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# Reviewing Tree Risk Inventory Model for Tropical Urban Trees by Malaysian Experts

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## Abstract

The study aims to develop a new framework of tree assessment that is suitable for Malaysia's tropical urban trees. A focus group discussion (FGD) method was conducted with Malaysian experts regarding the criteria needed to assess a tree's condition starting from the juvenile stage. Found that 92% of the participants agree with the preliminary framework presented. Additional components were added to the preliminary framework based on the data collected. The study could increase the relevant organizations' knowledge of managing urban trees and decrease the deterioration and decline of urban trees in Malaysia.

Keywords: hazardous trees; tree monitoring; urban forestry, tree assessment


DOI:

## 1.0 Introduction

The rate of urbanization in Malaysia is expected to increase to more than 77.6% of the total population by 2030 (Ho, 2008). Hence, increasing demand for construction to develop housing, industry, transport, and other urban infrastructure has put tremendous pressure on green and open spaces (Kanniah, 2017; Noresah, 2010). Urban green areas are particularly important for the maintenance of a high-quality urban environment by offering recreation opportunities. However, studies and comparative evidence on the number of urban green spaces and their planning and maintenance are lacking (Nor Akmar et al., 2011).

There is also an escalating pressure on government resources to cope with the rapid rise of urbanization in Malaysia (Ibrahim et al., 2020). Therefore, Malaysia has been planting many trees for the last three decades to create and preserve beautiful landscapes in the country (Sreetheran et al., 2006). Since National Landscape Department (NLD) was established under the Ministry of Housing and Local Government in 1996, many campaigns and projects were implemented to make Malaysia green. The national planting campaign, a national garden, and other relevant programs were implemented to emphasize various aspects of landscape maintenance management (Darkhani et al., 2019). However, the frequent lack of maintenance and management of trees and planting make the issues regarding hazard trees escalate by years (Sreetheran et al., 2006).

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The planting initiative should preferably be followed by instructions and requirements for the management and care of the trees (Sreetheran et al., 2006). Adequate management is required to ensure the sustainability of a country's landscape and green spaces (Darkhani et al., 2019). The management is intended to increase public safety, make the city more livable and enhance the environment (Hasan et al., 2018). However, Malaysia lacks qualified and competent arborists at various levels (Sreetheran et al., 2006). To facilitate effective tree maintenance and management, the involvement of other experts such as landscape architects, landscape contractors, etc., is significant to monitor the risk status of peach trees in urban areas.

In arboriculture and urban forestry, practitioners must consider a method of risk assessment that is suitable for the tree or trees to be evaluated, the tools required, and the objective of management. Although more detailed advanced risk assessment levels are assumed to provide more reliable details about the probability of failure (Koeser et al., 2017), it is not clear how this additional information influences the effectiveness of tree assessment on monitoring the tree risks status along the tree life cycle. Hence, a tree risk assessment should be less comprehensive to facilitate even more experts in the urban forestry field. However, it is crucial to study the suitable criteria required to assess the tree's condition from the juvenile stage.

Therefore, the study aims to collect the suggestions and comments by Malaysian experts regarding the criteria needed to assess a tree's condition starting from the juvenile stage. The study's findings are important for inventing a new method suitable for Malaysia's tropical urban trees.

## 2.0 Literature Review

### 2.1 Sustainable Landscape Management

The idea of a sustainable urban landscape incorporates environmental, human, and cultural sustainability and biodiversity, people's needs, and attitudes toward their surroundings. A sustainable urban landscape can be achieved by careful preparation, execution, coordination, events, availability, and use of guidelines (Darkhani et al., 2019). Since there are no proper management systems, preserving a sustainable environment has become a significant issue in developing countries (Kalantari et al., 2018).

