WEIGHTAGE FACTORS FOR MALAYSIA GREEN HIGHWAY ASSESSMENT

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To my beloved; Ismail Mohamed, Zainab Abd. Rahman, Rozana Zakaria and Assoc. Prof. Ir. Dr Rosli Mohamad Zin, and to all my research partners.

May God bless all of us.

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ABSTRACT

A green highway is an effort to achieve sustainable approach for sustainable infrastructure. Key requirements for realizing green highway goals comprise of the fulfilment of Green Highway Index (GHI). GHI development and establishment of its criteria provide alternative and appropriate options for highway assessments. The weightage factors help to set the priorities of green highway elements according to their numbering value. The aim of this research is to establish weightage factors for the green highway criteria to be used in the Malaysia Green Highway assessment. An extensive literature review was undertaken on five major criteria identified in the Malaysia green highways assessment which are Sustainable Design and Construction Activities (SDCA), Energy Efficiency (EE), Material and Technology (MT), Environmental and Water Management (EWM), and Social and Safety (SS). In overall, 133 variables were selected from five main criteria to run the weightage Factor Analysis of Malaysia Green Highway Assessment. The elements were confirmed by 140 respondents, participating in questionnaire surveys, and were analysed using SPSS 18.0. A pilot analysis was undertaken by the reductions of factors to select a number that was easy to analyse but explained most of the variance using Factor Analysis. Factor score was calculated for each variable by multiplying the mean value of criterion with respective Factor Loading. The calculation of weightage factor was done by determining the ratio of percentage of population over the percentage of sample in a main criterion. Criterion with higher weightage was considered more important than another. Out of 133 criteria, 7 criteria were chosen for SDCA: 4 for EWM, another 4 for MT, 6 for EE and 7 for SS. The results show that all of these five main criteria served as essential basis for the development of Malaysia Green Highway Assessment.

ABSTRAK

Lebuhraya hijau adalah suatu pendekatan lestari ke arah mencapai prasarana yang mampan. Kunci kehendak dalam mencapai sasaran lebuhraya hijau merangkumi kepatuhan terhadap Indeks Lebuhraya Hijau (GHI). Pembangunan GHI dan kewujudan kriterianya menyediakan alternatif dan pilihan yang bersesuaian terhadap penilaian lebuhraya hijau. Faktor pemberat membantu menetapkan keutamaan elemen lebuh raya hijau berdasarkan nilai penomboran mereka. Matlamat kajian ini adalah untuk menghasilkan faktor pemberat kepada kriteria yang mana akan digunakan dalam cadangan Penilaian Lebuhraya Hijau Malaysia. Sebuah kajian literatur telah dijalankan secara menyeluruh terhadap lima kriteria utama yang dikenalpasti dalam cadangan Penilaian Lebuhraya Hijau Malaysia iaitu Rekabentuk Lestari dan Aktiviti Pembinaan (SDCA), Kecekapan Tenaga (EE), Bahan dan Teknologi (MT), Pengurusan Air dan Alam Sekitar (EWM), serta Sosial dan Keselamatan (SS). Secara keseluruhan, 133 pembolehubah telah dipilih daripada lima kumpulan utama untuk menjalani Analisis Faktor pemberat bagi Penilaian Lebuhraya Hijau Malaysia. Elemen-elemen ini ditentusahkan oleh 140 responden, yang menyertai kajian soal selidik dan dianalisis menggunakan perisian SPSS 18.0. Satu analisis awalan dijalankan dengan pengurangan faktor untuk memilih bilangan faktor yang senang dianalisis tetapi menerangkan keseluruhan varian menggunakan kaedah Analisis Faktor. Skor Faktor dikira untuk setiap pembolehubah dengan mendarabkan Nilai Purata dengan Beban Faktor masing-masing. Pengiraan Faktor Pemberat dilakukan dengan menentukan nisbah peratusan populasi terhadap peratusan sampel dalam satu kriteria utama. Daripada 133 kriteria, 7 kriteria dipilih untuk SDCA, 4 kriteria bagi EWM, 4 kriteria untuk MT, 6 kriteria untuk EE dan 7 kriteria bagi SS. Keputusan menunjukkan kesemua lima kriteria utama menyediakan asas yang diperlukan kepada pembangunan penilaian lebuhraya hijau Malaysia.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BTU	British Thermal Unit
DID	Department of Irrigation and Drainage
DOE	Department of Environment
DWNP	Department of Wildlife and National Parks
EE	Energy Efficiency
EWM	Environmental and Water Management
GREENLITES	Green Leadership in Transportation Environmental Sustainability
GREENROADS	Greenroads Rating System
HDI	Human Development Index
ID	identification of criteria within a main criteria
I-LAST	Illinois-Livable and Sustainable Transportation Rating System
ILH@M	Indeks Lebuhraya Hijau Malaysia
KMO	Kaiser-Meyer-Olkin
LLM	Malaysia Highway Authority
MASMA	Manual Saliran Mesra Alam Malaysia
MT	Material and Technology
MVA	Mean Value Analysis
NWSC	National Water Services Commission
PCA	Principle Component Analysis
PWD	Public Works Department
REAM	Road Engineering Association of Malaysia
SDCA	Sustainable Design and Construction Activities
SPSS	Statistical Package for the Social Science
SS	Social and Safety
TEP	Tons Equivalent Petroleum

