Studies on Tree Pruning in Taichung City: Jian-Kang Park as an Example

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Key words: VTA, Pruning, Risk level, Topped, Flush cut

Summary

Trees that contribute to the aesthetic value in a park may bring certain hazards such as snapping branches and trunk failure that can kill and other potential risks. Thus, detecting and categorizing hazardous trees to enhance the safety level of park should be carried out. In this study, visual tree assessment (VTA), an evaluation tool developed by C. Mattheck was opted for the Jian-Kang Park trees evaluation.

The survey results show that the highest risk (level IV) tree species are Samanea *saman* at area A, Samanea.*saman* and Ficus *wightiana* at area B, Sphatodea *campanulata* of area C and D. The dangerous symptoms are cavities, large co-dominant branches, dry and rotting branches and stubs from tipping, asymmetry crown and fragile epicormic shoots. There are 9 trees in total, with all of them located next to the pathway. 48 trees are of risk level III (high risk), majorly with compression forks at co-dominant branches, epicormic shoots with odd bends, overlifted crowns, non-tapering trunk and asymmetry crowns. Out of 354 trees, 87% were found being topped and flush cut, causing decay and hollow parts, watersprouts which attach at a weak point, asymmetry crown etc. Trees in the park have non-tapering trunk majorly, and they are 72% of the assessed trees.

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Introduction

Tree maintenance, especially the tree pruning in local Taiwan has not been performed in a proper way as topping and flush cut trees can be found along the street normally. Trees develop bad structure and the mechanical supports are altered. The hazardous status of trees is expected to be the main factor that contributes to the safety issues that entail whenever they are pressure-loaded (wind, rain and snow) defeating the purposes of having trees in our environment.

Researches before that focus on VTA application to evaluate dangerous trees that caused by environmental and man-causing stress. As for my research, the main driving factor for the trees assessment was because of the improper pruning that has been practiced for decades. It is important to evaluate the safety level of the trees and review the overall tree conditions when the damages were expected to be huge in a glimpse. Moreover, park is an important place for recreation and health training purposes. A safety park can be achieved with the maintenance of the park facilities as well as the presence of safety trees. My study purpose is to find out the risk status of the trees in one of the park in Taichung area, with Visual Tree Assessment (VTA). It is a method which directs the tree surveyor through a procedure of biological and structural conditions observation.

Materials and Methods

Site survey was carried out with Garmin, in order to reflect the location of the trees in map. While assessment of each tree was carried out base on the evaluation criteria decided, pictures were also taken in order to record the failure symptoms.

1. Evaluation criterias

VTA was conducted base on the 3 criterias:

a) Topping and the emergence of epicormic shoot

b) Flush cut and the wound level

c) Mechanically weak aspects like trunk tapering, crown shape and the presence of weak branches.

With the segment of tree which was injured, a tree was further evaluated base on crown, fork area and main branch stem from fork and trunk.

2. Survey site

Jian-Kang Park is the biggest park in the southern region of Taichung, with the longitude, N 120" 67' 0.1" and, latitude, E 24" 11' 9.3". It was built in early 90's, with the park area proximally 5.7 hectares. There were 3 categories of the tree location: 'pathway' category for trees planted along the paved trails and the area which is frequented by publics (with the marks of the die back grass and hard soil surfaces around); 'trees in group' which refers to trees planted close to each other, with their crown canopy developed; trees that categorized under 'turf area' are those at grass-carpeted area, with certain distance from the non-pave-trails and paved trails. The park was divided into 7 plots, from plot A to plot G. Trees that were assessed in this research do not cover palm tree (in the Arecaceae family) and conifers (gymnosperms). As the trees in the park is grown from the sapling, only those with diameter at breast height (DBH, 1.3m from ground) more than 15cm were assessed. Some transplanted trees were topped at a height less than 1m, they were also omitted from the evaluation.

Table 2. Each tree location was marked with the Global Positioning System (GPS) device.

