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Appraisal of Urban Trees Value Using Thyer Method

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ABSTRACT

Urban tree-planting provides not only environmental benefits, but it also has significant value both socially and economically. Unfortunately, the economic benefits of urban trees are difficult to estimate due to the absence of a well-defined market. A range of methods have been developed to estimate the economic value of urban trees. Hence, this study attempted to appraise the value of urban trees in Kuala Lumpur using the Thyer method. Five hundred and three trees were selected upon consultation with Kuala Lumpur City Hall, and this was followed by field observations, which were carried out with the aim to document tree species, age, circumference, height, crown diameter and tree characteristics. Results indicated that *Pterocarpus indicus* has the highest value, with an estimated mean tree value of RM972,660. Meanwhile, the mean value per tree was estimated at RM435,851. However, the value of urban trees differs with respect to the physical and qualitative characteristics of the tree.

Keywords: Economic benefit, Kuala Lumpur, tree characteristics, tree value.

INTRODUCTION

The rising demand for green space in urban areas such as Kuala Lumpur resonates in most cities throughout the country. Therefore, a developing country like Malaysia should recognise the importance of sustainable management of urban planning in its decision-making process. The principle of sustainable management of urban areas acknowledges this crucial demand and it is reflected in its recommendations.

Up to now, there have been many programmes implemented by the government to increase green spaces such as planting trees along many roads, both in residential areas and urban parks. However, not many appreciate or even understand the

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innumerable benefits that come with urban tree-planting. Not only it benefits the area from an environmental perspective, it also generates economic benefits as well as other intangible benefits (social well-being and aesthetic values) to the urban communities.

Nonetheless, to set a numerical value on these benefits is a challenging task. One of the main reasons is the fact that the market price for these benefits is non-existent. Thus, the absence of such value has led to underestimation of the true values of these benefits and thus has artificially skewed many planning policies and programmes by allocating urban tree-planting the least attention.

Fortunately, there are several methodologies that can be utilised to appraise the value of urban trees in order to provide accurate information for policy-makers to make well-informed decisions.

In the past, researchers used various methodologies to appraise urban tree values. These include the Helliwell (Helliwell, 1967) – Great Britain; Burnley (McGarry & Moore, 1988) – Australia; Standard Tree Evaluation Method (STEM) (Flook, 1996) – New Zealand; Norma Granada (Asociación Española de Parques y Jardines Públicos, 1999) – Spain; Council of Landscape and Tree Appraisers (CTLA) (CTLA, 2000) – United States, Thyer Tree Valuation Method – Australia (Thyer, 2002); and VAT03 Model – Denmark (Randrup, 2005).

Watson (2002) evaluated a range of methodologies for tree appraisals. These include Helliwell, Burnley, Standard Tree Evaluation Method (STEM), Norma Granada and Council of Landscape and Tree Appraisers (CTLA). Nine appraisers have evaluated six different species using these methodologies. During the calculations, the disparities between the findings by the appraisers have a strong positive relationship between the coefficient of variation (CoV) and the mathematical operations.

Therefore, the reliability of the appraised methodologies may weaken if the results from the appraisers vary too greatly. In addition, the value of the appraisals may vary due to several factors such as tree size, species, location, condition and special factor. Moreover, these methodologies may provide an understanding of the values of public trees in the designated green areas through the provision of some good indicators.

In general, urban trees are considered as public goods and the maintenance cost is borne entirely using public funds. Often, these urban tree-planting programmes require significant amounts of financial investment. Therefore, an estimated true value of tree-planting may justify public funding of such programme. In Malaysia, research in this area is still very limited and currently, there is generally no well-accepted methodology available to appraise the value of urban trees.

Based on the realisation of the potential greater value of such programme, for the first time, this study attempted to appraise the value of urban trees in Malaysia. In specific, this study aimed to estimate the true value of urban trees in Kuala Lumpur, Malaysia, using the Thyer method.

MATERIAL AND METHODS

Study Site

The study was conducted in the capital city of Kuala Lumpur, Malaysia. The city is located between 03° 10' 00'' N latitude and 101° 42' 00'' E longitude. Kuala Lumpur has been ear-marked as a major development area to be awarded a modern city status by 2020 (KLCH, 2003 & 2007).