LIST OF TERMINALOGIES

Assessment	a process of gather, analyse, interpret, using information
Criteria	standard/rule/test on which a judgment/decision can be based
Eigenvalues	special set of scalars associated with linear equations
Element Description	brief explanation of the sub criteria
Factors	group of variables within the same tendency
Factor Loading	correlation coefficients between the variables and factors
Factor Score	scoring to evaluates something according to numerical value
Main criteria	five main criteria of proposed Malaysia Green Highway Assessment (SDCA, EE, MT, EWM and SS)
Models	rating index/collaboration/framework/initiatives
Stratum	a subset (part) of the population which is being sampled
Sub Criteria	a subset of main criteria
Variables	element description used in factor analysis
Variance	a measure of how far a set of numbers is spread out
Weightage	value/importance of something compared with another thing

CHAPTER 1

BACKGROUND AND INTRODUCTION

1.0 Background of Research

A green highway is a roadway constructed in a way that integrates transportation functionality and ecology. An environmental approach is used throughout the planning, design, and the construction. Green highways have invaluable benefits to environment; A green highway will benefit transportation, the ecosystem, urban growth, public health and surrounding communities. Landfill usage is favourably reduced as construction involves recycled materials. In addition, by using cutting-edge technologies in design, critical habitats and ecosystems are protected from the encroachment of highway infrastructure. Furthermore, a green highway provides superior watershed-driven storm water management that prevents leaching of metal and toxins flow into the streams and rivers. Accomplishment of green highway infrastructure calls for focus on integrating transportation needs. This objective can be realized by considering ecological protection, by avoiding subsequent environmental destruction and excessive resource consumption as well as by incorporating sustainable development concepts into infrastructure projects. A green highway necessitates commitment from all parties involved, such as business concerns, drivers and the government as their involvement can ensure that the green concept is long lasting. Reducing the pollution and preserving the nature must be the aim of every green development.

To achieve a green highway, harmonization of highway needs with local ecological protection considerations needs to be focussed. Moreover the questions such as how to avoid subsequent environmental destruction and excessive resource consumption and how to incorporate sustainable development concepts into highway projects need to be answered. In this regard, development of the green highway assessment system is the key to promoting sustainability and green highway construction. Hence, this study will come out with several fundamental elements of green highway development within Malaysian context. These elements will ultimately provide an essential guidance for the establishment of Malaysia's green highway framework model of assessment. Additionally, many parties in Malaysian highway industry will much benefit by incorporating green characteristics in managing and developing roads, pathways, expressways and other such concerns.

1.1 Problem Statement

The effects on local environment, economic and social along the pathway are significantly contributed by highway development. Present days have witnessed the raise in awareness and concern among government, concessions, and public on the importance of making the world a convivial place to live in, ensuring progressive growth as well as achieving sustainability. In addition to ideas of green highway, the world countersigned various efforts of assessments like the establishment of Greenroads® and GreenLITES®. Greenroads® is a rating system that distinguishes more sustainable, new, reconstructed and rehabilitated roads. Greenlites® is a self-certification program that distinguishes transportation projects and operations based on the extent to which they incorporate sustainable choices. However, these contemporary models and assessments of green highway performance has encountered several problems for instance, each single assessment is only valid to be used in a certain areas, as the criteria underlined in the model are restricted to particular areas only.

