

ESTABLISHMENT OF SUSTAINABLE DESIGN CRITERIA FOR MALAYSIAN
GREEN HIGHWAY INDEX

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ABSTRACT

The green rating system becomes a popular tool to confirm the green credential of an infrastructure. Malaysia has established the green rating system for building but not for highway. The aim of this study was to identify the suitable sustainable design criteria and sub-criteria of the green highway criteria for Malaysian Green Highway Index. The objectives of this study were to identify the suitable criteria and sub-criteria for sustainable design; and to identify the weighting of sustainable design highway criteria. The information was gathered from journals, books, conference papers, internet and others country green rating system manual. Other than that, it also included the discussion with the experts and questionnaire distribution. Experts are the academician, professional from government agency and private sector that have been involved in highway projects. This study focuses on the suitable design criteria for expressway and toll highway. The suitable design criteria and sub-criteria of sustainable design was analysed using the factor analysis. From the analysis, there are two criteria and seven sub-criteria of sustainable design that is suitable with Malaysian highway condition. Factor score were determined by multiplying the factor loading with a mean of each sub-criteria. Factor score were used as a weighting for determine the score point of sustainable design criteria and sub-criteria.

ABSTRAK

Sistem penarafan hijau telah menjadi medium yang popular untuk menentukan tahap kehijauan sesuatu infrastruktur. Malaysia telah menubuhkan sistem penarafan hijau untuk bangunan tetapi tidak untuk lebuhraya. Tujuan kajian ini adalah untuk mengenal pasti kriteria dan sub-kriteria kriteria reka bentuk mampan lebuhraya hijau yang sesuai untuk Indeks Lebuhraya Hijau Malaysia. Objektif kajian ini adalah untuk mengenal pasti kriteria dan sub-kriteria yang sesuai untuk reka bentuk yang mampan, dan untuk mengenal pasti pemberat kriteria reka bentuk lebuhraya yang mampan. Maklumat berkaitan dengan kajian telah diperolehi daripada jurnal, buku, kertas kerja persidangan, internet dan manual sistem penarafan hijau negara lain. Selain daripada itu, ia juga termasuk perbincangan dengan pakar-pakar dan pengedaran borang soal selidik. Pakar-pakar terdiri daripada akademik, profesional dari agensi kerajaan dan sektor swasta yang terlibat dalam projek-projek lebuhraya. Kajian ini memberi tumpuan kepada kriteria reka bentuk yang sesuai untuk lebuhraya dan lebuhraya tol. Kriteria dan sub-kriteria yang sesuai dengan reka bentuk yang mampan telah dianalisis dengan menggunakan analisis faktor. Daripada analisis ini, terdapat dua kriteria dan tujuh sub-kriteria reka bentuk yang mampan yang sesuai dengan keadaan jalan raya di Malaysia. Skor faktor ditentukan dengan mendarabkan faktor pemberat dengan min setiap sub-kriteria. Skor faktor telah digunakan sebagai pemberat untuk menentukan markah kriteria dan sub-kriteria reka bentuk yang mampan.

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LIST OF ABBREVIATIONS

ACEC-Illinois	-	American Council of Engineering Companies - Illinois
ACEM	-	Association of Consulting Engineering Malaysia
BEAM-Plus	-	Building Environmental Assessment Method
BERDE	-	Building for Ecologically Responsive Design Excellence
BOT	-	Build-Operate-Transfer
CASBEE	-	Comprehensive Assessment System for Built Environment Efficiency
CIDB	-	Construction Industry Development Board
DID	-	Department of Irrigation and Drainage
ECE	-	East Coast Expressway
ECE1	-	East Coast Expressway Phase 1
ELITE	-	Expressway Lingkaran Tengah Sdn. Bhd.
FDM	-	Fuzzy Delphi Method
FHR2	-	Federal Highway Route 2
GBI	-	Green Building Index
GreenLITES	-	Green Leadership in Transportation Environmental Sustainability
GRI	-	Global Reporting Initiative
HK-BEAM	-	Hong Kong Building Environmental Assessment Method
IDOT	-	Illinois Department of Transportation
I-LAST	-	Illinois-Livable and Sustainable Transportation
ILHAM	-	Index Lebuhraya Hijau Malaysia
IRTBA	-	Illinois Road and Transportation Builders Association
KLBK	-	Konsortium Lebuhraya Butterworth-Kulim
KLIA	-	Kuala Lumpur International Airport
KLK	-	Kuala Lumpur-Karak Highway

KMO	-	Keiser-Meyer-Olkin
LEED	-	Leadership in Energy and Environmental Design
MGHI	-	Malaysian Green Highway Index
MHA	-	Malaysian Highway Authority
NKVE	-	New Klang Valley Expressway
NSE	-	North-South Expressway
NYSDOT	-	New York State Department of Transportation
PAM	-	Pertubuhan Arkitek Malaysia
SDEB	-	Senai Desaru Expressway Berhad
SITES	-	Sustainable Site Initiative
SPDH	-	Seremban-Port Dickson Highway
TEY	-	Toyota Eco Youth
USGBC	-	United States Green Building Council
UTM	-	Universiti Teknologi Malaysia
WISE	-	Washington Internship for Students Engineering

CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

UMW Toyota Motor has been collaborated with the Ministry of Education in established the program of Toyota Eco Youth (TEY). This program has been started on 2001 which is aimed to awaken and nurture a sense of responsibility among the younger generation about the importance of preserving the environment in order to maintain a sustainable future. The participant of this program is over 1,600 students, principals and teachers from 146 schools across Malaysia. With the successful of this program, it has been leading the Toyota Motor Manufacturing Indonesia to launch their Eco Youth program in 2006 (TOYOTA, 2013).