Tree Selection

The selection of urban trees to be appraised was based on consultations with the Department of Landscape and Recreation of Kuala Lumpur City Hall. The urban trees under the scope of study are located along five major roads, namely; *Jalan* Ampang, *Jalan* Cheras, *Jalan* Kuching, *Jalan* Raja Laut and *Jalan* Sultan Ismail. These roads were chosen based on their status as "protocol roads" or main roads that lead to administrative buildings such as the Kuala Lumpur City Hall, Bank Negara, and other significant areas in Kuala Lumpur (Sharifah Dora, personal communication, 2009).

There are ten popular species of urban trees planted along these roads. The trees are *Acacia holosericea* (Akasia perak), *Bauhinia* spp. (Tapak kuda), *Calophyllum inophyllum* (Bintangor laut), *Ficus benjamina* (Ara), *Hopea odorata* (Merawan siput jantan), *Mimusops elengi* (Bunga tanjung), *Pelthophorum pterocarpum* (Jemerlang), *Pterocarpus indicus* (Angsana), *Samanea saman* (Rain tree) and *Tabebuia pallida* (Pink tecoma). All these trees were tagged and meticulously recorded by the Kuala Lumpur City Hall.

As stated earlier, this study attempted to apply the Thyer method as a means to appraise the value of urban trees. This method was chosen as it is a widely used methodology given the availability of data. The Thyer method requires data to be collected and collated using field data sheets. These data sheets contain information of measurements and observations in relation to the physical characteristics and qualitative features of the trees. Other information required includes tree inventory reports and planting costs, which were made available by Kuala Lumpur City Hall.

Data and information from 503 trees were measured and recorded (namely, the physical and qualitative characteristics). The measurements include the diameter at breast height (dbh), tree height, circumferences and crown diameter. The qualitative characteristics of each tree included vigour, condition, structure, health condition, quality, special situation, and quality characteristics. These qualitative characteristics were measured based on the qualitative score in accordance to the Thyer method.

Appraisal Method

Thyer Method

The Thyer method was developed in Sydney, Australia in 1984 (Thyer, 2002). The valuation reflects the contribution that trees render to the landscape, an expression of the positive qualities of the tree, and the extent to which these are appreciated. According to Thyer, the valuation for this method include measurements of several factors such as the size factor (S), age factor (A), physical and social qualities factor (Q), significant index (SI) and the planting cost (P) of trees in order to obtain the value of urban trees (V).

All measurements for the attributes of size factors (S) were calculated in meters, including tree height, area of canopy from side view, average diameter to dripline and tree circumference. A Haga altimeter was used to measure and to record tree height. The recordings were taken at a distance of 15 meters from any standing tree. The reason for this distance was to avoid trees fronting the measured trees, which tended to block the reading of tree height. If the measurements were taken at a further distance (> 15 meters), the view of crown height would overlap with the front trees. Additionally, diameter and tree circumference readings were recorded at 1.3 meters above the ground at breast height (dbh). This is a standard measurement for tree diameter in forestry study.

The Thyer method applies a standard parameter in the calculation of the age factor (A) through the assessment of tree age, multiply by 0.02 and adding 0.5. The physical and social qualities factors (Q) were calculated based on qualitative score. The indicators for the physical qualities factors (Qi) are the health of the trees, environmental benefits, life expectancy beyond the present time, re-establishment potential of the same species on site, and the rate of growth over the first 10 years. Meanwhile, the scales for the physical quality factors (Qi) range from the scores of 0, 1, 2, 4 and 8. In addition, the indicators for the social quality factors (Qii) are social benefits, form and features, as well as social significance. The scales for social quality factors (Qii) scores are 0, 2, 4, 8 and 16. The scores for the total Qi scores were then added with the total scores of Qii to obtain the physical and social qualities factors (Q). The significant index (SI) was calculated through the multiplication of the size factor (S), age factor (A), and physical and social factors (Q).

