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Formulation of a Hybrid Framework for Heritage Tree Expert Assessment and Classification: A Malaysian Perspective

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Abstract: In Malaysia, there is an abundance of tropical heritage trees throughout the country. Heritage trees are natural large trees with exceptional value due to association with age or special event or distinguished people. For sustainable heritage trees conservation, it is essential to set up a repository of such trees to prevent the trees from being destroyed unwittingly. In this regard, a general, yet localised framework for assessment and classification of the trees is essential. In this study, ten assessment and classification criteria with a total of forty-one sub-indicators were formulated. The framework supplements the general, easy-to-understand Tree Assessment for Heritage (TreeAH) model with localised Malaysian arborists' expert opinions elicited via rigorous Delphi and focus group techniques. The framework facilitates tree care experts the election of nominated trees as heritage trees. Efforts are currently underway by the Forest Research Institute of Malaysia (FRIM) to refine and customise the framework with more specific assessment scales and questionnaire for the purpose of quantifying values of trees in the FRIM campus in Kepong, Kuala Lumpur for UNESCO world heritage site application. Preliminary result shows promising prospect of the framework being used not only for the FRIM's use case but also at a larger scale nationwide for heritage tree assessment and classification.

Keywords: heritage tree, urban forestry, focus group, Delphi method, expert opinion

INTRODUCTION

A heritage tree is a natural large, individual tree with special value, which is considered unique due to its association with age, special event or distinguished people. Criteria to qualify a tree as a heritage tree normally include age, rarity, and size, as well as aesthetic, botanical, ecological, and historical value [1]. In Malaysia, there are many heritage trees planted before Malaya independence with immense social and economic values. There are also cities such as Melaka and Ipoh which are named after trees. Hence, the need to manage heritage trees in the urban setting has become an indispensable part of urban forestry.

At present, Malaysia has established several legislations which emphasize on heritage tree preservation as national asset, namely the National Landscape Policy [2], National Heritage Act [3], and the Tree Preservation Order of Local Government Planning and Development Act [4].

Globally, there are initiatives such as by the Monmouth City [5], Portland [6], Vancouver [7], Queenstown [8] and Tree Assessment for Heritage (TreeAH) [9], just to name a few, to preserve heritage trees. In this regard, Tree Assessment for Heritage (TreeAH) is a notable framework used to assess whether individual trees or groups of trees are of sufficient interest to be designated as a heritage tree. It was first conceived by Barrell Tree Consultancy (BTC) in 2008 [9] as a response to the increasing losses of irreplaceable heritage trees from development activity around the world. Since then, it has evolved through extensive international discussions and field testings [9].

PROBLEM AND MOTIVATION

Notwithstanding the importance and values of heritage trees and the presence of existing urban tree management framework, there are still incidents in Malaysia where trees which have heritage values being cut down unintentionally. Therefore, reassessment of heritage tree criteria needs to be carried out urgently to enhance the management of urban trees in Malaysia.

However, most of the existing heritage tree assessment criteria set in other countries are broadly

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general in context without specific detail that may facilitate execution of effective management of trees with heritage value fitting the local context, which in our case, the Malaysian context. In this regard, it is essential for a comprehensive, yet localised framework to be established to assess trees in urban context to identify heritage trees that are worth extra protection and care. As such, this research aims to address the gap by formulating a hybrid model for heritage tree assessment integrating the local arboriculture expert opinion and the globally adopted framework such as the Tree Assessment for Heritage (TreeAH) model. A comprehensive set of criteria and indicators to assess and classify heritage trees is hence formulated.

The rest of the paper is organized as follows. Firstly, overview of the novel framework formulation methodology based on the local Malaysian tree expert opinion is introduced. Secondly, TreeAH principles and indicators is elaborated. Thirdly, comparison between the Malaysian expert opinions and the TreeAH principles is highlighted. Fourthly, result of the integration of the two is presented as a Hybrid Framework for Heritage Tree Expert Assessment and Classification named HTEAC. Fifthly, promising prospect of the framework being used for heritage tree nomination, assessment and classification is illustrated via a real Forest Research Institute of Malaysia (FRIM) use case. Lastly, conclusion and direction for future work are summarized.

METHODOLOGY

In this study, ten assessment and classification criteria with a total of forty-one sub-indicators were formulated. The framework is a result of the general, easy-to-understand Tree Assessment for Heritage (TreeAH) model supplemented with the Malaysian arborists' expert opinions elicited via rigorous Delphi and focus group techniques.