Plot	Facility	Tree species
A	Skating rink	Samanea *saman*, Bomba*x ceiba*
B	Family square	Ficus *wightiana*, Samanea *saman*, Bombax *ceiba*, Acer *serrulatum*, Cinnamomum *camphora*
C	Children playground	Cassia *fistula*, Sphatodea *campanulata*, Terminalia *boiviini*
D	Muscle training area	Sphatodea *campanulata*, Terminalia *boiviini*, Samanea *saman*
E	Walking paths	Sweetinia *mahagony*, Cassia *fistula*, Alstonia *scholaris*
F	Turf area	Terminalia *catappa*, Sweetinia *mahagony*, Ficus *microcarpa*
G	Turf area	Bauhinia *blakeana*, Cassia *fistula*, Sweetinia *mahagony*

3. Risk categorization

Individual tree was evaluated on the risk of mechanical failure that is caused by bad pruning. Each tree was evaluated were graded into four levels:

Table 3. Risk level categorization.

Risk levels and symptoms
I –Fair: Minor wound that does not causing further decay and cavity with the development of woundwood (Mattheck, 1995; K. Brian, 2003, G.A. Dahle, H. H. Holt, 2006). Epicormic shoots may be available along tree trunk (Halle *et al*., 1978); branches and in herbaceous layer of the crown but their size (DBH <5cm) are too small to bring any danger to the public, with their height < 3m from the ground level.
II- Potentially risk: The tree has some epicormic shoots (> 5cm or <5cm) at a height >3m from ground level (Karlovich *et al*., 2000); some dried and decaying branches in the herbaceous/ frutescent part of the crown after tipping at crown. Dormant sprouts, codominant branches with included bark at the trunk (A. Shigo, 1991; C. Mattheck; 1995); overlifted crown (Gilman, 2002); vertical or rubbing branches within the crown (R. W. Harris, 2004), asymmetry crown (Skatter *et al.*, 2000,Olessen, 2001), if the combination of the risk criteria fulfill, they will bring certain risk at the present or potential hazard in the future.
III- High risk: This tree possesses codominant branches or multi-stems that grow > ½ size of the originating branch (Helliwell, R. 2004; S. Kellomaki *et al*., 1998); decay and hollow at the branch attachment point; included bark at the fork that supports high mass above; leaning trunk with dense crown which has a correction growth (branch stretch to the light direction); over-stretch non-tapering epicormic shoots (Luley *et al*., 2002; R. Milne,1991), asymmetry crown and slender trunk (Olessen, 2001). The listed parts are dangerous mainly because of the mass they possess and fail easier when loaded under high wind.
IV-Immediate risk: Severely decayed, cracked trunk and fork area; decaying big branch; stems or branches of arborescent part with some compression forks, supporting dense crown above; overlifted and asymmetry crown with non-tapering bole (Bruchert *et al*., 2006; J. Bond, 2010.). The tree that is found to have the listed criteria is very dangerous as high mass is supported by obsolete structure (branch/ trunk or attachment point) (Almeras, *et al*., 2009; J. R. Clark *et al*., 2010). This tree can fail any moment even though there is not the presence of load.