### 2.2 Organization

Some organizations have represented Malaysia's landscape professionals to lead policies, stewardship, planning, design, maintenance, and landscape management in Malaysia. Forest Research Institute Malaysia (FRIM), formerly known as Forest Research Institute, FRI in 1929, was the earliest organization established to advance the research, development, commercialization, and implementation of tropical forestry in the region. In 1981, the Institute of Landscape Architects Malaysia (ILAM) was the second organization established before the National Landscape Department or Jabatan Landskap Negara (JLN) in 1996 under the Ministry of Housing and Local Government. JLN is responsible for greening the nation and ensuring that the country's landscape is in the best shape. In 2005, after almost ten years, FRIM founded Persatuan Arborist Malaysia (PArM) to promote tropical arboriculture in Malaysia. They serve as an umbrella body for arboriculture practitioners engaged in the conservation and management of urban forest trees and build a minimum risk environment, a healthy and conducive urban landscape.

### 2.3 Development of Tree Risk Management

Local governments are responsible for creating and maintaining safe and useful urban trees for their constituents. Arborists and tree workers must be trained and skilled in order to recognize different levels of risk and manage urban trees at an acceptable level of risk. Tree risk management involves the process of identifying and assessing trees for their potential to injure people or damage property (Pokorny et al., 2003). Proper pruning and health care practices should be used by tree owners to reduce risk, and it should include a written, systematic procedure for inspecting and evaluating potentially hazardous trees, as well as implementing corrective treatments (Pokorny et al., 2003; Purcell, 2015).

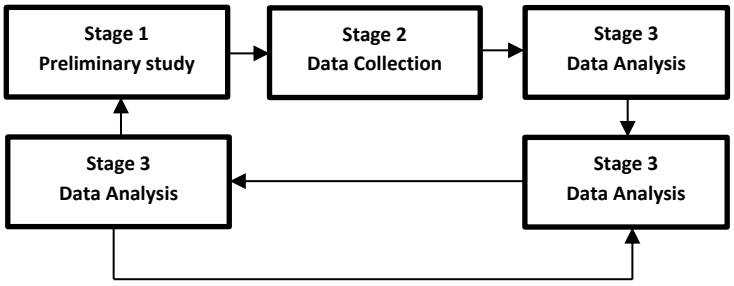


Figure 1: Tree risk management cycle

### 2.4 The Factor of Urban Tree Growth Disorder

Trees cannot serve ecological roles in the long term if they don't have the right growing circumstances. Climate change, long-term pollution, and biotic degradation are significant stressors for trees in urban woodlots (Sæbø et al., 2005). Soil serves various ecological purposes, including climate change mitigation, carbon absorption, water retention, and serving as a microorganism development habitat (Devigne et al., 2016). However, soil degradation occurs due to urbanization, putting plants under stress (Czaja et al., 2020).

Major problems concerning anthropogenic soils that will affect soil structure and functioning are soil compaction, soil moisture, soil temperature, and soil pH. These issues are contributed to by heavy traffic, constant construction activities, and crowded buildings (Czaja et al., 2020). Soil degradation results in poor water and air permeability and becomes a substantial reason for tree mortality in cities. Plants require water and mineral nutrients to grow since their root systems are responsible for water absorption. However, due to the physical difficulties of root development and poor capillary movement, water absorption is reduced, which significantly disturbs assimilation processes and mineral uptake (McGrath and Henry, 2016). Appropriate tree management can therefore change potential stress factors into favorable conditions.

## 3.0 Methodology

Exploratory case analysis was used as part of the research technique. As shown in Figure 2, the study is divided into four stages: basic research, data gathering, data analysis, and reporting. First, a preliminary study is carried out to determine the study's context, need, gap, and goals. Second, twelve Malaysian experts were interviewed in a focus group discussion. In keeping with the exploratory study, open-ended interview questions were pre-tested and asked as an aid to the memory to provide respondents free rein and freedom to react (McNamara, 2017). The transcribed text, audio recordings, and ATLAS.ti version 8.4.25 research software were all documented and organized. Finally, the codes, categories, and topics are determined by content analysis. (Mayring, 2014).