Criteria and Indicators of Heritage Tree by Expert Opinion

The "National Tree Conservation Criteria and Indicator Formulation" workshop was held by the Faculty of Forestry, Universiti Putra Malaysia (UPM) in collaboration with Malaysian Arborist Association (PArM). The key objective of the workshop is to elicit Malaysian arboriculture expert opinion in formulating the criteria and indicators of heritage trees. Figure 1 shows the process flow of the expert workshop.

The experts were divided into three focus groups, namely the certified arborist, the arborist practitioner (architects and landscape architects) and arborist researchers (researchers and lecturers). Participants were divided into four groups, each led by an experienced facilitator and an assistant. Participants were required to discuss the possible criteria and indicators in the Malaysia context. The facilitators finally summarized all criteria and indicators. After focus group session had ended, all participants gathered again, where the facilitator of each group presented their results and the leader of the facilitators jot down and summarized the results. Final summary of results was discussed and voting of criteria and indicators was carried out.

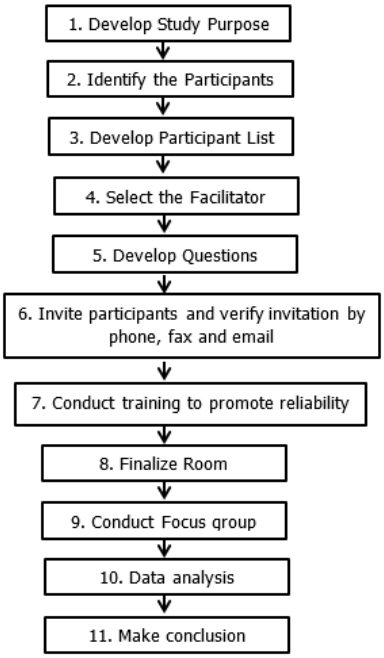

Figure 1: Process flow of the expert workshop to formulate criteria and indicators of heritage trees

Subsequently, Delphi technique was employed to identify and justify the criteria. First, all possible criteria and indicators from experts were disseminated to expert panel members in the form of questionnaires. There were three rounds of questionnaires distributed to all the participants. In answering the questionnaires, the expert panels independently brainstormed their own ideas and choices in identifying the criteria. They set priorities and provided justifications. This process was repeated for three rounds. Final criteria and indicators were selected considering factors such as feasibility, desirability and importance of the criteria.

The criteria and indicators identified from the expert workshop are summarized in Table 1. There are in total forty-one indicators categorized into one of the ten proposed criteria, namely the history and heritage value, botany value, culture and social value, uniqueness of age, uniqueness of size, aesthetic value, environmental services and ecology value, species and economy. Each of the sub-indicators can be verified by

some verifiers. For instance, age of the tree can be verified by tree records and field data collected while botany value of the trees can be verified using visual inspection by arborists apart from tree records.

Table 1: Criteria and indicators of heritage tree by expert opinion

No	Proposed Criteria and Indicators	Verifier
1	**History and heritage value**	
	a) Age of tree more than 100 years old	Tree records, field data collected (Increment borer)
	b) Landmark to towns and cities	Local authorities (Municipal and city councils),
	c) Planted by distinguished persons	Tree records
	d) Related to political event	News report
	e) Industrial and commodity history	Department of National Heritage
2	**Botany value**	
	a) Good plant structure and growth	Visual inspection (arborist)
	b) Contribute to botany knowledge	Tree records
	c) Beautiful and attractive shape	Visual inspection (arborist)
	d) Corridor to wildlife	-
	e) Available in certain place (endemic)	Tree records
3	**Culture and social value**	
	a) Symbol to ethnic group	-
	b) Big tree	Tree records
	c) Trees which create sense of place.	-
	d) Trees which can increase property value	Tree economic valuation
	e) Trees which have unique botany value	Visual inspection (arborist)
4	**Uniqueness of age**	
	a) Age of tree more than 100 years old	Tree records, field data collected (Increment borer)
	b) Age of tree more than 30 years old	Tree records, field data collected (Increment borer)
	c) Age of tree between 50 and 99 years old	Tree records, field data collected (Increment borer)
5	**Uniqueness of size**	
	a) DBH size more than 40 cm (slow growth)	Measurement (diameter tape)
	b) DBH size more than 100 cm (fast growth)	Measurement (diameter tape)
	c) Perfect symmetry value	Visual inspection (arborist)
	d) Beautiful shape	Visual inspection (arborist)
6	**Aesthetic value**	
	a) Attractive shape	Visual inspection (arborist)
	b) Perfect symmetry value	Visual inspection (arborist)
7	**Environmental services and ecology value**	
	a) Tree serves as habitat for fauna	-
	b) Tree serves as food source for some wildlife	-
	c) Tree serves as genetic pool or mother plant	-
	d) Tree serves as food source for some wildlife	-
	e) Tree which have barrier function	-
8	**Species**	
	a) Rare	IUCN Red List of Threatened Species*
	b) Native	IUCN Red List of Threatened Species
	c) Exotic	IUCN Red List of Threatened Species
	d) Endangered	IUCN Red List of Threatened Species

