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Awareness of Green Highway Concept and Terminology: A Perspective of On-Site Personnel in Malaysian Highway Construction Industry

Fatin Najwa Mohd Nusa[1*], Shahrin Nasir[2], Intan Rohani Endut[3]
[1]Malaysia Institute of Transport (MITRANS), Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia. [2]Faculty of Business Management, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia. [3]Faculty of Civil Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.
*Corresponding Author: fatinnajwanusa_89@yahoo.com

Abstract

The commitment to manage vast construction of highway projects has driven to the green highway concept development. This paper aims to identify the awareness of the green highway concept by prevailing common terminology of green highway among highway project stakeholders. A preliminary study was conducted with on-site personnel from highway concessions and highway authority in Malaysia. Results show that (55.6%) of respondents were aware about the green highway concept and terminology. Whereas, five aspects of green highway terminologies namely; (1) conservation and ecosystem management, (2) life cycle energy and emission reduction, (3) recycle, reuse, and recycle, (4) watershed driven storm water management, and (5) overall societal benefits were identified as common understandings among the stakeholders. This paper also suggests some rating tools for the green highway for the government and departments of highway project construction to take appropriate measures in ensuring a comprehensive implementation of green activities for highway projects.

Keywords: Green highway, Green awareness, Common terminology, Green Concept

Introduction

Highway construction sector is a part of the most conservative segment in the Malaysian construction industry that conforming to the standard (Zakaria & Sufian, 2009). With the growing awareness of sustainability and climate change, highway authorities and government agencies are engaging on necessary course of actions to overcome carbon emissions from highway infrastructure on a life cycle basis (Shen, 2011; Zhu et.al., 2011). Combination of awareness and efforts of on-site contractors on green principles plays a conclusive role through the implementation of green practices especially on the construction site (Zhou et.al.,

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2018). Recently, issues related to sustainability in the construction industry have been widely debated (Zakaria et al., 2013; Zhou et al., 2018). Massive highway construction projects have contributed towards environmental problems such as exposure to contaminated and hazardous materials, depletion of coastal zones resources, habitat disturbance, noise, ground and water pollution, and many more (Ashraf et al., 2012; Yahya & Peng, 2010). According to Mulmi (2009), highway project activities give high impact to the environment. This scenario may bring about bad implication to the environment and create a sustainable issue (Bryce, 2008; Daud et al., 2009).

As a developing country, Malaysia has a wide range of highway network systems that link facilities and people within and across the country. In providing the nation with a good, modern, and a green transportation system, a specific guideline such as a standard or a policy for this industry need to be developed to enable people together with the environment to move towards sustainability. As a result, the concept of green highway was incorporated in the highway construction industry, and was drawn from the concept of sustainable development, striving as a tool to alleviate the environmental impact produced by construction activities in the whole life cycle of the highway project (MHA & UTM, 2015).

Rafidah et al. (2014) mentioned that sustainable development is the key issue to reach to the environmental objectives and to fulfil the demand of large infrastructure projects due to the increasing number of population growth and urban density. One of the most successful implementations towards sustainability is the green building rating system which further has been employed into the highway projects. This system helps to make sure that the highway design is sustainable, environmentally friendly, and inflicting less damage to the environment (Wright et al., 2004). Malaysia Green Highway Index (MyGHI) manual has been introduced as a guideline to confirm the credential of a highway in the Malaysian highway construction industry where it helps to measure the greenness level of a highway (MHA & UTM, 2015; Singh et al., 2011).

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Unfortunately, this guideline has never been attempted before in Malaysia (MHA & UTM, 2015).

Currently, project practitioners in Malaysia are only relying on the existing guideline provided by the Public Works Department (PWD) known as PWD 203A contract that has less coverage on the green highway characteristics and concept (MHA & UTM, 2015; Public Work Department (PWD), 1986). Even though the Malaysian Highway Authority (MHA) had launched MyGHI, the implementation of this guideline towards the highway projects in Malaysia is still in its infancy. It has been classified by Rozana et al. (2012) that the concept of green highway is considered new in Malaysia due to lack of implementation.