Results

1. Location and risk level

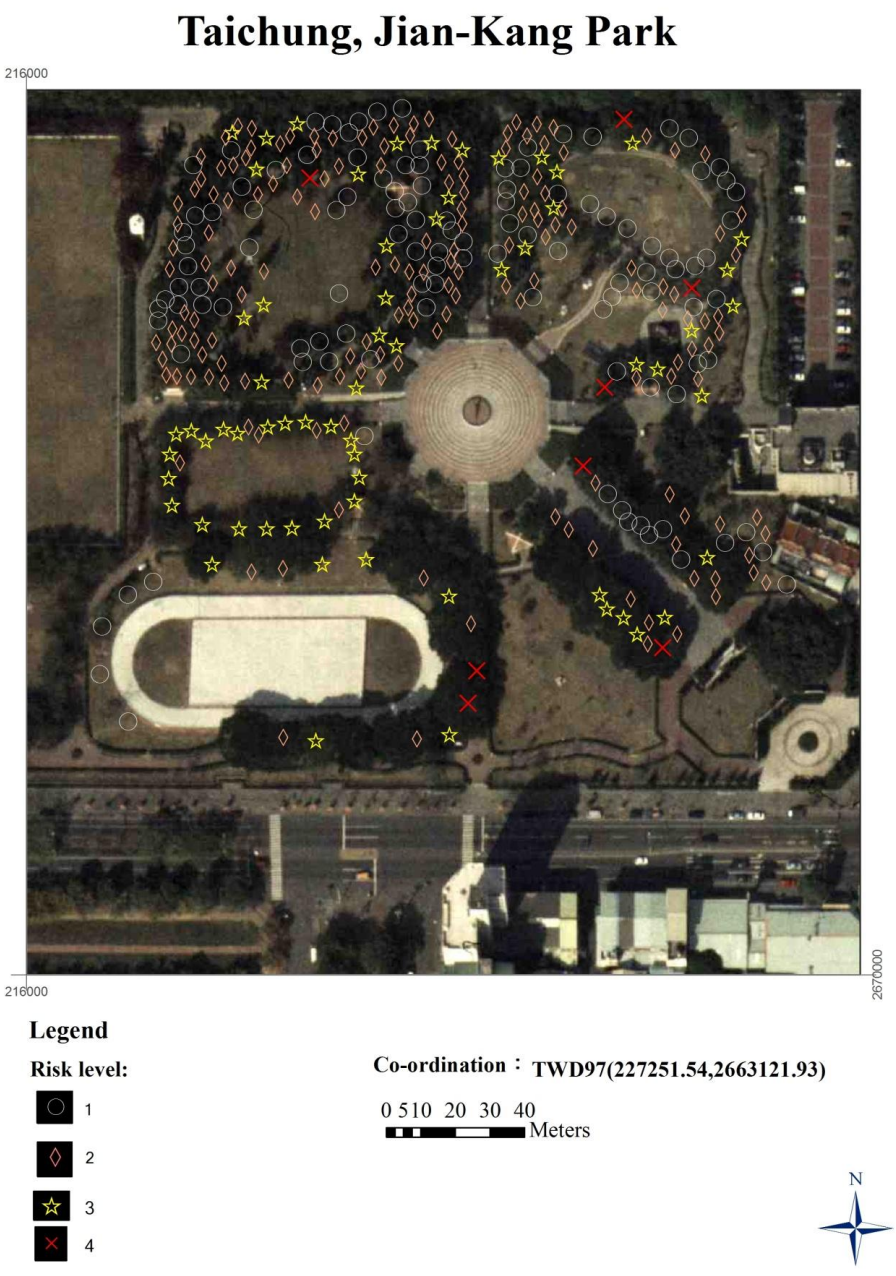

Fig. 1. Mapping of trees according to the risk levels.

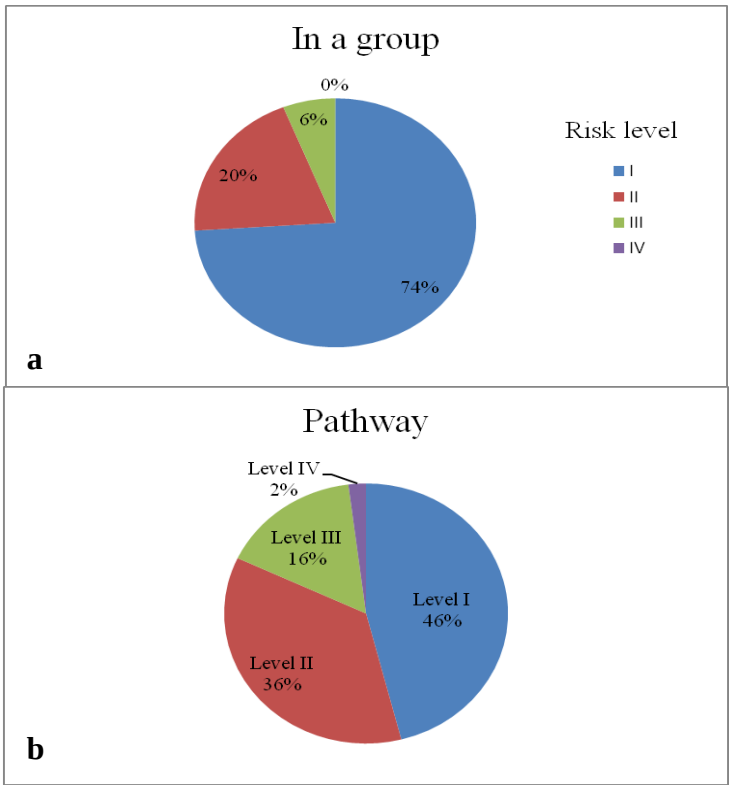

Fig. 2a,b. Different areas in the park with risk level categorization of trees.

A total of 224 trees planted along the pathway. With the consideration that trunk, branches and crown failure will threaten the lives of publics, they were attended with more pruning on crown reduction and risk reduction. However, the more they were pruned, with topping and flush cut method, pathway trees with risk level III and IV found to be more.

