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Green Rural Road Elements for Rural Road in Malaysia

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ABSTRACT

Nowadays, the implementation of green practices has become one of the most favoured 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. Through an intensive literature review, 32 elements for green rural road networks were identified 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 [1]. 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 [2]. According to Robinson [3], rural roads generally contribute to development by facilitating local and international trade, 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

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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 [2]. Moreover, rural roads play are vital road networks as they play an important role in connecting highways, arterial roads, towns, villages and tourist spots. To add, rural roads encourage labour transfer to the non-agricultural activities. Identically, Zhou *et al.,* [4] 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 [5].

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. Even though in Malaysia, there are two established green rating systems for roads, MyGHI for highways and pHJKR (Roads) for federal roads (with project values of more than RM 50 million), there is currently no specific guideline for green rural roads. Furthermore, from literature, only three (3) rating systems apply to road-specific categories, namely Greenroads, STARS and pHJKR (Federal Roads) while others are strictly developed for highways. Severely, none of the sources mentioned, are built in the operation and maintenance process for the layout and handling of rural roads. Hence, the absence of guideline for green rural roads needs is found as a gap that needs to be filled through a systematic approach. There is a need to proposes green rural road network elements that are expected to benefit Malaysia in preserving the rural areas in environmental, social and economy aspects. Additionally, this study provides imperative findings regarding the acceptance and adoption of green rural roads in Malaysia.

2. Literature Review

2.1 Green Rural Road Network Elements

In this study seven (7) green road rating system were benchmarked and referred. This rating system are Greenroad (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 / Attribute	Greenroad [6]	Green-LITES [7]	I-LAST [8]	STARS [9]	ENVISION [10]	MyGHI [11]	pHJKR (Jalan) [12]
Water	✓	✓	✓	✓	✓	✓	✓
Runoff Quantity	✓	✓	✓	✓		✓	✓
Water Quality	✓		✓	✓		✓	✓
Air	✓				✓		
Light	✓	✓	✓		✓		
Noise	✓	✓	✓		✓		
Carbon		✓	✓			✓	
Recycling	✓	✓			✓	✓	✓
Energy	✓	✓	✓	✓	✓	✓	
Electricity		✓	✓		✓		
Fuel		✓					
Ecosystem	✓	✓	✓	✓	✓	✓	✓
Facilities					✓	✓	✓
Material	✓	✓	✓	✓	✓	✓	✓
Lifecycle cost	✓			✓			
Innovation	✓	✓	✓			✓	✓
	12	12	11	7	10	10	8

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2.2 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 [13] 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 [14] highlighted the importance of protecting several facets of rural character, including natural areas, farms and cultural elements. Moreover, as stated by UN DESA [15], rural areas play an important role in preserving a country's ecology and environment. Malik *et al.,* [16] 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 [17] 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 [11]. 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 [18]. Therefore, the main economic sector in rural areas should not be negatively affected by rural road development and operation. Cotton [19] 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.,* [20] 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 [21] 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, Najwa *et al.,* [22] also emphasized the importance of rural character, which includes cultural elements, natural areas, views of nature and farms. Apart from that, Ngah [21] 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 Kementerian Kesejahteraan Bandar, Perumahan dan Kerajaan Tempatan Malaysia [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.,* [22] 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.,* [23], a green road can be one of the factors that can minimize the impacts of roadways on the environment. Sipes *et al.,* [24] 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.

3. Methodology

The researcher employs a five-phase methodology process in this study. The phases are as follows:

i. Phase 1: Intensive Literature Review
ii. Phase 2: Instrument Development
iii. Phase 3: Main Data Collection
iv. Phase 4: Data Analysis (Goodman-Kruskal Gamma)
v. Phase 5: Validation Process based on Expert Views.

This study serves two main purposes:

i. the development of Green Rural Road Network Elements
ii. the association of Green Rural Road Network Elements with socioeconomic development indicators.

However, this paper focuses solely on the first purpose; therefore, only Phase 1 is presented, as illustrated in Table 2.

Table 2
Research methodology for Phase I

	Problem Identification	Green Rural Road Network Elements	Characteristics, issues related to rural area in
LITERATURE REVIEW (Phase 1)	• Review on the impact of unsustainable road • Impact of the large-scale development towards rural as a solution.	Comparative Review on The Established International and Local Green Road Rating.	Review Characteristics, issues related to rural area in Malaysia.

On this phase, it involves the identification and proposal of the elements to be included in the green rural road networks. The first step is identifying the common core attributes from green road rating tools locally and internationally. Sources of official documentation review comes from relevant road agencies such as Public Work Department (JKR) for phJKR (jalan) and Malaysia Highway Administration (MHA) and UTM for myGHI and other international rating systems such as Greenroads, Envision, GreenLITES, Invest, Illinois-Livable and Sustainable Transportation (I-last). The most common elements in that core attribute were used as elements to be proposed in the green rural road networks elements, while the second step is focusing on the elements associated with the characteristics and issues in rural areas, Malaysia. A thorough review of several issues related to the issues and characteristic in rural areas in Malaysia has been conducted. Several rural development policies also lead to the identification of green rural road elements that are related to rural characteristics and issues.

4. Result

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 1.