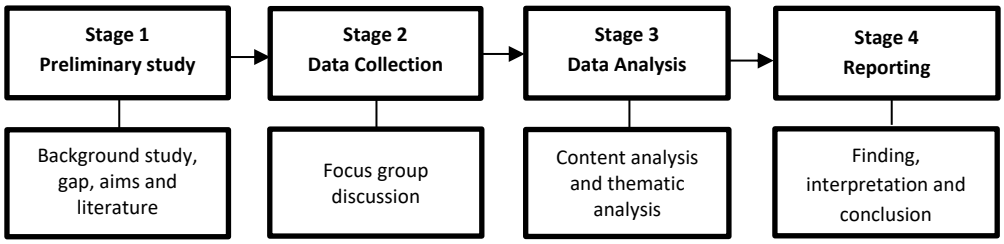


Figure 2: Study procedures

Themes were also interpreted and mapped using thematic analysis. The analysis comprises diving into the link between the categories and the topic, spotting trends, and charting a course of action (Maguire & Delahunt, 2017). Finally, the findings and interpretations are discussed, and the conclusion is derived from the research's objectives.

Table 1. Interviewees' information

| Interviewee | Field of work | Education | Years of experience |
|---|---|---|---|
| E1 | Arborist | Local | Expert |
| E2 | Arborist | Local | Expert |
| E3 | Contractor | Local | Beginner |
| E4 | Landscape Architect | Local | Intermediate |
| E5 | Arborist | Local | Expert |
| E6 | Local Authorities | Local | Expert |
| E7 | Landscape Architect | Local | Beginner |
| E8 | Local Authorities | Local | Intermediate |
| E9 | Academician | Abroad | Intermediate |
| E10 | Landscape Architect | Local | Expert |
| E11 | Local Authorities | Local | Intermediate |
| E12 | Local Authorities | Local | Beginner |

Twenty-seven experts in the related field were invited to the focus group discussion, but only 12 of them attended the discussion. They consist of arborists, lecturers, landscape architects, and representatives from municipalities. The researcher led the discussion in one group. Before the discussion took place, experts were briefed about the aim and objectives of the research study. Participants were required to discuss the possible criteria to be added or deducted based on the conceptual framework. The final summary of results was discussed, and voting on the criteria was carried out. To make identification easier, each interviewee was given an alphanumerical code (E1-E12), and the information about each interviewee is included in Table 1.

*Notes: Beginner (< 10 years) / Intermediate (10 < 20 years) / Expert (> 20 years)*

## 4.0 Findings

### 4.1 Prior Knowledge Regarding TRA

Interviewees were asked about their prior knowledge regarding the Tree Risk Assessment (TRA) methods. Five types of TRA methods have been selected and questioned by the interviewees. The results are classified into five types of TRA categories, as illustrated in Figure 3.

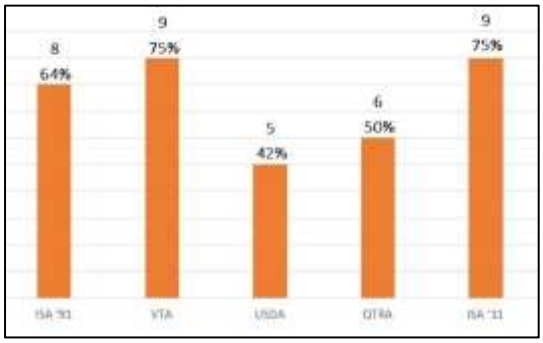


Figure 3: Prior knowledge regarding the TRA methods

The study determined that among the five methods, the highest percentage of familiarity is Visual Tree Assessment (VTA) and ISA Tree Risk Assessment (ISA '11), which have 75% each, followed by ISA Tree Hazard Evaluation (ISA '64) with a percentage of 64%. Half of the interviewees were familiar with Quantified Tree Risk Assessment (QTRA), while only 42% of them were familiar with USDA Forest Services Community Tree Risk Evaluation Method (USDA). E5 and E7 highlight that the Arborist Certification Program in Malaysia is under the ISA Certification, and most of the forms they use are either ISA '91 or ISA '11 which they modify based on the local context. Hence, E1, E2, E4, E5, E6, E7, E9, and E10 are familiar with both of the ISA methods. E1, E5, E7, E9, and E10 have familiarity with all of the TRA methods, while E2 is familiar with all except for USDA. Other than ISA '11, VTA also has the highest percentage (75%) of familiarity since VTA is a limited visual assessment (level 1). Most of the interviewees that are familiar with ISA '91 and ISA '11 are also familiar with the VTA.