Trees under risk level category I mostly had their reduction pruning by tipping at the crown branches (crown reduction pruning) to create a smaller crown. At the same time, group planting showed that trees were pruned lesser and 74% of them fell under level I and regarded fairly safe. ‘Immediate risk’ trees (level IV) were not found under this group. This is because they form canopy to support each other as a group, where as the heaviest part of the tree (crown) were stabilized with high damping ratio within a group, compression forks in dense stands would be able to survive since wind loads in dense stands are limitted (Mattheck, 1991).

2. Topping and flush cuts

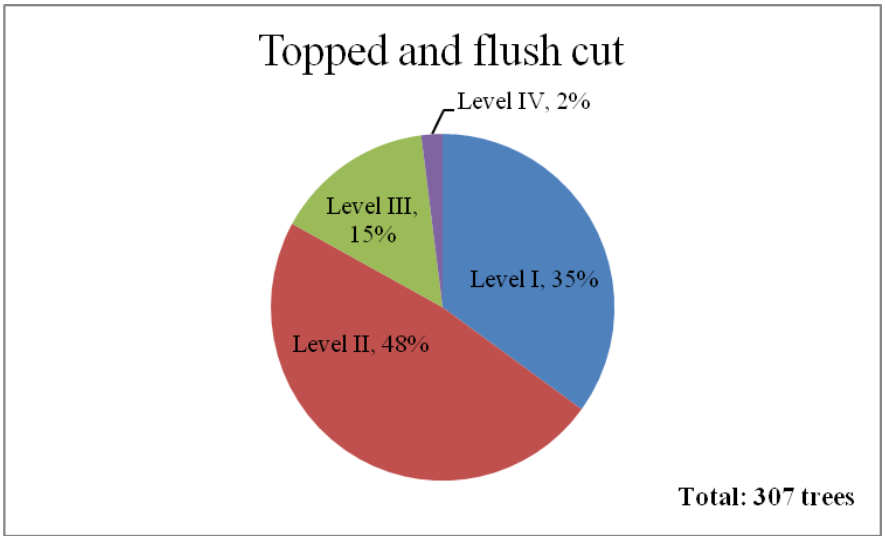

Fig 3. Improper pruning and risk level categorization of trees.

This chart shows different types of improper pruning and how they relate to the risk level of a tree. Out of 354 trees, 87% were found being topped and flush cut, causing decay, craks and hollow parts, watersprouts which attach at a weak point, asymmetry crown etc. Trees under risk category I were wounded-trees that could not sustain the growth of epicormic shoots; with dried topped parts and stubs, woundwood or decaying spots. Most trees with risk level II ,had the presence of watersprouts along tree trunks, crown ,where size is very small, small sprouts that bend oddly and were rubbing with other branches and co-dominant branches that form within the crown or at a height not more than 6m from ground level.

Trees under risk category III possess co-dominant branches or multi-stems that grow > ½ size of the originating branch; decay and hollow at the branch attachment point; included bark at the fork that supports high mass above; leaning trunk with dense crown which has a correction growth (branch stretch to the light direction); over-stretch non-tapering epicormic shoots. They can be so dangerous mainly because of the mass they possess and fail easier when loaded under high wind. Trees of risk level III and IV were found to have higher percentage of topping and flush cuts at the same time. These trees usually able to regenerate after topping but the new parts were topped again some time after so to reduce their mass. This cycle is repeated until the tree is too weak to regenerate/reiterate.

