



Green Rural Road Network Elements for Rural Road in Malaysia

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ABSTRACT

Nowadays, the implementation of green practices has become one of the most favored methods in road construction, given that these vital infrastructure assets have a significant impact on the environment and human well-being. These impacts include alterations to the physical landscape and a negative effect on the quality of life for the surrounding communities. In Malaysia, particularly in rural areas, the networks comprise the largest proportion of roads in the country, making efficient and sustainable rural road networks even more crucial. Therefore, this study aims to identify the elements of green rural road networks that should be considered in the development of rural roads. Moreover, the absence of a specific guideline for green road development in rural areas highlights the need to address this gap through a systematic approach. This study employs five phases of methodology process in order to achieve its objectives. Through an intensive literature review, 32 elements for green rural road networks were identified. These elements were then presented in the form of a questionnaire. A pilot test was conducted involving 53 road experts and practitioners in Malaysia. The respondents were individuals working in the field of Civil Engineering, specializing in road construction and maintenance work in Malaysia. In this study, descriptive analysis was conducted to interpret the demographic data of the respondents and the Cronbach's alpha was used to determine the internal consistency of the green rural road elements. Based on the analysis, 32 elements of green road were finalized based on common core attributes of green rating system and rural characteristics and issues in Malaysia.

1. Introduction

Rural road are essential lifelines of rural communities, as it is the only networks that providing connectivity and access to good and services. Therefore, efficient and sound infrastructure development, such as rural road construction and upgrading the rural road networks that link rural areas to urban areas are necessary. Resilient infrastructure should be focusing on both rural and urban area without prone to urban areas. To add, rural roads play an important role in socioeconomic development by providing access to economic and social activities [1]. According to Robinson [2], rural roads generally contribute to development by facilitating local and international trade,

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improving access to jobs, education, healthcare, and other services worldwide. Robinson further emphasises that an effective and efficient road transport system can lead to higher incomes, greater economic well-being, increased personal mobility and facilitated economic growth. In return, it assists in reducing poverty and contributes to social development. Therefore, in many developing countries, investment in rural road infrastructure has continued to be a priority, as structured rural road plays a catalyst role in socioeconomic development and provides access to amenities such as education, healthcare, marketing and many other important assets. Furthermore, well-planned rural connectivity improves the economy and reduces poverty level, and leads to increased agricultural productivity by bringing in new land into cultivation [1]. Moreover, rural roads play are vital road networks as they play an important role in connecting highways, arterial roads, towns, villages and tourist spots. Apart from that, they also serve as a medium for the flow of people, logistics, and information in rural areas. Moreover, rural roads encourage labour transfer to the non-agricultural activities. Identically, Zhou *et al.*, [3] elaborate on the function of rural roads on agricultures areas, highlighting their significant contribution to rural revitalization and agricultural productions.

However, road development and operation involve large-scale activities that can significantly contribute to negative impact to both human and the environment, this impact includes; enormous ecological effects and the disruption of community quality of life throughout its lifecycle. To add, rural road construction can lead to issues such as land fragmentation and deterioration of cultivable land areas, which in turn affect the agricultural productions [4]. Therefore, the adoption of sustainable approach by implementing green elements in the development and operation of rural road infrastructure is the ideal way forward in order in order to concurrently meet economic, social and environmental needs.

2. Methodology

In this study, the researcher employs five (5) phases of methodology process. The phases involved in this study are; Phase 1 – Intensive Literature Review, Phase 2 –Instrument Development, Phase 3– Main Data Collection, Phase 4 – Data Analysis (Goodman Kruskal Gamma) and Phase 5 – Validation Process based on Expert View. However, in this research it is divided into two main purposes namely; a) Development of Green Rural Road Network Elements, b) Association of Green Rural Road Network Elements and Socioeconomic Development Indicator. Therefore, for the first purpose only two phases involved; Phase I and Phase II that been shown in Figure 1.