Rating Tools for Green Highway

Highway projects, in particular, have a significant impact to the environment. Green highway rating tools have been developed to address the sustainability elements for the conservation of the environment. This section discusses the fifteen prominent green highway rating tools which include the Malaysia Green Highway Index (MyGHI), An Evaluation of Sustainable Design and Construction Criteria for Green Highway, Storm Water Management Criteria for Malaysia Green Highway, Energy Efficient Index (EEi), Infrastructure Voluntary Evaluation Sustainability Tools (INVEST), ENVISION, Green Roads Rating System, Green Leadership in Transportation, Environmental Sustainability (GreenLITES), BE2ST-In-Highways, Illionois-Livable and Sustainable Transportation (I-LAST), STAR, Australia IS Rating System, CEEQUAL, and HTMA SHMT.

The review on the green highway rating tools shows that there are similarities between each of the rating tools. Precise and clear comparisons of the criteria in each green highway rating tool are tabulated in Table 1. Comparisons are made in regard to the energy efficiency, design and construction, storm water management, energy and atmosphere, project lifecycle, water and waste water energy, recycle materials in pavements, lightings, access and mobility, behavioural

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change and capacity building, using resources, project management, and climate change.

Table 1: Rating Tools for Green Highway

Rating Tools	Country	Criteria	Organisation	Reference(s)
Malaysia Green Highway Index (MyGHI)	Malaysia	Energy efficiency	Construction Research Centre (UTM), Construction Research Alliance (UTM), and Malaysian Highway Authority (MHA)	(MHA & UTM, 2015; Salfiza et al., 2014)
An Evaluation of Sustainable Design and Construction Criteria for Green Highway	Malaysia	Design and construction	Department of Civil Engineering (UTM) and Department of Quantity Surveying (UiTM)	(Rafidah et al., 2014)
Storm Water Management Criteria for Malaysia Green Highway	Malaysia	Storm water management	Faculty of Civil Engineering (UTM)	(Hazwani, 2013)
Energy Efficient Index (EEi)	Malaysia	Energy efficiency; energy and atmosphere	Construction Technology and Management Centre (CTMC), UTM, and Malaysian Highway Authority (MHA)	(Zakaria et al., 2013)
Infrastructure Voluntary Evaluation Sustainability Tool (INVEST)	United States	Project lifecycle (Design a custom on web based interface)	Federal Highway Administration (FHWA)	(Clevenger et al., 2013; Federal Highway Administration (FHWA), 2008; Rafidah & Zaimi, 2014)
ENVISION	United States	Water and waste water Energy	Zofnass Program for Sustainable Infrastructure, Harvard Graduate School of Design, and Institute for Sustainable Infrastructure (ISI)	(Clevenger et al., 2013)
Green Roads Rating System	United States	Energy efficiency	University of Washington	(Clevenger et al., 2013; Eisenman, 2012; Rafidah & Zaimi, 2014)
Green Leadership in Transportation and Environmental Sustainability (GreenLITES)	United States	Energy and atmosphere	New York State Department of Transportation (NYSDOT)	(Clevenger et al., 2013; Fortmann et al., 2010; Rafidah & Zaimi, 2014)

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BE2ST-In-Highways	United States	Recycle materials in pavement	Recycled Materials Resource Centre (RMRC), College of Engineering, University of Wisconsin	(Clevenger et al., 2013; Miller, 2012; Rafidah & Zaimi, 2014)
Illinois – Liveable and Sustainable Transportation (I-LAST)	United States	Lighting	Illinois Department of Transportation (IDOT), American Consulting Engineers Council (ACEC), and Illinois Road and Transportation Builders Association (IRTBA)	(Clevenger et al., 2013; Rafidah & Zaimi, 2014)
STARS	United States	Access and mobility	The North American Sustainable Transportation Council	(Rafidah & Zaimi, 2014)
INVEST	Australia	Behavioural change and capacity building	Road Corporation of Victoria	(Rafidah & Zaimi, 2014)
Australia IS Rating System	Australia	Using resources	Australian Green Infrastructure Council	(Rafidah & Zaimi, 2014)
CEEQUAL	United Kingdom	Project management	Institution of Civil Engineers (ICE)	(Rafidah & Zaimi, 2014)
HTMA SHMT	United Kingdom	Climate change and energy	Highway Term Maintenance Association (HTMA)	(Rafidah & Zaimi, 2014)