3. Tree species and improper pruning

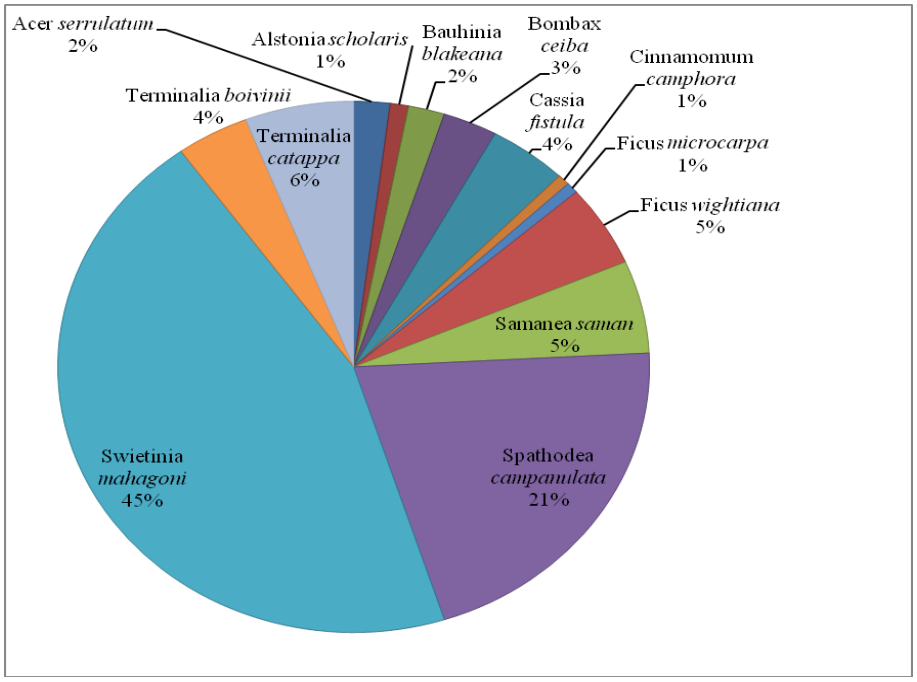

Fig 5. Topped and flush cut tree species with risk level I & II.

Swietinia trees showed high compartmentalization ability under topping and flush cut, with very less amount of trees revealing serious cavities and rotting branches/ structure, contributing to the largest group that fall under risk level I and II. Besides that, group planting also serve to reduce the risk level of this tree species as their crown form canopy that was able to support each other in high wind/rain.

Out of 71 trees, 92% of the Sphatodea trees were topped and decay spread from the wound. However, 88% of them were still rated under risk level I and II. The main reason is the weak compartmentalization ability of this tree species. Decay that started from the topped area extended down to the trunk flare. Watersprouts struggle from the decaying points and majority of them do not develop into canopy. Some shoots even dried out, as the rotting are not resisted by compartmentalization. This is further supported by DBH data where75% of the trees have DBH reading less than 30cm, little branching which contribute to sparse crown, smaller foliage size in general.

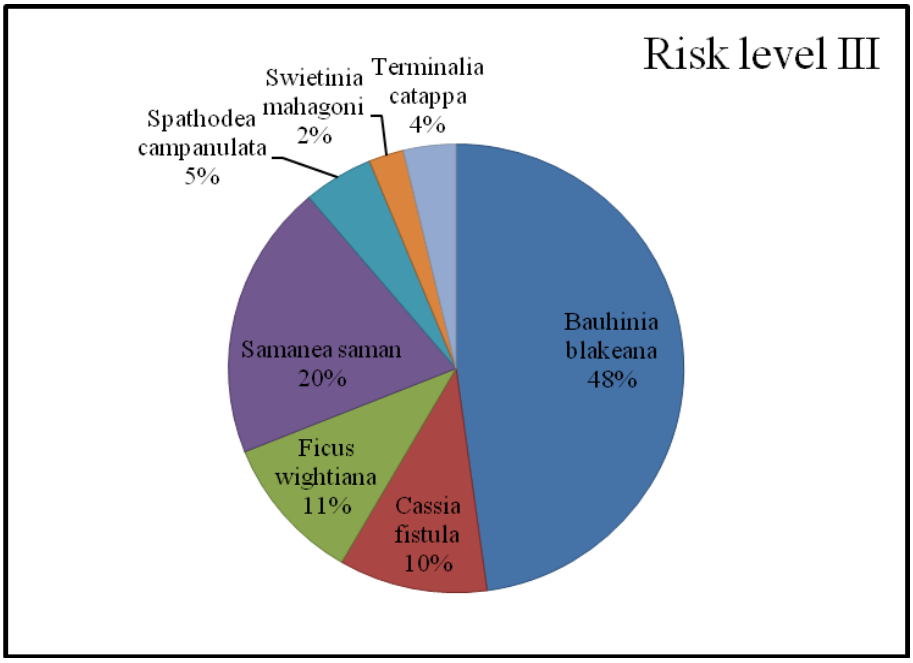

Fig 6. Topped and flush cut tree species with risk level III.

