

PLANT MATERIALS AS AN INDICATOR FOR LOW
CARBON URBAN PARK PLANNING AND DESIGN

BY

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ABSTRACT

Plant materials are essential in reducing the carbon dioxide in the air and function as a carbon sink by reducing air pollutant levels and sequestering atmospheric carbon dioxide (CO₂). Nowadays, the concept of a low carbon urban park is becoming a new approach for low carbon cities development in support of Sustainable Development Goals (SDGs) and commitment towards reducing carbon emission. Several studies reported limited published information on the extent of carbon storage and sequestration on planting materials in Malaysia, especially in urban parks. Therefore, finding a valuable plant for CO₂ absorption is one of the critical challenges and remains accomplished. This research aimed to investigate the plant materials as an indicator for low carbon urban parks through carbon sequestration rate assessment to enable future optimal carbon accumulation in reducing carbon emissions. The research employs a qualitative method which consists of a case study approach and observation. The three urban parks were sampled based on their locality, park age and specified planting material factors. The observation checklists were developed accordingly. The carbon sequestration rate (CSR) calculation was used to analyse the collected data of three selected urban parks. The findings revealed four main factors identified as plant materials indicators for low carbon urban parks: planting design composition, plant's growth, green area distribution, and planting density. These key factors are then categorized into eleven criteria. Identifying these key factors that influenced carbon sequestration rates is beneficial to develop a greater understanding of building a low carbon urban park with optimum carbon sequestration rates, thus helping to strengthen the ecosystem services, alleviating urban heat island global warming. These findings become an added value for the planning and design guidelines to further support the existing carbon reduction rating system, simultaneously contributing to a green practice approach to neutralize carbon emission towards environmental quality with better design solutions, cost-effective and environmentally friendly. The formulation of the framework is the final output that contributes to the overall understanding of plant materials as an indicator for a low carbon urban park. Hence, selecting landscape planting design settings plays an essential role in contributing to the higher CSR value. In addition, a higher percentage of the green area has much influenced in contributing more excellent CSR value. Suitable planting design composition by adequately selecting the right plant materials with higher specifications and larger quantities also contributed to the optimum value of carbon sequestration rate in urban parks. Furthermore, the key factors influencing the CSR rate are plants' growth performance and planting density. Suitable plant species and higher planting density supported with good plant growth contributed to the more excellent CSR value. Proper application of landscape maintenance activities and good park management services contributed to better plant growth performance, providing larger plant biomass obtained through carbon estimation.

خلاصة البحث

تعتبر المواد النباتية ضرورية لتقليل ثاني أكسيد الكربون في الهواء وتعمل كبالوعة للكربون عن طريق تقليل مستويات ملوثات الهواء وعزل ثاني أكسيد الكربون في الغلاف الجوي (CO_2). في الوقت الحاضر، أصبح مفهوم الحديقة الحضرية منخفضة الكربون نهجًا جديدًا لتطوير المدن منخفضة الكربون لدعم أهداف التنمية المستدامة (SDGs) والالتزام بالحد من انبعاثات الكربون. أبلغت العديد من الدراسات عن معلومات منشورة محدودة عن مدى تخزين الكربون وعزله في مواد الزراعة في ماليزيا، لا سيما في الحدائق الحضرية. لذلك، فإن العثور على مصنع قيم لامتصاص ثاني أكسيد الكربون هو أحد التحديات الحاسمة ولا يزال منجزًا. يهدف هذا البحث إلى التحقق من المواد النباتية كمؤشر للحدائق الحضرية منخفضة الكربون من خلال تقييم معدل عزل الكربون لتمكين تراكم الكربون الأمثل في المستقبل للحد من انبعاثات الكربون. يستخدم البحث طريقة نوعية تتكون من منهج دراسة الحالة والملاحظة. تم أخذ عينات من المنتزهات الحضرية الثلاثة بناءً على موقعها وعمرها وعوامل مادة الزراعة المحددة. تم تطوير قوائم المراجعة وفقًا لذلك. تم استخدام حساب معدل عزل الكربون (CSR) لتحليل البيانات المجمعة لثلاث حدائق حضرية مختارة. كشفت النتائج عن أربعة عوامل رئيسية تم تحديدها كمؤشرات للمواد النباتية للحدائق الحضرية منخفضة الكربون: تكوين تصميم الزراعة، ونمو النبات، وتوزيع المناطق الخضراء، وكثافة الزراعة. ثم يتم تصنيف هذه العوامل الرئيسية إلى أحد عشر معيارًا. يعد تحديد هذه العوامل الرئيسية التي أثرت في معدلات عزل الكربون مفيدًا لتطوير فهم أكبر لبناء حديقة حضرية منخفضة الكربون مع معدلات عزل الكربون المثلى، وبالتالي المساعدة في تعزيز خدمات النظام البيئي، وتخفيف الاحترار العالمي لجزيرة الحرارة الحضرية. أصبحت هذه النتائج قيمة مضافة لإرشادات التخطيط والتصميم لزيادة دعم نظام تصنيف خفض الكربون الحالي، والمساهمة في نفس الوقت في نهج الممارسة الخضراء لتحديد انبعاثات الكربون نحو الجودة البيئية مع حلول تصميم أفضل، وفعالة من حيث التكلفة وصديقة للبيئة. صياغة إطار العمل هو الناتج النهائي الذي