	e) Endemic	IUCN Red List of Threatened Species
9	**Economy**	
	a) Trees which have high value of RM	Tree economic valuation
	b) Trees which have market value	Tree economic valuation
	c) Trees which can increase property value	Tree economic valuation
	d) Trees which can generate economy of country	Tree economic valuation
10	**Tree health**	
	a) Excellent annual shoot growth	Visual inspection (arborist)
	b) Excellent vigor class	Visual inspection (arborist)
	c) Good foliage colour and density	Visual inspection (arborist)

* IUCN Red List of Threatened Species: https://www.iucnredlist.org/assessment/process

Heritage Trees Principles and Indicators of TreeAH

TreeAH principles and indicators were studied and extracted from existing literature [9]. TreeAH considers factors that make trees especially interesting and creates a ranking mechanism that permit comparisons at local, national and international level. TreeAH contains three principles and twelve indicators in total to identify heritage trees. The three key principles manifested by TreeAH framework are i) special visual interest, ii) special scientific interest, and iii) special cultural interest as listed in Table 2.

Though TreeAH manual is mainly focused on the United Kingdom (UK) context but its underlying principles are applicable universally. Firstly, the indicators for special visual interest are memorable features, memorability and size, unusual characteristics as well as low visibility of the trees. Secondly, special scientific interest principle is indicated by whether the species is rare, its age, or whether the tree habitat is rare etc. Thirdly, special cultural interest manifests in the form of indicators such as whether the tree is planted by a well-known person, association with historical events etc.

Hence, it is adopted as a reference for the formulation in this research.

Table 2: Principles of determining heritage trees by TreeAH

No	Principle	Indicator
1	**Special visual interest**	**a. Memorable features** Trees with spectacular characteristics that people remember are likely to score for memorability, but they also must be seen by enough people to qualify as a heritage tree.
		b. Memorability and size The context and the setting of the tree or group is a very important consideration. For instance, a tree can be large, but so are the other trees in the vicinity and hence, it does not stand out as a landmark tree in the wider setting. Although it is seen by many people, it may not be sufficiently memorable to qualify as a heritage tree.
		c. Unusual characteristics This tree has unusual and memorable characteristics, but it may not be seen by enough people to qualify as a heritage tree.
		d. Low visibility Striking trees that are not seen by enough people may not have sufficient visibility to qualify for heritage status.
2	**Special scientific interest**	**a. Rare species** For instance, the elm tree in Brighton (UK) not only has good habitat potential, but is also part of a unique collection of elm trees that has survived Dutch Elm Disease. For these reasons, it is of significant scientific value and likely to qualify as a heritage tree.
		b. Great age Trees of great age are generally rare and represent are source that cannot be replaced within a reasonable timescale. The age that will qualify a tree as being

