

PAPER • OPEN ACCESS

Critical green road criteria for Malaysia green rural road index

To cite this article: M H S Abd Rashid *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **849** 012039

View the [article online](#) for updates and enhancements.



ECS **240th ECS Meeting**
Digital Meeting, Oct 10-14, 2021

**Register early and save
up to 20% on registration costs**

Early registration deadline Sep 13

REGISTER NOW

Critical green road criteria for Malaysia green rural road index

M H S Abd Rashid^{*1}, R Zakaria¹, E Aminudin¹, J A Adzar¹, S M Shamsuddin², V Munikanan³, N E Alias¹, S Z Sooria⁴ and K M Saha⁴

¹School of Civil Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia

²Faculty of Architecture Planning and Surveying, Universiti Teknologi MARA, Shah Alam, Malaysia

³Civil Engineering & Architecture Department, Faculty of Engineering, Universiti Pertahanan Nasional Malaysia, Kuala Lumpur, Malaysia

⁴Jabatan Kerja Raya, Malaysia

Email: hafizuddinsyafiq92@gmail.com

Abstract. Malaysia is on its path in adapting the green roadway system. The introduction of green road rating tools such as Malaysia Green Highway Index (MyGHI) for highways and Penarafan Hijau (pHJKR Jalan) for non-toll roads which the value of the projects are more than RM50 million are parts of the green initiatives taken towards the sustainable development in Malaysia. However, there is no specific green road rating tool focusing on rural roads in Malaysia. The rural road falls under the state road category, which contributes the largest proportion of the road network in Malaysia. The absence of specific green road rating tools for the assessment of the largest network of the road in Malaysia is seen as the gap that needs to be filled with a systematic approach. With that, this paper highlight the methodology of the study to develop a specific green road rating tool that suits the nature of rural road in Malaysia which is called Malaysia Green Rural Road Index (MyGreen RRI). It also aims to highlight a thorough comparative review of the established criteria of the existing international and local green road rating tools by using cross-national comparison. This comparative review leads to a set of proposed criteria to be used in MyGreen RRI. The analysis is later will be extended for the development of score and to be used for the assessment of MyGreen RRI. The establishment of MyGreen RRI as the later final output of is expected to benefit the nation in the environment, social and economic perspectives.

1. Introduction

Infrastructure expansion is occurring at a dramatic rate in all over the world. Since the year 2000, the total network of roads has increased by 12 million km worldwide, with an additional of 25 million km projected by 2050 [1]. The increased awareness on the environmental impact of the construction and development of infrastructures such as highways and roadways has emerged the interest of the industry practitioners to come out with green initiatives. To date, attention and effort to combine the development needs and the ecological interest can be seen through the introduction of various green rating tools across the world. These are parts of the strategies to limit the environmental impacts of the development. Malaysia is also way forward in implementing the sustainable roadways development system. This can



be seen through the introduction Malaysia Green Highway Index (MyGHI) in 2014, by the collaboration initiatives of Malaysia Highway Administration (LLM) and Universiti Teknologi Malaysia (UTM) as a performance baseline standard in order to measure the level of the greenness of highways in Malaysia [2]. On the other hand, the establishment of Penarafan Hijau (pHJKR Jalan) by Public Work Department (JKR) Malaysia as the assessment tool for the federal roads which the value of the projects are more than RM50 million are responding to the development of the green infrastructure in Malaysia [3]. At this recent movements, the evaluation for the green road in Malaysia only concentrates on Toll road expressway and Federal Highway which most of the involved road are in high hierarchy road quality and connecting the urban area. This situation has raised the concern on the level of greenness and the evaluation system for the rest road networks in Malaysia. The rural road falls under the state road category, which contributes the largest proportion of the road network in Malaysia. The absence of specific green road rating tools for the assessment of the largest network of the road in Malaysia is seen as the gap that needs to be filled with a systematic approach.

2. Literature Review

2.1 Sustainable Roadway Development

The emergence of green rating tools throughout the world responsive to sustainable building infrastructure development. Hence it is indirectly receptive to the concept of sustainable development which meets the needs of the present without compromising the ability of future generations to meet their own needs [4]. Sustainable highways or roadways are a direct medium of injecting and reflecting the sustainability elements throughout the highway development to produce a sustainable roadway [5]. Sustainable design is one of the factors that can minimize the impacts of the highway to the environment [6]. Thus the green highway or green road developments are the reflection of green highway or green road that comply with the principles of sustainability throughout their development life cycle.