يساهم في الفهم العام للمواد النباتية كمؤشر لحديقة حضرية منخفضة الكربون. ومن ثم، فإن اختيار إعدادات تصميم زراعة المناظر الطبيعية يلعب دوراً أساسياً في المساهمة في زيادة قيمة المسؤولية الاجتماعية للشركات. بالإضافة إلى ذلك، فإن نسبة أعلى من المساحات الخضراء قد أثرت كثيراً في المساهمة بقيمة أكبر في المسؤولية الاجتماعية للشركات. كما ساهم تكوين تصميم الزراعة المناسب عن طريق الاختيار المناسب للمواد النباتية المناسبة بمواصفات أعلى وكميات أكبر في القيمة المثلى لمعدل عزل الكربون في الحدائق الحضرية. علاوة على ذلك، فإن العوامل الرئيسية التي تؤثر على معدل المسؤولية الاجتماعية للشركات هي أداء نمو النباتات وكثافة الزراعة. ساهمت الأنواع النباتية المناسبة وكثافة الزراعة العالية المدعومة بنمو جيد للنبات في زيادة قيمة المسؤولية الاجتماعية للشركات الممتازة. ساهم التطبيق السليم لأنشطة صيانة المناظر الطبيعية وخدمات إدارة المنتزهات الجيدة في تحسين أداء نمو النبات، مما يوفر كتلة حيوية أكبر للنبات تم الحصول عليها من خلال تقدير الكربون.

APPROVAL PAGE

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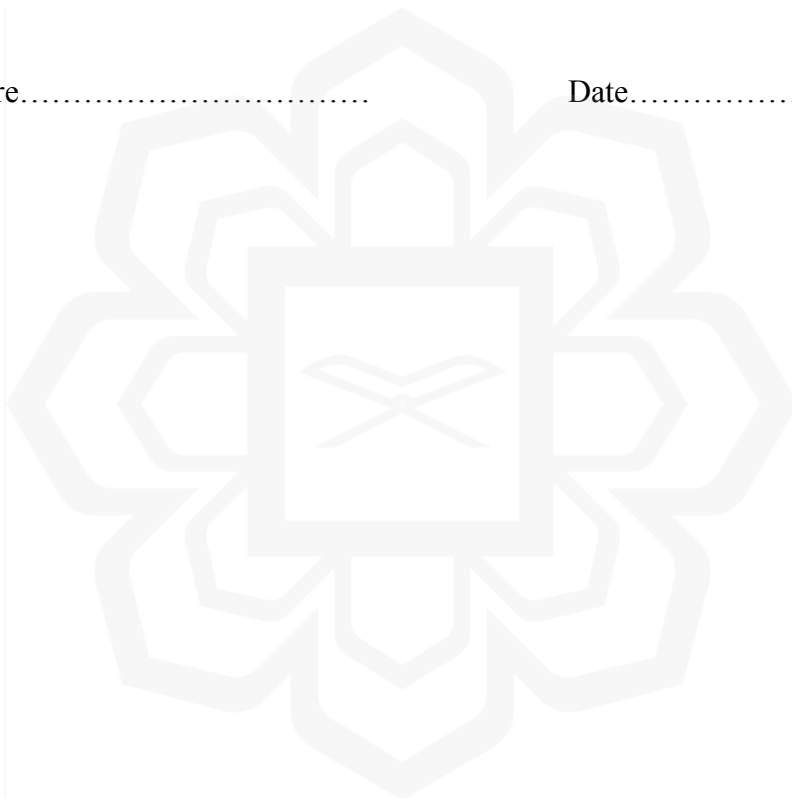
DECLARATION