		of scientific value will vary with species. For instance, Yews and oaks are known to live for well over 1,000 years and trees of these species that are only a few hundred years old would be unlikely to qualify for heritage status.
		c. First introduction For instance, soon after the discovery of the dawn redwood in China in 1949, seedlings were planted in many parks throughout China and represent the earliest introduction of the species from the wild. As one of the oldest individuals outside of the wild population, this tree in Qingdao has good potential to qualify as a heritage tree.
		d. Rare habitat If a tree contains habitat that is disappearing or under threat of being lost, then that may be sufficient to qualify a tree or group for heritage status under the scientific criterion. For instance, old fruit trees have their own unique associates making them important ecological reservoirs of scientifically important species.
3	**Special cultural interest**	**a. Trees planted by important people** Trees planted by important people have cultural significance. The more well known the person is, the greater the weight that should be placed on the importance of the tree.
		b. Planted trees This big old tree was planted by a deceased relative of the owner. It has links with the family home, but it is not historically linked with anyone known beyond the immediate family. It is unlikely to be deemed as special by enough people to justify qualifying as a heritage tree under the cultural criterion.
		c. Documented cultural associations For instance, English oaks in Port Arthur, Tasmania, were brought over from England circa 1835–1838, planted by the Commandant because he was homesick! The planting date was estimated from charcoal drawings made by convicts. This is a strong and reliable cultural association, and likely to justify heritage status for the group.
		d. Trees linked to historic events For instance, the Tolpuddle Martyrs met under this sycamore tree in 1834 to form a protest group against poor wages. They were deported to Australia and later pardoned, being credited with starting the first union movement. The tree is estimated to date from 1680 and so would have been a large tree when the meeting occurred. This is a strong and reliable cultural association, and likely to justify heritage status for the tree.

Assimilation of Expert Opinion and TreeAH Criteria

Figure 2 shows the process of obtaining the final criteria and indicator for heritage tree. Malaysian expert opinions on heritage tree criteria and indicators were compared to TreeAH criteria and indicators. Similarities were identified, and non-overlapped indicators were retained as shown in Table 3.

The comparative study showed that most of the criteria and indicators from the Malaysian expert opinion coincide with TreeAH criteria. Special economic interest criteria which were absent from TreeAH, supplemented by the expert opinion, were added to the final framework.

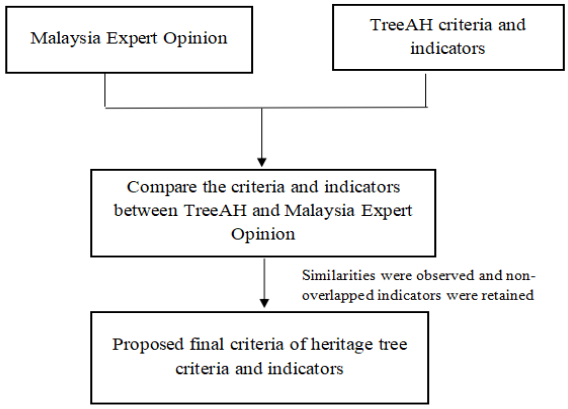

Figure 2: Process flow of obtaining the final criteria and indicator for heritage tree

Table 3: Comparative study of the criteria and indicators of TreeAH principles and Malaysian expert opinion

No	TreeAH -Principles	Malaysian Expert Opinion
1	**Special visual interest**	**History and heritage value**
	a) Memorable features b) Memorability and size c) Unusual characteristics d) Low visibility	a) Landmark to towns and cities
		Botany value
		a) Good plant structure and growth
		b) Beautiful and attractive shape
		Uniqueness of size
		a) Perfect symmetry value
		b) Beautiful shape
		c) DBH size more than 40 cm (slow growth)
		d) DBH size more than 100 cm (fast growth)
		Aesthetic value
		a) Attractive shape
		b) Perfect symmetry value
2	**Special scientific interest**	**Species**
	a) Rare species b) Great age c) First introduction d) Rare habitat	a) Rare
		b) Native
		c) Exotic
		d) Endangered
		e) Endemic
		Uniqueness of age
		a) Age of tree more than 100 years old
		b) Age of tree more than 30 years old
		c) Age of tree between 50 and 99 years old
		Botany value
		a) Contribute to botany knowledge
		b) Corridor to wildlife
		c) Mother plant
		Environmental services and ecology value
		a) Tree serves as habitat for fauna
		b) Tree serves as food source for some wildlife
		c) Tree serves as genetic pool or mother plant
		d) Tree which have barrier function
3	**Special cultural interest**	**History and heritage value**
	a) Trees planted by important people b) Planted trees c) Documented cultural associations d) Tree linked to historic events	a) Planted by distinguished persons
		b) Related to political event
		c) Industrial and commodity history
		Cultural and social value
		a) Symbol to ethnic group
		b) Trees which create sense of place
4	**Special economic interest**	**Economy**
	(Criteria added for Malaysian condition)	a) Trees which have values of RM

		b) Trees which have market value
		c) Trees which can increase property value
		d) Trees which can generate economy of country

THE HERITAGE TREE EXPERT ASSESSMENT AND CLASSIFICATION FRAMEWORK (HTEAC)

The key TreeAH principles were adopted as the main categories in the hybrid framework of Heritage Tree Expert Assessment and Classification (HTEAC). Under each category, sub-criteria and indicators were named according to the classification proposed by Malaysian experts to suit local context as presented in Table 4.