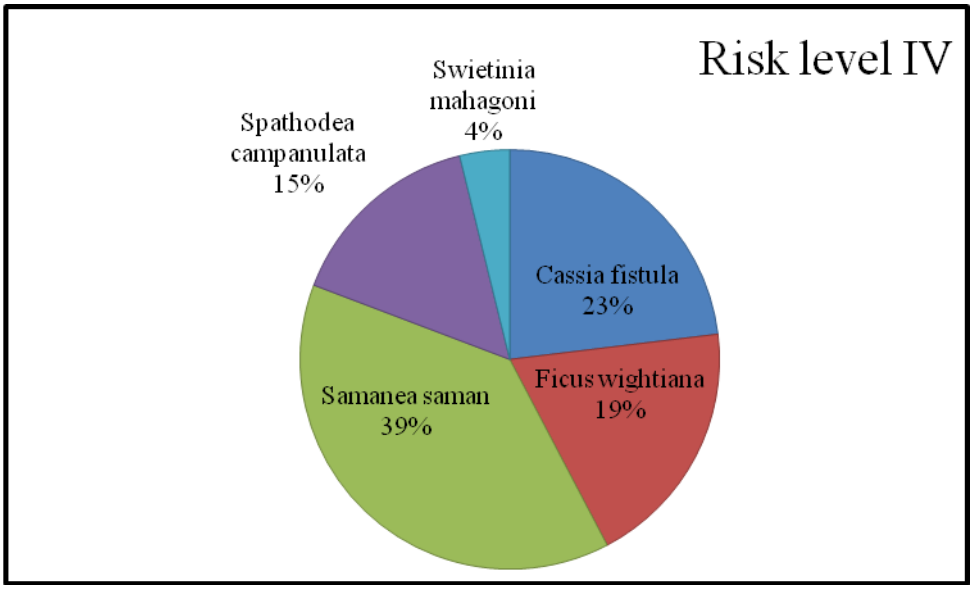

Fig 7. Topped and flush cut tree species with risk level IV.

There were variations in how different tree species react to pruning. Large pruning wounds should be avoided with species that have weak compartmentalization capability, as well as with those do not form branch collars (Einser *et al.*, 2002).Trees species with low compartmentalization ability like Ficus, Spahtodea and Cassia, when receiving repeated topping and flush-cut deteriorate to become 'immediate risk' trees.

Most Spahtodea trees that were topped or had their big branches removed have large decays and wound that spread down to the trunk flare, cavities, numerous dried watersprouts and small DBH reading that delineates stunted growth of the trees. Ficus *wightiana* which were topped develop serious trunk decay. It is the group planting that helps reducing the possibility of mechanical failure of the trees as their crown canopy greatly enhance the damping ratio.

Cassia trees, with smaller trunk and main branches naturally, mostly topped at fork and crown segment. With the fast growing ability and the reserved storage energy, they were still able to carry out photosynthesis process. They react to repeated topping by developing numerous epicormic shoots and vigorous leave-flush. These shoots were found to have compression forks at the upper portion of the tree, high mass, dangerously thin branches, contribute to the risk level IV.

Samanea trees do not fall under the weak compartmentalization tree species. They contributed to the largest percentage of 'immediate risk' group because of the uncountable dried branches and stubs (>5cm circumference) left on trees. As Samanea trees grow fast to have large and long limbs, they were found to be tipped and topped halfway through the branches at whichever branches that were considered to be 'too long'. These branches dried and decayed eventually as they lost all their photosynthesis organ, and being shaded from the sunlight.

Discussion

Many trees in urban landscapes were not planted closed to each other so they develop an unnatural open form. These trees lack good mechanisms for handling the spreading low-branching habit that results from growing in the open urban or suburban landscape (Gilman *et al.*, 2005.). Without a planned pruning program and proper pruning knowledge, many trees in urban and suburban landscapes are pruned to create more safety problems. Trees were topped in order to get rid of their heavy mass in the easiest and fastest way. As this study found that group-planted trees received lesser topping and flush cut pruning, this method should be applied in the trees planting in a park. This is especially important for trees with decurrent form as they have weaker branch compare to trees with excurrent growth. These trees have more rounded outlines because there are many more branched stems with numerous V-shaped crotches. Group-planted trees form crown canopy and the dense stands reduce wind loads on weak structure. These criteria greatly contributed to the lower risk level (level II) of Swietenia *mahagoni* trees at Area E. Besides the fact that Swietenia was a species that produce quality hard wood and good compartmentlization ability, group planting should be adopted when planting trees in the park. Terminalia *catappa* had pagoda tree form and tier branches and thick layer of foliages for each tier layers, making it a very shady tree. This tree form made it a least-pruning tree species. Bombax *ceiba* at area A and B also come with pagoda tree form. However, this species did not able to provide shadiness like *T. catappa.* Sphatodea *campanulata* and Ficus *wightiana* should not be chosen as these species appeared to be very fragile under topping and flush cut. Another alternative to solve pruning-created-issue is to have flowering shrubs to plant along the pathway as they survive better under hard pruning and will not tend to threaten the public safetiness with weak structures.