2.2 Sustainable Rural Development

Government planners have often seen road expansion as a cost-effective means to accelerate economic growth and social integration. However, the magnitude and nature of such benefits vary widely and depend on the local context. [7]. Rural development in Malaysia also in focal to be in line with the urban development, which basically the development efforts to integrates the three main pillars of sustainability which are the environment, social and economic. Such plans are aimed to solve problems such as poverty gap between urban and rural areas, contrast in the economic growth and inequality of infrastructures provision [8]. This situation indicates that the road development as a medium of connectivity in the rural area will continue to take place, thus, the consideration of the sustainable development should be given attention. However, the development in rural areas shall be carried out with proper planning. The development of rural areas should be conducted with high consideration of sustainable pillars to ensure that the originality of the rural landscape can be preserved. This is explained by the fact that forest and green lands are the prime assets of the rural community of Malaysia [9]. Therefore in the assessment of green road construction, for example in its construction phase, it is normally involved the removing of green area. Thus, the green elements should be injected in this phase by considering the healthy way to maintain the environmental sustainability.

2.3 Green Road Rating System

The green rating system is the medium used to track the sustainability performance of a particular development. It can be used for the purpose of benchmarking and identifying areas of opportunity for improvement in sustainability aspects. Green rating systems provide credits for sustainable choices or practices, and according to that certification awarded [9]. They also added that green rating system can be defined as sets of organized references for the sustainability performance measurement which may facilitate the application of sustainable practices in the development by the stakeholders. The stakeholders involved in the infrastructure development lifecycle require a systematic tools to assist them in adapting the sustainability practices [7]. The green highway rating system was introduced to

determine the level of greenery and environmental friendly of the highway. Nowadays, green rating system becomes a popular tool to certify the level of the greenness of the particular development. Most countries have developed their own green building rating system [6]. The rating system should have criteria and points allocated to the respective criteria to be obtained [10]. A green highway rating system is a proposed standard for justifying sustainable elements associated with the roadway's development life cycle [11]. It can be used to certify roadway projects based on the sustainable checklist of the sustainable requirements and the total points earned. Such a standard helps improvement and innovation in roadway sustainability, and provide baseline sustainability standards for planning and designing of highways. In this sense, rating systems that evaluate the sustainability of roads are currently being developed and include Greenroads, I-LAST (Livable and Sustainable Transportation), GreenLITES (Leadership in Transportation and Environmental Sustainability), STARS (Sustainable Transportation Analysis and Rating System), ENVISION and BE2ST (Building Environmentally and Economically Sustainable Transportation Infrastructure Highway). These rating systems are used in benchmarking and identifying areas of opportunity for improvement in the road and highway development.

2.4 Road and Highway in Malaysia

In 2017, the Public Work Department (JKR) [12], reported that there is 237,022.353 km of roads in Malaysia. The total length of the road network including highway, federal road, and rural road. It is reported that federal roads consist of 17,949.731 km length and highways contributed 2,000.880 km. The rest network of roads is contributed by the state road with a total length of 217,071.742 km. These facts shown that state roads contributing the largest proportion of road with the total length percentage of more than 90 %. Along with this 90% of state roads it is currently managed by few agencies and authorities includes JKR State, JKR District, Local Authority and few under Department of Rural Area. This multi authorisation triggers the research questions on who and whose take care on sustainability consideration for rural roads? Therefore, it is an urgency of having a specific green road rating tools for this category of road since the facts of development cycle involved in this largest network of the road in Malaysia will definitely provide the higher potential to contributing to the socio-economic impact on the Malaysia development [12]. Without denying the importance of rating tools to highways such as MyGHI, and pHJKR (Jalan) for the federal road, rural roads which are mostly categorized under the state road category should also be given the attention as they contribute a large proportion of the road network in Malaysia due to it is expecting intensive social criteria may arise in line with the requirement of social needs for rural area. The following Section 3 explained the methodology used for the development of critical review and critical analysis for Malaysia Rural Road Index (MyGreen RRI). Yet this paper is only present the achievements of Phase 1 and Phase 2.

3. Methodology

In developing the proposed My Green RRI Criteria, there are five phases of operational framework line up to be used throughout this study. The phases involve Phase 1 – Intensive Literature Review; Phase 2 – Proposal of Criteria, Sub-criteria and Elements of MyGreen RRI; Phase 3 – Expert Discussion (Questionnaire Survey); Phase 4 – Data Analysis (Weightage Factor and Factor Score); and Phase 5 – Validation on the Factor Score and Implementation of MyGreen RRI. The following Figure 1 portrays the operational framework of this research.