Data on planting cost (P) was obtained based on the average landscape industry rate report provided by the Kuala Lumpur City Hall for various species and tree sizes. The formula to calculate the value of a tree is as follows:

Tree value (V)
= significance index (SI) [size factor (S) × age factor (A) × physical and social qualities factors (Q)] × planting cost (P)

[1]

Statistical Analysis

Statistical analysis and description of the data for the urban trees include the mean, minimum, maximum and standard deviation. In this study, the mean value of urban trees was calculated based on the species, diameter class and height class. In addition, the relationship between height and diameter at breast height (dbh), as well as between crown diameter and diameter at breast height, (dbh) was also examined.

RESULTS AND DISCUSSION

The characteristics of the urban trees measured, based on the selected urban tree species, are presented in Table 1. The results of this study indicated that *P. indicus* has the highest mean height of 22.52m, mean diameter at breast height (dbh) of 66.64cm, mean crown diameter of 14.51m, mean circumference of 2.09m, mean age of 74 years, mean tree volume of 2.85m^3 and mean significant index (SI) of 1095.34. A possible explanation for this is that *Pterocarpus indicus* is a fast growing tree and it provides much needed shades within the shortest growth time (Wee & Corlett, 1986).

Fig.1 presents the relationship between tree height and *dbh*, while Figure 2 shows the relationship between tree crown diameter and *dbh*. Both the figures demonstrate that there is a positive relationship between tree parameters, height and *dbh*, r = 0.442, and crown diameter and *dbh*, r= 0.524. The positive correlation signifies that as tree height and crown diameter increase, there are corresponding increases in the *dbh* of urban tree species as well. As the r value gets nearer to 1, the relationship between tree height and *dbh* becomes stronger.

Table 2 presents the overall estimated tree values. The average tree value ranges from RM82,953 to RM972,660. The estimated total value of 503 observed urban trees is RM4,358,510 and the mean value per tree is RM435,851. The highest tree value is indicated for *P. indicus*, with the estimated mean value of RM972,660 per tree. The tree attributes that affect the value of trees include tree height, *dbh*, crown diameter, planting cost and the significance index.

The estimated mean values for each species, based on the tree height class, are presented in Table 3. Five species, namely, *A. holosericea*, *Bauhinia* spp., *H. odorata*, *P. pterocarpum* and *S. saman,* show a positive relationship between mean tree values and tree height class. Among the selected species, *C. inophyllum* shows that the mean tree value is negatively correlated with tree height class. Most of the urban trees in the study area are planted within good planting distance; therefore, the crown diameter of the trees is able to grow unobstructed by adjacent trees.

The results reveal that *S. saman* species has the highest mean tree value with respect to tree height class, which is amounted to RM5,637,578. The estimated mean tree values ranged from RM144,870 to RM1,395,182.

Table 4 depicts the estimated tree values for each species based on tree *dbh* class. The five species, namely *Bauhinia* spp., *C. inophyllum*, *H. odorata*, *P. indicus* and *T. pallida,* reveal that the mean tree value is positively related with tree *dbh*. Meanwhile, *T. pallida* provides the highest mean tree value with respect to tree *dbh* class, which is, RM4,934,034 per tree. The estimated mean tree value ranged from RM231,298 to RM1,647,600. The urban trees that are in good condition possess higher potential to expand its *dbh* over time. Most urban trees within the study scope are in dire state. In more specific, there are insufficient room for the roots to grow and thus the growth