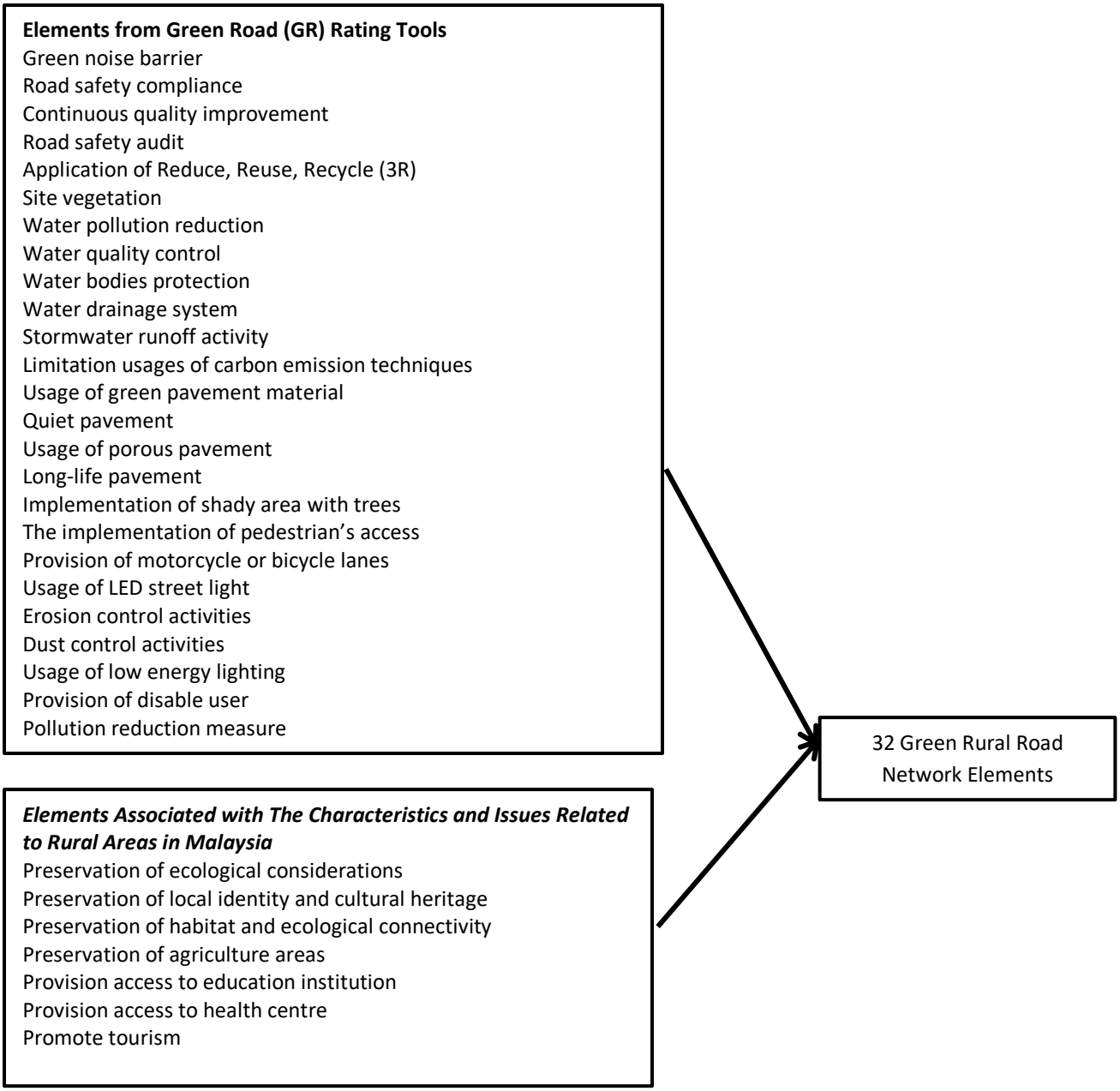

Fig. 1. Conceptual Framework of 32 Green Rural Road Networks Elements

5. Conclusion

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. This study demonstrates the necessity of focusing on the attributes and elements of green rural road networks that must be considered in their development. It highlights the need for a specific green road element as the existing guideline are not universally applicable due to the diverse needs and requirements of local contexts. These elements aim to establish a linkage and synergy between rural development and the concept of sustainability. By incorporating these green rural road elements, the unexploited ecological, cultural and heritage aspects of rural areas, along with the unique rural characteristics in Malaysia can be preserved while simultaneously fostering the development of rural socioeconomic activities. This study underscores the importance of focusing on the unique characteristics and needs of rural areas

when developing green road networks. It highlights the necessity of creating a specific set of green road elements that are tailored to the local context, rather than relying on generic guidelines that may not be applicable in rural settings. By incorporating green elements into the development of rural roads, Malaysia can create a more sustainable and resilient rural infrastructure that supports ecological preservation, cultural heritage and socio-economic development. The integration of these green rural road elements has the potential to establish a balanced relationship between development and sustainability, ensuring that the ecological, cultural and socio-economic aspects of rural areas are preserved for future generations. Through this approach, Malaysia can demonstrate how green infrastructure can be effectively applied in rural contexts, promoting more sustainable future for rural communities.

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