Toyota, a well-known auto company has led the automotive industry in green building efforts. It has achieved the Leadership in Energy and Environmental Design (LEED) certification for their 29 facilities which is 11 Toyota/Lexus U.S. facilities and 18 Toyota/Lexus dealership. Since 2003, Toyota Motor Sales started achieved the LEED certificate for its facilities. The Toyota Motor Sales South Campus at Torrance, California is the first Toyota facilities that achieved LEED certified with Gold Certificate. The latest one is Toyota Motor Sales Kansas City Regional Technical Training Center in Kansas City which had achieved LEED Gold Certified on May 2012 (TOYOTA, 2012).

Development of the LEED has initiated the other countries to started establish their own green rating system. One of the criteria in rating system is

sustainable design. In earlier decade, sustainable development idea has grown up from numerous environmental movements. Recently sustainable issues have been widely discussed especially in construction industry. Sustainable development is a key issue in order to meeting the environmental objectives and fulfils the demand of the large infrastructure projects due to increasing numbers of population growth and urban density (Constandopoulos and Nation, 2010). In the rating system, in order to maintain, support or endure the long term maintenance of responsibility, sustainable design becomes one of the most important criteria for giving a credit (McLennan, 2004). This is one of the strategies that encourage minimizing the impacts on ecosystem and water resources (USGBC, 2011).

Sustainable design can be one of the factors that can minimize the impacts of the highway to the environment. Noise, ground and water pollution, habitat disturbance, land use, air, climate change vibration and contamination to plant and wildlife are the effects of construction and vehicle emissions (Griffith and Bhutto, 2009). The impact can change by design, construction and management of road, parking and other facilities. Washington Internship for Students Engineering (WISE) has introduced the green highway rating system. The rating system is to make sure the highway design is sustainable, environmental friendly and giving less impact of environment damage (WISE, 2011) which can be used for developing and classifying an environmentally and economically sustainable highway (Bryce, 2008a). In the modern highway design, the new technology such as advance planning, intelligent construction and transport system and maintenance technique has been used to reduce the impact of highway to the environment.

Many researches in highway construction have been done especially in road materials. Modification of bitumen and pavement can improved the quality of highway and road structure. Modification of the bitumen was not a new technology because it has been started for more than 30 years ago (Kersey, 2000). The use of non-recycle and waste materials such as plastic in highway construction has been developed by a team of entrepreneurs in Bangalore, Hyderabad, India (Ahmad, 2012). Other researchers have founded modifiers for bitumen such as softwood bark charcoal (Chebil, *et al.*, 1999), maleic anhydride and dicarboxylic acids (Herrington,

et al., 1999), recycled polymer (Murphy, *et al.*, 2000), tire rubber (Navarro, *et al.*, 2002), rubber latex and crumb rubber.

The green highway rating system was introduced to determine the level of greenery and environmental friendly of the highway. Since roads run through the landscape, road have point source impact and linear effect (McClendon, 2012). *Greenroads* is the first green highway rating system that has been established in United States. It is a voluntary third party rating system for road project which seeks to recognized and reward the roadway projects that exceed the public expectation for environmental, economic and social performance (WISE, 2011).

University Teknologi Malaysia (UTM) and Malaysian Highway Authority (MHA) have been collaborated to produce the Malaysian Green Highway Index (MGHI). In Malaysia, MGHI is a new project that will used to evaluate the highway. It is the rating system that would classify the highway and rate it based on their environmental sustainability. The MGHI focus on highway and it concept is almost the same as the Green Building Index (GBI) and LEED which provides a checklist of prerequisites and credit required to evaluate the environment performance (Tsai and Chang, 2011).

1.2 Problem Statement

Nowadays, green rating system becomes a popular tool to confirm the green credential of building. Most countries have developed their own green building rating system. The country that already has the rating system is United States, Canada, Australia, United Kingdom, Hong Kong, Japan, Taiwan, Singapore, Philippine, European, Korea, India and Australia (FMLink, 1996). Malaysia also owns the green building rating system which is GBI.

With the successful implementation of green building rating system, the rating system has been widened into the highway. There are three rating system for the highway that has been found which is *Greenroads*, Green Leadership in

Transportation and Sustainable (Green*LITES*) and Illinois-Livable and Sustainable Transportation (I-LAST). The evaluation for the green highway is not yet available in Malaysia. This is because it is a new project which is still in the process of developing.

1.3 Objectives of the Study

The aim of this study is to identify the suitable sustainable design criteria and sub-criteria to be included in the green highway criteria for the Malaysian Green Highway Index. More specific objectives of this study are:

- a) To identify the suitable criteria and sub-criteria for sustainable design; and
- b) To identify the weighting of sub-criteria for sustainable design highway criteria.

1.4 Scope of the Study

The scope of this study is focus on the sustainable design criteria for expressway and toll highway only. The expressway and toll highway in Peninsular Malaysia is taken as a case study area. It is to obtain the simulation of suitability analysis based on the perspectives of the Malaysian stakeholders which are consist of academicians, government agency specialists and private sector specialists.

1.5 Significant of the Study

This study is to identify the sustainable design criteria in rating system that can provide a method of measurement to evaluate the highway. The criteria can be used as a gauge for the improvement of existing highway and guideline for the new highway so it can be more environmental friendly.

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