Rating tools are important in providing useful frameworks and in implementing strategies towards the development of green highway. Most researchers design a rating tool to evaluate the certification level of green highway. Current popular established rating tools are Illionois–Livable and Sustainable Transportation (I-LAST) and ENVISION (Clevenger et al., 2013), Infrastructure Voluntary Evaluation Sustainability Tools Index (INVEST) (Zhuet al., 2011), Green Roads Rating Systems (Eisenman, 2012), Green Leadership in Transportation and Environmental Sustainability (GreenLITES) (Fortmann et al., 2010), BE2ST-In-Highways (Miller, 2012), Energy Efficiency Index (EEi), and Malaysia Green Highway Index (MyGHI) (MHA & UTM, 2015; Salfiza et al., 2014). Hence, practitioners in highway projects can also utilise these findings when considering any of green highway rating tools listed above.

In addition, Lim (2009) mentioned that there is a lack of awareness regarding the sustainability concept and very limited studies on the evaluation of

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green highway development that have been carried out in Malaysia (Rozana et al., 2012). Thus, the objective of this paper is to identify the awareness of the green highway concept by prevailing common terminology of green highway among highway project stakeholders.

Terminology used for Green Highway Aspects

There are terminologies or a system of words with a particular technical application used in green highway aspects. Five terminologies of green highway aspects are listed as follows:

1) Conservation and Ecosystem Management

Ecosystem management awakens the restorative action techniques that will emphasise a healthy future environment for the entire biotic life. Conservation and ecosystem management in green highway involve the wildlife buffer zones, animal crossing structures, and underpass to avoid the vehicle wildlife collision (MHA, 2010; MHA & UTM, 2015; Nusa et. al., 2015).

2) Life Cycle Energy and Emission Reduction

Life cycle energy and emission reduction technique is achieved by the replacement of cement in highway construction with fly ash, blast furnace slag, foundry sand, or waste rubber tyres and rubber pieces (MHA, 2010; MHA & UTM, 2015; Nusa et. al., 2015).

3) Recycle, Reuse, and Renewable

Derivation of using recycle materials from industrial by-products is not only significant in reducing the greenhouse gas emissions and the energy consumed by a highway, but it also reduces the overall highway construction cost (MHA, 2010; MHA & UTM, 2015; Nusa et. al., 2015).

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4) Watershed Driven Stormwater Management

Watershed driven stormwater management is defined as a process of reducing the water runoff from the highway, or in other words, treating the water runoff as well as diverting the water runoff to the place where the water can be infiltrated into the groundwater table (MHA, 2010; MHA & UTM, 2015; Nusa et. al., 2015). Examples of watershed driven stormwater management technologies are bio-slopes, bio-swales, bio-retention cell, permeable pavers, vegetated filter strip, and street trees.

5) Overall Societal Benefits

A highway can be classified as a serviceable highway for the society, if it is designed under the standard that can increase the economy by supplying strategic locations for the economic growth with plenty of local jobs and affordable tax income to the community (Nusa et al., 2015).

Method

Subsequent to the literature review, a close-ended questionnaire survey was carried out to validate the status of green highway concept awareness and responses to the common terminologies of green highway. The questionnaire comprises two sections: (i) General information of respondents, (ii) Awareness on green highway concept (shown in Table 2), and (iii) Terminology used for green highway aspects (shown in Table 3). The questionnaire survey was conducted using the postal and web-based questionnaires among actively involved on-site personnel in highway projects. A total of 72 questionnaires were sent to the respondents using opportunistic or emergent sampling. The completed questionnaire had been analysed using the descriptive analysis. The detailed process of data collection is presented in Figure 1.

