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An evaluation of sustainable design and construction criteria for green highway

Raja Rafidah Raja Muhammad Rooshdi^{a*}, Nurizan Ab Rahman^a, Nazurah Zahidah Umar Baki^a, Muhd Zaimi Abdul Majid^a, Faridah Ismail^b

^aDepartment of Civil Engineering, UTM, Johor Bharu 81300, Malaysia

^bDepartment of Quantity Surveying, UiTM, Shah Alam 40450, Malaysia

Abstract

Sustainability has been widely debated in the construction industry in recent years. Though various assessments have previously been developed to help improving sustainability of construction projects, those assessments seem missed the base network for cities and buildings which are highways. Therefore, there is the need to select variety of design and construction activities criteria for green highway and determine the weightage factor for every criterion in order to categorize which criteria that most contribute to the green practices based on the priority. The aim of this paper is to explain the determination of weightage for criteria of design and construction activities. The methodology processes begin with data collection by using questionnaires distribution to the expertise who involve in highway development and also green issues. There were 140 respondents had been chosen to fill in the questionnaires survey. The data had been analysed using SPSS with factors analysis method. Results from the analysis show the evaluation of the criteria base on the important criteria in design and construction action of green highway.

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1. Introduction

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

* Corresponding author.

E-mail address: raja_rafidah@yahoo.com

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 [1]. 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 [2]. The impact can be changed by design, construction and management of road, parking and other facilities.

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. *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 recognize and reward the roadway projects that exceed the public expectation for environmental, economic and social performance [3]. 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 [4]. 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 [3] which can be used for developing and classifying an environmentally and economically sustainable highway [5]. 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.

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 countries that already have the rating system are United States, Canada, Australia, United Kingdom, Hong Kong, Japan, Taiwan, Singapore, Philippine, European, Korea, India and Australia. 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 (*GreenLITES*) and Illinois-Livable and Sustainable Transportation (*I-LAST*). The evaluation for the green highway is not yet available in Malaysia.

2. Criteria

As development of criteria for green highway, there were several green rating tools which are *Greenroads*, *GreenLITES*, and *I-LAST* had been reviewed as a summary of green highway criteria. The criterion are sustainable site, water efficiency, energy and atmosphere, material and resources, indoor environment quality, innovation and design, project requirement, access and equity, construction activities, pavement technology, custom credits, planning, design, transportation, lighting, management, and environmental. Clark et al. (2009) state that the rating system consist the explanation of different certification level and the total points that needed to obtain them [6]. Starting with the least green to exceptional green, most of the certifications are distinguished by four different levels. There are some common criteria that can be found in every green rating system such as sustainable site, water efficiency, energy efficiency, materials and resources and innovation. Tsai and Chang (2011) have developed the sustainable items for highway design based on LEED and Global Reporting Initiative (GRI) [7]. The development process of this item involved the addition, integration and removal of the preliminary 45 items. The 45 techniques and 15 materials items have been categorize into 14 disciplines which consist of various number of technique and material items. The sustainable criteria includes of geometrics and alignment, earthworks, pavement, drainage, retaining walls, slope protection, landscape ecology, transportation facilities, maintenance, bridges, sound insulation, tunnels, electrical and mechanical and lighting. But those criteria were different in every project especially during design and construction activities stage. Therefore, this paper attempts to identify the criteria and sub criteria according to the stage of construction by means of the nominal group technique which generate and prioritize a large number of issues within a structure that gives everyone an equal voice.

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