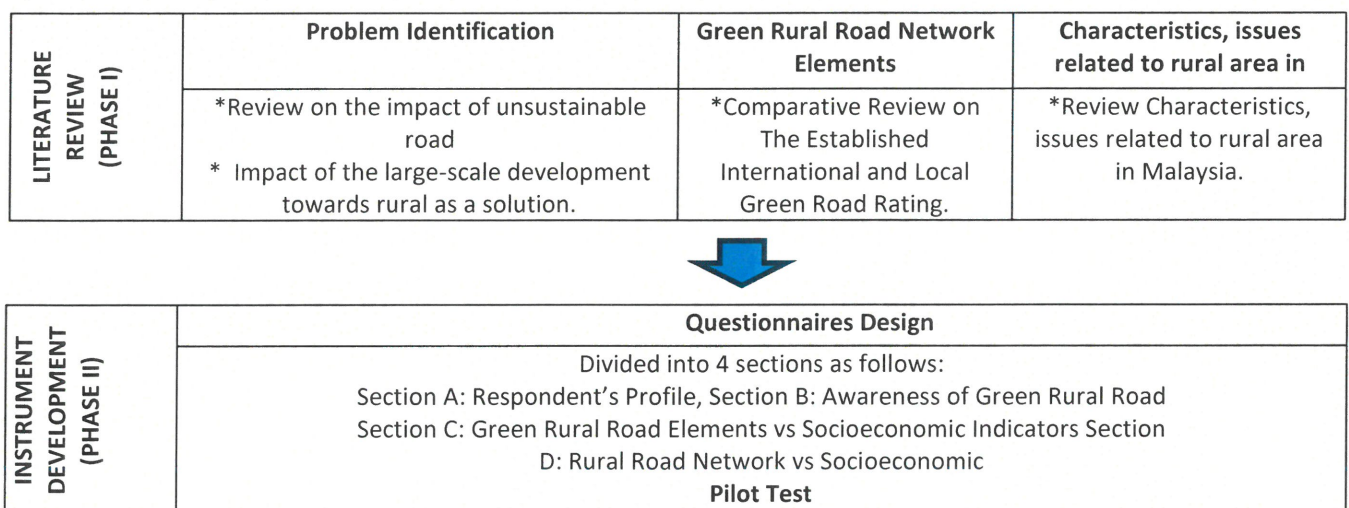


Fig. 1. Research Methodology for Phase I and Phase II

3.0 Literature Review

3.1 Green Rural Road Network Elements

In this study seven (7) green road rating system were benchmarked and referred. This rating system are Green road (United States), Green Leadership in Transportation and Environmental Sustainability (GreenLITES) (United States), Illinois Liveable and Sustainable Transportation (I-LAST) (United States), Malaysia Green Highway Index (MyGHI)(Malaysia), Sustainable Transportation Analysis Rating System (STARS) (United States), ENVISION ((United States), Penarafan Hijau (Jalan) (pHJKR Road) (Malaysia). Based on the critical literature review of global and local green road rating systems, common attributes have been identified across various rating tools These include water management, runoff control, air quality, noise control, carbon emissions, recycling, energy efficiency, erosion control, safety measures, materials selection, facilities and ecological considerations. These attributes consistently emerge as core criteria in most green rating tools. After determining the common attributes, the green road elements from established global and local green road rating systems were selected. Green rating systems and their attributes were shown in Table 1.

Table 1
Green Rating Systems and their Attributes

Rating System	Greenroad [5]	Green-LITES [6]	I-LAST [7]	STARS [8]	ENVISION [9]	MyGHI [10]	pHJKR (Jalan) [11]
Water	✓	✓	✓	✓	✓	✓	✓
Runoff	✓	✓	✓	✓		✓	✓
Quantity							
Water Quality	✓		✓	✓		✓	✓
Air	✓				✓		
Light	✓	✓	✓		✓		
Noise	✓	✓	✓		✓		
Carbon		✓	✓			✓	
Recycling	✓	✓			✓	✓	✓
Energy	✓	✓	✓	✓	✓	✓	
Electricity		✓	✓		✓		
Fuel		✓					
Ecosystem	✓	✓	✓	✓	✓	✓	✓
Facilities					✓	✓	✓
Material	✓	✓	✓	✓	✓	✓	✓
Lifecycle cost	✓			✓			
Innovation	✓	✓	✓			✓	✓

3.2 Attributes from Green Road Assessments

Based on the critical literature review of established global and local green road rating systems, common attributes have been identified across various rating tools. These include water management, runoff control, air quality, noise control, carbon emissions, recycling, energy efficiency, erosion control, safety measures, materials selection, facilities and ecological considerations. These

attributes consistently emerge as core criteria in most green rating tools. After determining the common attributes, the green road elements from established global and local green road rating systems were selected. Apart from considering green rural road network elements from common core attributes of established green road rating systems, the characteristics and issues related to rural areas in Malaysia also been considered in this study.