TABLE 1
Descriptive statistics of tree characteristics by species

Tree Species	N		Tree Height (m)	Crown Diameter (m)	Circumference (m)	Dbh (cm)	Tree Age (years)	Significance Index (SI)
Acacia holosericea	11	Mean	16.41	12.10	1.30	41.37	46	510.47
		Std. Deviation	3.47	1.47	0.70	22.20	25	164.16
		Variance	12.07	2.15	0.49	492.81	607	26,949.10
Bauhinia spp.	7	Mean	8.66	7.09	0.79	25.17	28	93.41
		Std. Deviation	2.87	2.86	0.11	3.62	4	46.61
		Variance	8.23	8.17	0.01	13.13	15	2,172.67
Calophyllum inophyllum	15	Mean	10.90	8.32	1.21	38.60	43	187.00
		Std. Deviation	1.11	0.40	0.25	7.88	9	77.06
		Variance	1.22	0.16	0.06	62.17	75	5,938.07
Ficus benjamina	9	Mean	14.49	11.87	1.88	59.93	67	597.93
		Std. Deviation	8.30	8.28	1.56	49.53	55	591.42
		Variance	68.93	68.58	2.42	2,453.03	3033	349,780.97
Hopea odorata	22	Mean	14.77	7.59	0.60	19.16	21	264.88
		Std. Deviation	1.84	1.37	0.21	6.77	7	116.38
		Variance	3.40	1.89	0.04	45.82	56	13,544.11
Mimusops elengi	6	Mean	8.27	6.88	0.75	23.93	27	215.00
		Std. Deviation	0.33	0.73	0.36	11.47	13	27.77
		Variance	0.11	0.54	0.13	131.54	166	771.29
Pelthophorum pterocarpum	110	Mean	14.81	11.51	1.35	43.03	48	441.85
		Std. Deviation	3.73	3.83	0.55	17.54	19	275.22
		Variance	13.90	14.67	0.30	307.56	380	75,747.93

cont'd Table 1

Pterocarpus indicus	185	Mean	22.52	14.51	2.09	66.64	74	1,095.34
		Std. Deviation	5.71	3.89	0.59	18.71	21	976.91
		Variance	32.64	15.12	0.35	350.16	432	954,349.11
Samanea saman	100	Mean	16.18	13.59	1.85	58.81	65	918.66
		Std. Deviation	4.76	4.96	1.04	33.20	37	1,453.68
		Variance	22.66	24.60	1.09	1,101.93	1362	2,113,172.47
Tabebuia pallida	38	Mean	15.79	9.85	1.38	44.02	49	583.70
		Std. Deviation	5.87	4.55	0.62	19.86	22	910.31
		Variance	34.48	20.74	0.39	394.27	487	828,660.80
Total	503	Mean	17.74	12.54	1.68	53.54	59	769.11
		Std. Deviation	6.24	4.61	0.82	26.07	29	976.72
		Variance	38.92	21.28	0.67	679.48	838	953,983.24

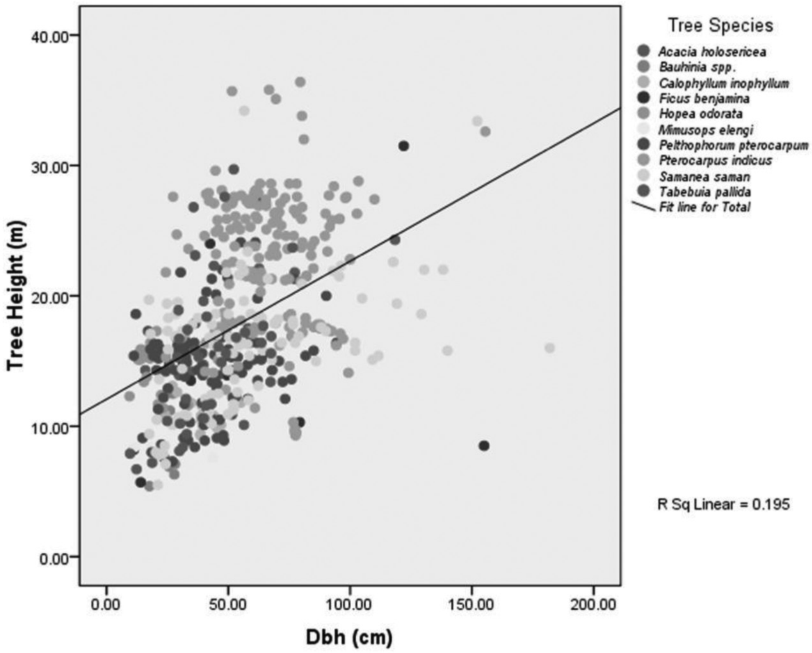

Fig.1: The relationship between tree height and dbh

TABLE 2
Descriptive statistics of tree values

Tree Species	N	Mean (RM)	Std. Deviation
Acacia holosericea	11	453,293	145,775
Bauhinia spp.	7	82,953	41,392
Calophyllum inophyllum	15	166,058	68,428
Ficus benjamina	9	530,963	525,184
Hopea odorata	22	235,214	103,345
Mimusops elengi	6	190,914	24,663
Pelthophorum pterocarpum	110	392,364	244,398
Pterocarpus indicus	185	972,660	867,494
Samanea saman	100	815,766	1,290,864
Tabebuia pallida	38	518,324	808,354
Average all trees		435,851	411,990
Total Value	503	4,358,510	4,119,898

