrogen enrichment of the soil. Nitrogen fixation at roots improves soil nutrition. Grasses under and near rain trees will remain luxuriant and green.

Based on the observation tree health in Padang Kawad, most of the trees classified as fair condition (Figure 6). This is due to the trees had an unbalance tree shape, exposed root and moderate leaf density. Many trees develop lean as they grow into open light areas and away from larger trees or structures [15].

Trees were classified as poor condition had rare leaf density, thinning crown and unbalance tree shape (Figure 7). The leaf colour of the trees showed that it had not normal colour. There were chlorosis symptoms on the leaf which the green leaves become yellowing. This might be due to a lack of chlorophyll. Hickman et al. [16] found that decline in colour of leaf cover and trunk condition was defined as the most important predictive characteristic related to failure.

The highest number of trees in Minden was in good condition. Based on visual tree assessment, the trees had a living crown, dense leaf density and total alive trunk with natural lean trees and exposed root. The trees should also be planted at suitable depth to avoid problems such as wilting, shrinking of the trunk, reduced canopy size, root rot or untimely death [17]. This can be the reason of why no rain trees were in excellent condition because most of the trees in Minden were planted along the drainage and some were planted in sloped and paved area make it the root were exposed and had limited space to
grow (Figure 8). Rain trees have shallow surface roots that thrust up above soil level as they mature, causing damage to pavements and sidewalks as well as building foundations if planted too close [1].

![Figure 6. Rain trees classified as fair condition](image1)

![Figure 7. Rain trees classified as poor condition](image2)

![Figure 8. Exposed root of rain trees in Minden](image3)

Rain trees are fast growing although suboptimal conditions such as poor soil or restricted rooting area in urban areas often result in dwarving effects on tree growth [1]. This finding can be supported by [18] who observed that roadside plants generally grow unhealthy. Most the crown of rain trees in Minden were leaning towards the drive way and foot path. Rain trees tend to have a large crown with wide-spreading branches and their branches can stretch right across roads [19]. This can impose threat to tree fall during heavy rainfall. High wind will cause the branches to drop or break the heavy branches.
4. Conclusion
Overall, most of the rain trees in USM campus were in good condition. Based on the result, several factors such as stress factor on trees planted in paved area and present of defect characterisics on trees increase the chance to tree failure. However, maintenance should be taken immediately for the trees nearby foot path, parking area and drive way in order to maintain and enhance the safety of the public. All planted trees should be monitored from time to time to avoid any falling trees and to prevent any unwanted accidents to happen. Proper maintenance of the trees and further research is needed to improve the tree health of rain trees to serve sustainable environment in USM main campus.

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