Tree topping causes poor tree architecture like asymmetry crown and non-tapering branches (Oldeman, F. H., 1978; R. W. Harris, 2004.). Topped and flush cut trees were deformed to a point where they have dangerous structure/form (rated as risk level III and IV). The asymmetry crown produced was of imbalance mass distribution and gravity center greatly changed. These characters did not fulfill the requirement of ‘windfirm’ trees.

A tree can have their trunk topped in the first round. Some years later, the epicormic shoots that develop into main branches after the topping were mutilated again. Tree structures that are subjected to repeated-topping will have their stress concentration part to change from one point to another. A non-topped tree may have their stress concentrated at the trunk, with its crown overlifted; a topped tree will have their stress concentrated only at the sprouting point as they grow bigger. Topping causes abrupt change in shape (such as a dogleg); a sudden reduction in

surface area such as a large decay area and notches of all kinds (such as holes, cankers, bulges and cracks). These are stress raisers which serve as the primary factor that jeopardize the safety factor of the mechanical support. Structure tapering and crown symmetry serve as the secondary factors that trigger the mechanical failure of a tree. Under the negative effects mentioned, trees need to be pruned and train under a planned schedule over a period of years, especially when a crown raising is needed. Overpruned at one time will force the tree to grow taller, losing its trunk tapering and also stress the tree. From the VTA assessment, trees in this park were found to have their crown highly lifted and deprive the chance for the trees to develop proper caliper. Slender tree trunk that have lower load bearing strength compare to trunk of proper tapering. For both tree forms, low branches need to keep small so they droop and a small wound is left following removal. If large stems or upright branches form in what will become the lower of the canopy when it nears maturity, storms could break these trees easier than those pruned to a stronger structure (Gilman, 2002).

As topping and flush cut are widely applied, trees in the park need to be assessed for their risk levels or to quantify their decay levels. At the same time, research on topping and relationship with trees architecture, how different trees species react to topping and flush cut can be studied and evaluated in more detail since the dangerous and deformed trees are not to be remove at once.

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台中市的公園樹木修剪現況調查與研究
-以健康公園為例

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關鍵字：VTA、修剪、風險水平、打頂、環枝組織被剪除

摘要：公園是公眾休閒的主要選擇的地方。樹木有助於公園的美化， 營造讓人放鬆心情的美好環境。 但是， 不適當的樹木修剪卻能為公眾帶來一定的危害，輕者影響公園的美觀；重者殺人奪命。因此，評估和分類危險的樹木，以提高公的安全水平是必要的。在這項研究中，運用 C. Mattheck 發展出來的視覺評估（VTA）發評估健康公園樹木在長期修剪下的危險度。

調查結果顯示，風險最高(第 IV 級)的樹有有 9 棵，樹種 為 A 區的雨豆樹(Samanea *saman*)，B 區的鳥榕(Ficus *wightiana*)，C 和 D 區的火焰木(Sphatodea *campanulata*)，它們的危險症狀為大面積的枝幹腐爛，夾皮雙主幹，腐朽的殘存樹枝，不對稱的樹冠和著附脆弱的不定芽。這些樹都在公園的鋪面路徑旁。 另外，第三級風險(高風險)的樹木為 48 棵。它們的危險症狀為夾皮雙主幹與不定枝、修的過高的樹冠、太過細瘦的樹幹和不對稱樹冠。在所調查的 354 棵樹當中，87％發現是被修剪除了環枝組織，導致腐爛、中空腐朽、著附脆弱的不定芽。 另外，也發現打頂修剪後所造成不對稱冠樹的樹木。公園裡 72％的樹木的主幹都是過於細瘦的。

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