TABLE 3
Average tree value by tree height class

Tree Species	N	Height Class (m)	Mean (RM)	Std. Deviation
Acacia holosericea	8	10 - 14.99	394,442	91,523
	3	20 - 24.99	610,230	161,669
Bauhinia spp.	4	< 9.99	59,353	12,536
	3	10 - 14.99	114,419	48,010
Calophyllum inophyllum	3	< 9.99	175,269	55,016
	12	10 - 14.99	163,755	73,350
Ficus benjamina	3	< 9.99	247,912	243,240
	4	10 - 14.99	357,023	286,950
	1	20 - 24.99	1,681,864	-
	1	> 25	924,979	-
Hopea odorata	7	10 - 14.99	135,692	46,410
	15	15 - 19.99	281,658	88,508
Mimusops elengi	6	< 9.99	190,914	24,663
Pelthophorum pterocarpum	12	< 9.99	170,209	90,064
	39	10 - 14.99	336,997	189,259
	47	15 - 19.99	424,220	214,905
	11	20 - 24.99	664,056	353,446
	1	> 25	731,653	-
Pterocarpus indicus	8	< 9.99	200,956	15,447
	10	10 - 14.99	370,690	238,237
	42	15 - 19.99	877,175	494,874
	47	20 - 24.99	747,621	420,600
	78	> 25	1,316,001	1,136,362
Samanea saman	7	< 9.99	49,270	19,692
	25	10 - 14.99	228,711	120,830
	53	15 - 19.99	734,666	473,556
	13	20 - 24.99	1,946,269	1,851,692
	2	> 25	5,637,578	5,967,934
Tabebuia pallida	6	< 9.99	75,190	42,811
	9	10 - 14.99	310,114	324,066
	16	15 - 19.99	401,226	257,630
	4	20 - 24.99	1,755,998	2,137,679
	3	> 25	1,003,517	30,763

cont'd Table 3

Total	49	< 9.99	144,870	94,963
	117	10 - 14.99	283,764	191,292
	173	15 - 19.99	614,806	435,932
	79	20 - 24.99	990,897	1,033,845
	85	> 25	1,395,182	1,433,677