### 4.2 Experience Regarding TRA

Interviewee were questioned about their experience in using the TRA methods. The results are classified into yes and no categories, as illustrated in Figure 4.


Figure 4: Experience regarding the TRA methods

The finding indicated that at least half of the interviewees have experience with each TRA method, except for the USDA, where only 3 (25%) interviewees have the experience to use it. VTA and ISA '11 were found to have the highest percentage of interviewees' experience, while ISA '91 and QTRA had only 6 (50%) interviewees and 5 (42%) interviewees, respectively.

Second, only E2 and E5 have experience using all of the TRA methods, while E1 and E4 have all experience other than the USDA method. Based on their experience of using rating systems by numbers, errors more often happen due to different perceptions compared to the matrix table system. Hence, why does USDA have the lowest percentage (25%), and why does ISA '91 have a slightly lower percentage compared to ISA '11 because both USDA and ISA '91 are using rating systems. In spite of that, each arborist still has their own preference regarding which method to use to assess a tree.

Meanwhile, E9 and E10 have the same situation where both of them have experience only with the ISA '91, VTA, and ISA '11. E5 also explained that most of the TRA forms prepared by the Malaysian experts for the local context were modified based on the ISA and VTA methods.

### 4.3 Viewpoint Regarding Preliminary Conceptual Framework

The preliminary conceptual framework of the Tree Risk Inventory for Tropical Urban Trees in Malaysia was presented to interviewees to collect their reviews and comments. Generally, the preliminary conceptual framework has eight main criteria and some attributes needed to assess a tree. The presented conceptual framework is shown in Table 2.

Table 2. Tree Risk Assessment Model

| No. | Criteria | Attributes |
|---|---|---|
| 1 | Tree characteristics | Species, DBH, estimated age, form, live crown ratio, canopy spread, pruning history, special value. |
| 2. | Tree health | Foliage colour/density, shoot growth, sound wood dev., vigour, growth obstruction, epicormic, twig dieback, leaf size, root decay, pest/biotic, abiotic |
| 3 | Site condition/factor | Site character, landscape type, irrigation, dripline, soil condition/problem, obstruction, wind, topography, site changes, common weather |
| 4 | Target assessment | Occupancy, target protection, target zone, restriction practical |
| 5 | Tree defect | Root, tree lean, soil cracking, decay in the plane of the lean, buttress, compounding factor, crown, dead twig/ branches, sapwood damage/decay, conks, heartwood decay |
| 6 | Load factor | Wind exposure, relative crown size, crown density, interior branches, vines/mistletoe/moss |
| 7 | Risk categorization/ Hazard rating | |
| 8 | Hazard abatement/ Mitigation option | Prune, removes tree/target |

Interviewees were asked about their views on the preliminary conceptual framework of the Tree Risk Assessment Model for Tropical Urban Trees in Malaysia. The results are classified into agreeing, not agree, and no answer categories, as illustrated in Figure 5.

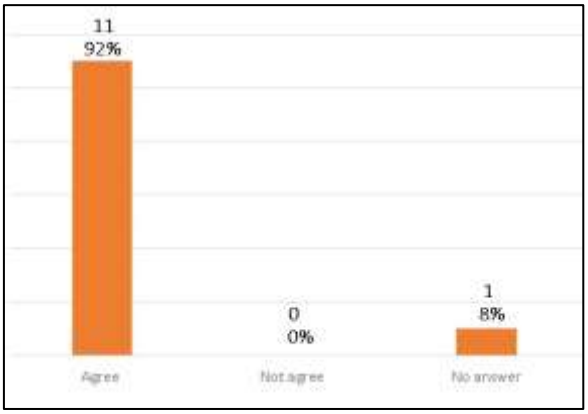


Figure 5: Viewpoint on the Preliminary Conceptual Framework

A total of 11 (92%) interviewees agreed with the presented framework, while only E3 did not give any answer. However, E3 did agree that the framework is good enough to be a future reference for policymakers to make a decision. Despite not answering, E3 also suggested that the framework should consider the planning stage regarding the planting space and was supported by E1, E2, E5, E6, E9, and E10. E1 also added that it is good to include a monitoring timeline to help ensure continuous monitoring of the tree growth, while E9 believes that the involvement and implementation of TPO during the design and planning is very important since TPO is not fully implemented.