I hereby declare that this thesis is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

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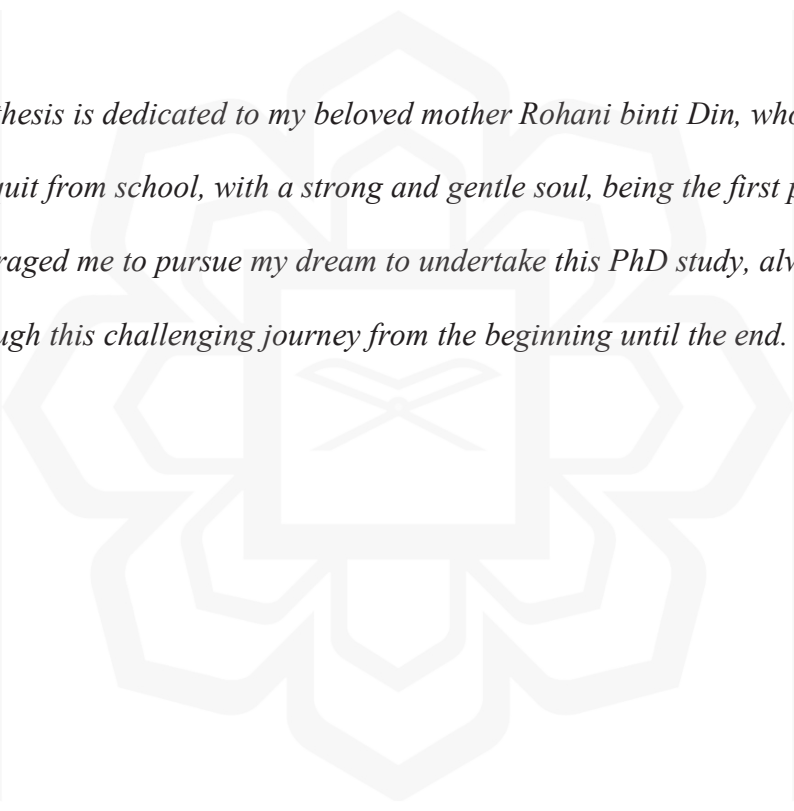
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This thesis is dedicated to my beloved mother Rohani binti Din, whose sacrificed her life quit from school, with a strong and gentle soul, being the first person who truly encouraged me to pursue my dream to undertake this PhD study, always been with me through this challenging journey from the beginning until the end. Thank you Mak.

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LIST OF ABBREVIATIONS

%	Percent	IPCC	Intergovernmental Panel on Climate Change
°C	Degree Celsius	kgCO ₂ e	Kilogram of carbon dioxide equivalent
<	Less than	kg	Kilogram
>	More than	Km ²	Kilometre Square
≤	Less than or equal to	LCCF	Low Carbon City Framework
≥	More than or equal to		
A	Acre	MyCREST	Malaysian Carbon Reduction and Environmental Sustainability Tool
AGB	Above Ground Biomass	m	Meter
BGB	Below Ground Biomass	m ²	Meter Square
C	Carbon	O.H	Overall height
CCS	Carbon capture and storage	SDGs	Sustainable Development Goals
ft	Feet	T.D	Trunk diameter
CO ₂	Carbon dioxide	T.H	Trunk height
cm	Centimetre	nos	Number of species
CSR	Carbon Sequestration Rate	tCO ₂ e	Tonnes of carbon dioxide equivalent
DBH	Diameter at Breast Height	TCO ₂ W	Total Carbon Dioxide Weight
DNDC	Denitrification-Decomposition	TCW	Total Carbon Weight
GBI	Green Building Index	TDW	Total Dry Weight
GHG	Greenhouse Gas	TGW	Total Green Weight
Ha	Hectare	UHI	Urban Heat Island
Inch	Inches		