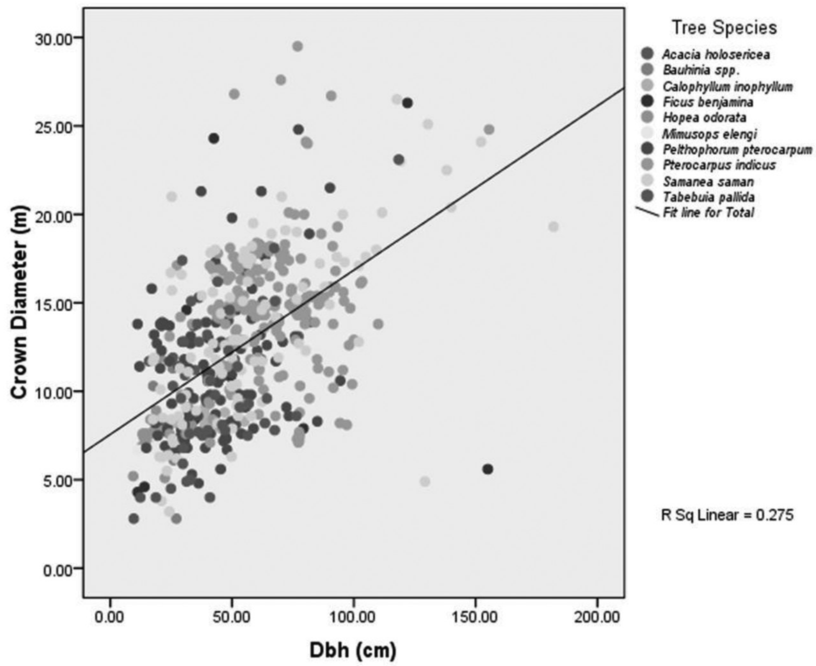

Fig.2: The relationship between tree crown diameter and dbh

TABLE 4
Average tree value by tree dbh class

Tree Species	N	Dbh Class (cm)	Mean (RM)	Std. Deviation
Acacia holosericea	1	< 19.99	347,960	-
	7	20 - 39.99	401,082	96,752
	2	60 - 79.99	516,943	7,700
	1	> 80	796,803	-
Bauhinia spp.	1	< 19.99	56,193	-
	6	20 - 39.99	87,413	43,461
Calophyllum inophyllum	10	20 - 39.99	162,133	69,262
	5	40 - 59.99	173,908	74,020

cont'd Table 4

Ficus benjamina	2	< 19.99	107,802	23,397
	2	20 - 39.99	458,728	450,345
	2	40 - 59.99	949,768	1,035,339
	1	60 - 79.99	292,962	-
	2	> 80	726,555	280,615
Hopea odorata	14	< 19.99	231,029	53,731
	8	20 - 39.99	242,537	163,042
Mimusops elengi	3	< 19.99	181,481	23,424
	2	20 - 39.99	206,322	34,581
	1	40 - 59.99	188,397	-
Pelthophorum pterocarpum	8	< 19.99	332,765	164,328
	42	20 - 39.99	363,783	181,015
	41	40 - 59.99	327,743	177,991
	15	60 - 79.99	643,305	328,948
	4	> 80	533,000	559,292
Pterocarpus indicus	7	20 - 39.99	468,904	313,793
	59	40 - 59.99	764,166	376,180
	78	60 - 79.99	869,004	553,905
	41	> 80	1,555,897	1,474,106
Samanea saman	3	< 19.99	302,356	212,514
	25	20 - 39.99	257,001	214,616
	38	40 - 59.99	526,299	364,951
	14	60 - 79.99	976,495	457,134
	20	> 80	2,028,712	2,455,494
Tabebuia pallida	3	< 19.99	42,546	8,657
	15	20 - 39.99	353,467	336,029
	13	40 - 59.99	462,758	330,856
	6	60 - 79.99	552,799	360,579
	1	> 80	4,934,034	-
Total	35	< 19.99	231,298	133,426
	124	20 - 39.99	310,581	224,374
	159	40 - 59.99	550,289	380,038
	116	60 - 79.99	825,400	514,072
	69	> 80	1,647,600	1,814,710

of the tree dbh is disturbed. A research by Ning *et al.* (2008) found that factors such as unhealthy soil, construction-related stresses, environmental pollution and heavy traffic are the main causes for low survival rate and unhealthy growth of the urban trees along many main roads.

CONCLUSION

In summary, due recognition should be accorded to urban trees as a provider of many benefits to communities. This value can now be described and represented in monetary terms. However, the study has demonstrated that the values of urban trees may differ based on their size, age, quality characteristics and planting cost.

Thus, a proper management of urban trees is crucial to ensure improved health of the surrounding urban communities, as well as to enhance functional values and at the same time, maintain the quality of the environment. It is hoped that the outcome of this study will assist decision-makers to justify the prioritisation of tree management programmes in urban areas.

Any urban tree-planting programme should invite community participations, whose collective decisions have cumulative impacts on the survival of the urban trees. In addition, environmental education and awareness programmes are equally crucial in the efforts to ensure the well-being of the trees. The monetary values attached to the trees within the study area justify the investment and expenses required for sustainable urban tree management programmes. These programmes should also include ones that involve removal of hazardous (including dead and declining) trees. This is critical to ensure public safety and to minimise damages and liabilities arising from improper disposal or lack of efforts in the removal of hazardous trees. The removal of dead and declining trees will provide more spaces for responsible tree replanting exercises. More importantly, the maintenance costs for healthy trees are much lesser than that of the cost incurred to maintain hazardous, especially dead and declining trees.

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