Special visual interest criteria of a tree that warrants heritage status are such as history and heritage value, botany value, uniqueness of size and aesthetic value. Special scientific interest criteria include type of species, uniqueness of age, botany value and environmental services and ecology value while special cultural interest criteria are history and heritage value, and cultural and social value.

In the context of urban tree management, the framework serves as a comprehensive reference framework for arborists and local authorities to assess and classify heritage trees.

Table 4: The hybrid Framework for Heritage Tree Expert Assessment and Classification (HTEAC)

Criteria and sub criteria	**Indicators**
1. Special visual interest a) History and heritage value b) Botany value c) Uniqueness of size d) Aesthetic value	a) Landmark to towns and cities
	b) Good plant structure and growth
	c) Beautiful and attractive shape
	d) Perfect symmetry value
	e) Beautiful shape
	f) DBH size more than 40 cm (slow growth)
	g) DBH size more than 100 cm (fast growth)
	h) Attractive shape
	i) Perfect symmetry value
	j) Big tree
2. Special scientific interest a) Species b) Uniqueness of Age c) Botany value d) Environmental services and ecology value	a) Rare
	b) Native
	c) Exotic
	d) Endangered
	e) Endemic
	f) Age of tree more than 100 years old
	g) Age of tree more than 30 years old
	h) Age of tree between 50 and 99 years old
	i) Contribute to botany knowledge
	j) Corridor to wildlife
	k) Mother plant
	l) Tree serves as habitat for fauna
	m) Tree serves as food source for some wildlife
	n) Tree serves as genetic pool or mother plant
	o) Tree which have barrier function
3. Special cultural interest	a) Planted by distinguished persons
	b) Related to political event

a) History and heritage value b) Cultural and social value	c) Industrial and commodity history
	d) Symbol to ethnic group
	e) Trees which create sense of place
4. Special economic interest	a) Trees which have values of RM
	b) Trees which have market value
	c) Trees which can increase property value
	d) Trees which can generate economy of country

USE CASE: HERITAGE TREE NOMINATION, ASSESSMENT AND CLASSIFICATION FOR THE PROPOSED FRIM UNESCO WORLD HERITAGE SITE

Forest Research Institute Malaysia (FRIM) is one of the leading institutions in tropical forestry research in the world. The Institute sits on a 545-ha site adjacent to the Bukit Lagong Forest Reserve in Kepong, 16 km northwest of Kuala Lumpur [10]. FRIM was gazetted as a Natural Heritage Site on Feb 10, 2009 under the National Heritage Act 2005 (Act 645) for conservation.

On 7 July 2017, FRIM was accepted at the 41st World Heritage Committee (WHC) Meeting held in Krakow, Poland, in the Tentative List of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Sites. FRIM is currently working towards submitting a complete dossier to UNESCO by 2019 for the attainment of the recognition as a UNESCO World Heritage Site. Part of the criteria and requirements is to quantify the combined values of the trees in the FRIM campus. The hybrid framework for the Heritage Tree Expert Assessment and Classification (HTEAC) presented in this paper has been identified as the main reference framework. Effort is currently underway by the FRIM economic valuation unit to refine and customize the framework for the evaluation and quantification of trees in the FRIM campus. FRIM targets to attain its UNESCO world heritage site status by 2020.

CONCLUSION

In this paper, the formulation process of a novel hybrid heritage tree assessment and classification framework based on TreeAH and Malaysian expert opinion has been presented. The framework is sufficiently general to be adopted across geographical context, while it also fulfills the specific need as outlined by the Malaysian experts. Results of the utility and usability of the framework for assessment and classification of trees in the FRIM's UNESCO World Heritage Site use case would be presented in our future publication. The result will serve as a vindication of the prospect of the framework being used at a larger scale nationwide for heritage tree nomination, assessment and classification. Implementation of a full-fledged online Heritage Tree Expert Assessment and Classification (HTEAC) system for nomination, assessment and classification of heritage trees as prototyped in Boung Yew et. al. [12] will be the next step forward.

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