Second, E10 advised that the researcher need to consider the tree assessment based on the objective-driven and should be streamlined to all parties involved in urban forestry, while E2 and E5 suggested including the specific age of trees and considering the latitude and longitude of trees in the framework. Both E2 and E5 believe that tree assessments tend to become less practical with vast numbers of trees if there is no new method with a user-friendly element.

Third, E4 recommends focusing more on environmental and external factors rather than only focusing on the tree itself, while E11 suggests considering the use of drone technology for tree assessment. Overall, all of the interviewees agreed that the framework should be tailor-made to suit the local criteria that are necessary to be evaluated. It needs to begin at the design and planning stage.

## 5.0 Discussion

Generally, this framework will benefit not only inventory but also decision-making. This conclusion was confirmed through in-depth discussion with the interviewees.

In general, VTA and ISA '11 are likely to have the most suitable criteria used by arborists in Malaysia. VTA and ISA '11 is a TRA method that analyzes the risk. Besides that, the proposed framework was accepted and improved by Malaysian experts and is expected to become a starting point for enhancing the management of tropical urban trees in Malaysia. The fact that only one (8%) of the interviewees was not answered their viewpoint on the proposed framework was likely because the interviewee perceived that the framework would not succeed without the full enforcement of policy and act by the federal government.

However, policymakers are expected to set some tree selection and specifications for the design stage with proper enforcement. Most of the interviewees also agree that: 1) trees should be monitored starting from the plant selection in a nursery, and 2) trees should be assessed by a layman with a level 1 assessment before being analyzed and decided by tree experts.

Table 3. Tree Risk Inventory Framework for Tropical Urban Trees in Malaysia

| Assessment phases | | Criteria | |
|---|---|---|---|
| **PHASE 1** | **PLANNING POLICY** | Tree characteristics | Site condition |
| **PHASE 2** | **IMPLEMENTATION** | Tree health | Tree defect |
| | | Site condition/factor | Hazard abatement |
| **PHASE 3** | **RISK PROTECTION** | Tree characteristics | Tree defect |
| | | Tree health | Load factor |
| | | Site condition/factor | Hazard rating |
| | | Target assessment | Hazard abatement |
| | **RISK TREATMENT** | Tree characteristics | Tree defect |
| | | Tree health | Load factor |
| | | Site condition/factor | Hazard rating |
| | | Target assessment | Hazard abatement |

Table 3 shows the research conclusion after analyzing all the data and considering some additional inputs. The framework is divided into three stages: 1) Planning and Policy stage; 2) Implementation stage; 3) Risk Protection and Treatment, and eight main criteria: 1) tree characteristic; 2) tree health; 3) site condition; 4) target assessment; 5) tree defect; 6) load factor; 7) hazard rating; 8) hazard abatement. In Phase 1 of the assessment, the only main criteria involved are 1) tree characteristics and 2) site condition. In Phase 2 of assessment, the main criteria applied are 1) tree health, 2) site condition, 3) tree defect, and 4) hazard abatement. Lastly, in Phase 3, all eight main criteria will involve.

## 6.0 Conclusion and Recommendation

Having one specific method of risk inventory for tropical urban trees in Malaysia is of great importance. With this method, many functions can be undertaken, such as tree data collection, tree monitoring, tree assessment, tree risk analysis, maintenance and management system, and tree planting design.

It is recommended that additional research be conducted on tree risk inventory as a new management system for tropical urban trees that can coordinate all the local authorities in Malaysia to have equal and standardized methods.

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## Paper Contribution to Related Field of Study

This study's contribution is to provide insights for researchers and professionals to undertake future research that helps to enable the local authorities in Malaysia to get the full advantage of the existing landscape in Malaysia.

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