3.3 Specific Element for Green Rural Road Networks

For the purpose of defining specific green element for rural roads, issues that arise from the development of rural areas and highlighted rural development policy has been considered. For instance, the issues highlighted in DPF Desa Negara 2030 [12] serve as the basis for the identification of green rural road network elements. DPF Desa Negara 2030 emphasizes several issues, including: reservation of natural resources, preservation of cultural heritage and rural identity, maintaining and improving socioeconomic conditions and improving the quality of life for local communities. Furthermore, Ryan [13] highlighted the importance of protecting several facets of rural character, including natural areas, farms, and cultural elements. Moreover, as stated by UN DESA [14], rural areas play an important role in preserving a country's ecology and environment. Malik *et al.*, [15] further elaborate that rural areas consist of imperative assets, such as forests and green lands, which are prime assets for countries like Malaysia.

In addition, based on the perspective of rural communities, Freshwater [16] emphasizes that sustainable development must address how people in the community generate income to maintain their lifestyle. In Malaysia, the main economic activities in rural areas are agriculture and the tourism industry. The agricultural sector includes subsistence agriculture, commercial agriculture, husbandry, fishing, and paddy planting [10]. In the field of tourism, the homestay program recorded a revenue of RM15.74 million in 2011, encompassing a network of over 3,000 operators located in rural areas [17]. Therefore, the main economic sector in rural areas should not be negatively affected by rural road development and operation. Cotton [18] adds that sustainable rural roads not only focus on environmental issues such as water quality, land conservation, and wildlife protection, but also enhance the quality of life for rural people by calming traffic, limiting noise and speed, and reducing road hazards. Furthermore, Mazlan *et al.*, [19] elaborate that there are two components that need to be considered in maintaining rural neighbourhood characteristics: the physical component and the social component. The physical component involves the natural landscape (vegetation, terrain) and the cultural landscape (traditional houses or religious monuments). Then, regarding the social component, it involves the quality of life, safety, and comfort of the rural community.

Similarly, Ngah [20] mentioned that rural development should emphasize the preservation of cultural heritage, traditions, and values, as they can enhance the resilience of communities. Similarly, in his study, Ryan [13] also emphasized the importance of rural character, which includes cultural elements, natural areas, views of nature and farms. Apart from that, Ngah [20] mentioned that the concept of rural development should emphasize on the preservation of cultural heritage, traditions, and values that could enhance the resilience of communities. To add, in study conducted by Ryan [13], the scholar details several aspects of rural character, including natural areas, views of nature, farms, and cultural elements.

On the other hand, Mohd Nusa *et al.*, [21] states that the main objective of implementing green road concept is to protect and enhance the quality of the ecosystem and environment and resource efficiency and to improve the quality of social life or no-energy benefits. Based on the issues that been highlighted, the green approach is the ideal way forward to preserve the local characteristic and minimizing the negative impact of road development in rural areas. According to Rooshdi *et al.*,

[22], a green road can be one of the factors that can minimize the impacts of roadways on the environment. Sipes and Sipes [23] delineate various aspects that will be essential in both human and environment through the implementation of a green development. They assert that a green roadway should prioritize the protection of natural resources by minimizing road impact, decreasing carbon emissions, preserving trees, and effectively managing water.

4.0 Results

In this study, the identification of green rural road elements was derived from two sources: established green road rating tools and characteristics and issues related to rural areas. The thirty-two (32) finalized elements are shown in Figure 2.