Practically, every single assessment model of green highway is different from the other. This is because each model is generally being designed and built based on local capacity in particular regions, encompassing local needs only. For instance, an assessment model for a region is sometimes not suitable to be applied to other areas. This problem might be contributed by different elements of weightage used in every single model.

The elements of current highway assessment are limited and not do vary in terms of practicability, as for example, if 'Model A' does not have assessment criteria for social and safety for 'Highway B', the models are not dependable and cannot be used, as the weightage factor is being affected. On the other hand, there is no standardization between models of assessment as they come out with their own interpretation. In order to adapt with this problem, Malaysia highway authority and other responsible parties will have to come up with some kind of new list of elements to be considered in developing the weightage of Malaysia green highway assessment elements. This can be accomplished by undertaking several studies involving in-depth analysis of several key phases, which is planning, designing, construction, operation and maintenance of highway development.

1.2 Aims and Objectives

The aim of this research is to establish green highway weightage factor of green highway criteria to be used in Malaysia Green Highway assessment. The study was carried out based on the following objectives:

i. to determine critical criteria and elements of green highway,
ii. to develop green highway weightage factor for green highway assessment, and
iii. to analyse the weightage factor for Malaysia green highway.

1.3 Scope of the Study

This research determines factors and elements to be used for Malaysia Green Highway assessment. Possible elements, criteria and sub criteria related to highway were gathered from various assessments, ratings, initiatives and collaborations. The statistical and mathematical models in the market were studied to calculate weightage factors. A pilot analysis was conducted through reductions of factors conduct using factor analysis method. To carry out the weightage factor analysis, 133 variables were selected. Factor score and weightage factors were calculated for each variable. Several parties from government and private sectors, including Malaysia Highway Authorities, highway concessionaires like PLUS and MTD, contractors, suppliers and others related personnel, were approached for comments, views, perceptions and suggestions towards the problems. The weightage factors for criteria, sub criteria and element descriptions were established for Malaysia green highway assessment model.

1.4 Brief Research Methodology

The research methods employed for this study included the review of literature including books, journals and information from Internet. Data were collected using questionnaire; the respondents were individuals who were involved with the highway construction. Several analyses were conducted to identify the elements, contributing most in the green highway, this would establish green highway weightage factor to be used in developing Malaysia green highway assessment model.

1.5 Significance of Research

Effective green highway infrastructures enable people to access vital services such as healthcare and education, to travel for employment, to transport and sell goods, to access social networks, and to make their voices heard in the political arena. Ultimately, a green highway will support the sustainable principles as it leads to improved social development, economic growth and friendly environment. Thus, providing a weightage factor of green highway criteria is a sustainable goal to achieve more reliable, comfortable and convenient highway assessment system.

1.6 Outline of the Thesis

This thesis consists of 5 Chapters. A brief summary of each is outlined as follows: Chapter 1 comprises of introductory section which develops the reason for the direction of this research. It is also states the research background, research problems, research objectives, brief discussion on methodology, research scope and significance of the research. Chapter 2 describes the key terms used in the research as well as summarises the current state of knowledge by examining relevant background literature. This chapter also comprises the literature review on the history of green highway, the relation between highway, sustainability and green ideas, the concepts and definitions of green highway assessment, the proposed Malaysia green highway assessment criteria and statistical approaches to weightage analysis. Chapter 3 describes the research methodology in detail including the research plan, data collection method, type of data collected, respondents involved, pilot study, reliability, validity and data analysis. This chapter also explains how the data were acquired and how the respondents were selected and approached. Chapter 4 presents the analysis and interpretation of qualitative data using SPSS 18.0 software. The end of this chapter summarise the weightage factors for Malaysia green highway assessment. Chapter 5 concludes the findings from the research. This chapter also shows the most relevant factors for Malaysia green highway assessment, the limitations of the research and the suggestions for the future study.

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