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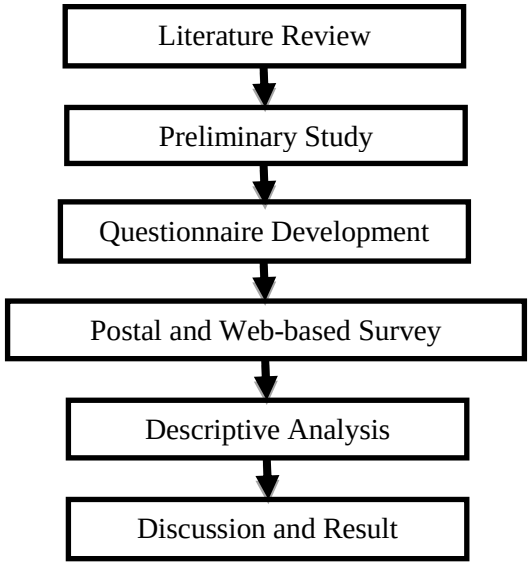

Figure 1. Process of data collection

Discussion and Result

The respondents involved in this study include the highway concessions (33.3%), contractors (28.6%), government professionals (22.2%), consultants (6.3%), and private professionals (9.5%). Table 2 shows the respondents' awareness on green highway concept. The repondents were asked to state either 'Yes' or 'No' whether they have heard about green highway.

Table 2:Awareness on green highway concept

Have you heard about green highway?	Percentage (%)
Yes	55.6
No	44.4

Based on the results, almost half of the respondents (55.6%) indicate that they know about green highway. It shows that these stakeholders do aware on the sustainable and green concept, however on a surface level, rather than its applications and practical actions. Normally, on-site personnel only focus on the general layouts plan of construction site during the project life cycle due to the additional cost incurred, incremental time, and lack of knowledge on current

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practice and technologies. However, it should be noticed that, awareness without execution is not worth much for a successful implementation of green construction.

Table 3 presents gap analysis for five aspects of green highway terminology. The respondents were asked to state either 'Yes' or 'No' whether they have come across any of the terminologies related to green highway.

Table 3:Gap analysis for Terminology of Green Highway Aspects

Have you come across any of the following before?	Percentage (%)		
	Yes	No	*Gap (No – Yes)
Conservation and ecosystem management	50.8	49.2	-1.6
Life cycle energy and emission reduction	49.2	50.8	1.6
Recycle, reuse and renewable	47.6	52.4	4.8
Watershed driven storm water management	25.4	74.6	49.2
Overall societal benefits	23.8	76.2	52.4

*Note: Approaching zero (0) is consideredas small gap

By referring toTable 3, two aspects of terminology used for green highway were identified to be a large gap namely conservation and ecosystem management (-1.6%); life cycle energy and emission reduction (1.6%); recycle, reuse, and renewable (4.8%). The rest were considered as small gap. Based on the phenomenon, this all five aspects can be divided into two categories. One is categorised under 'commonly used' terminology frequency and the other is under 'uncommonly used' terminology frequency. Commonly used terminology is a particular technical application regularly used in green highway aspects. Uncommonly used terminology is a particular technical application irregularly used in green highway aspects. It demonstrates disparity of awareness between these groups which create impossible situation for on-site personnel with unfamiliar understanding of green construction awareness in order to comply with green activities up to the desired level.

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Conclusion

This paper only review the awareness and common terminologies of green highway. Although these terminologies have not been widely known by the stakeholders, based on the results, they still aware about the concept of green highway. With the current state of awareness, the policy makers and government should focus on implementing significant investments to encourage green highway initiative among highway construction practitioners, for instance through seminars and trainings and capacity building of expertise in the area. On the other hand, practitioner's awareness will be nurtured accordingly as per government aspiration in order to benefit the ecological, social, and economic sustainability. Hence, the five clarified terminologies are potentially to be used as a new strategy in giving an understanding of the green highway concept to the related stakeholders to embark on sustainable or green initiatives related projects.

There were some limitations in this research paper. There might be difference in knowledge and reflections from managers, decision makers, and academicians compared to the respondents' responses since they were all from construction site. Moreover, the sample size was fairly small and the survey setting was in the Malaysian context. Therefore, cautions should be taken into account when interpreting and deducing the results. A comprehensive survey and interview should be devised for future research to discard the limitations, especially to investigate the challenges, characteristics, and success factor to implement green highway. Despite these limitation, this paper motivate and suggest useful indication for the government and departments of highway construction to take green initiatives measures at construction sites.

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