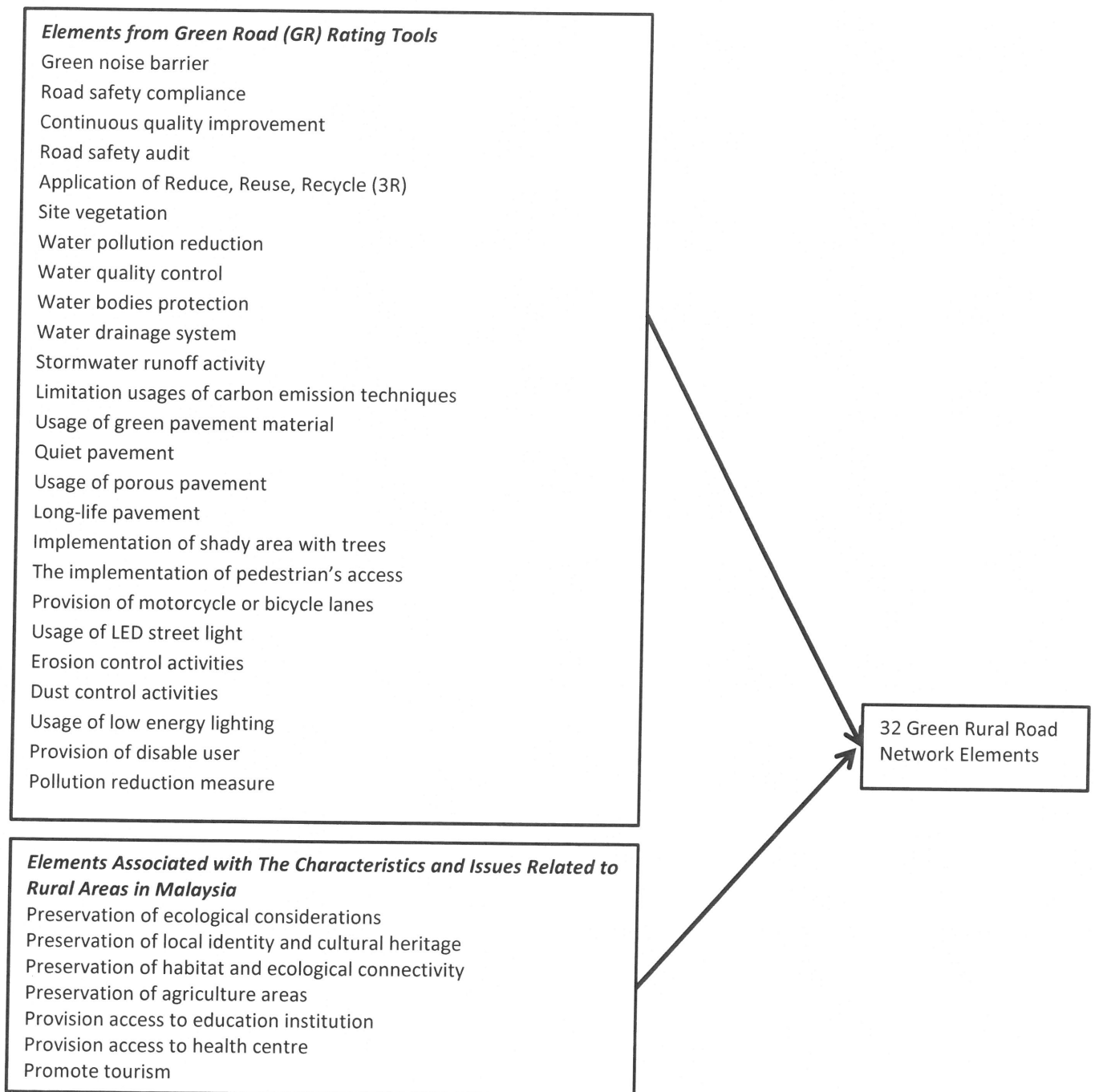


Fig. 2. Conceptual Framework of 32 Green Rural Road Networks Elements

5. Conclusions

A total of thirty-two (32) green rural road network elements were finalized in this study, derived from common attributes found in seven (7) green rating systems and elements associated with the characteristics and issues specific to rural areas in Malaysia. Prior to the main survey, a pilot test was conducted. In this study, both data from the pilot test study and main questionnaire surveys were analysed using SPSS version 26.0. For the pilot test, the internal consistency of the data was assessed using Cronbach's Alpha (α). Based on the analysis, only seventeen (17) green rural road elements were retained, as their values were greater than or equal to 0.70, surpassing the minimum threshold of 0.70 [Nunally]. This study proves that a specific study that focuses on the attributes and elements of green rural road networks that need to be considered in the development of green rural road as that a particular green road assessment is a need as the existing rating system are not applicable to all roads due to the varying needs and requirements of local contexts. With two different green road rating tools available in Malaysia, it is logical to explore why a new specific study is required.

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