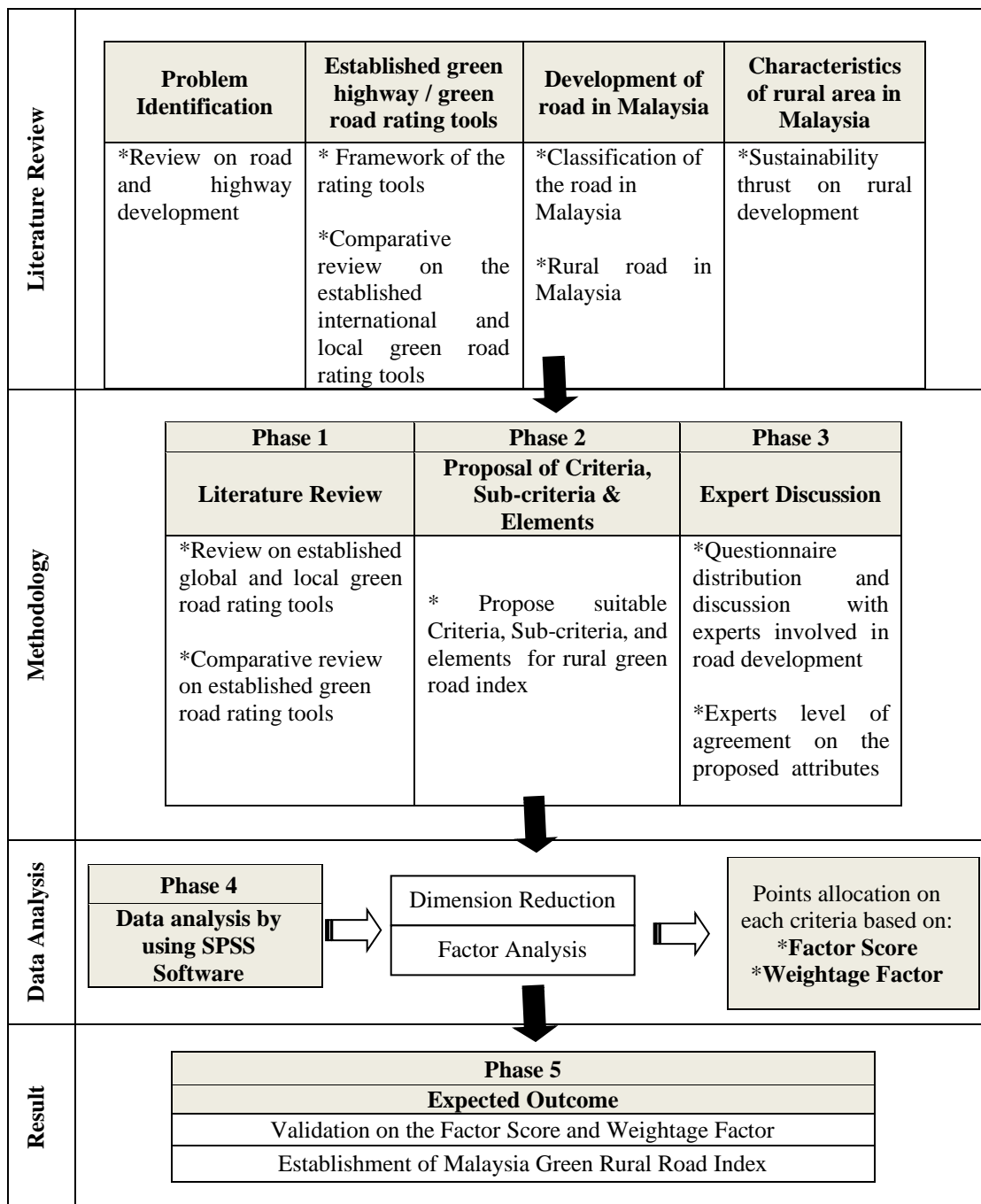


Figure 1: Flow of Methodology Operational Framework

4. Result: Critical Criteria for Malaysia Green Rural Road Rating Tools

The following are the explanation on the methodology that leads the result of Phase 1 and Phase 2.

4.1 Intensive Literature Review

This study started with the intensive literature review on the existing and established green highway or green road rating tools available globally and in Malaysia. A thorough comparative review on the criteria of the established international and local green road rating tools has been done by using cross-national comparison. This comparative review will lead to a set of proposed criteria to be used in MyGreen RRI. Literature review on the local rural issues will also be included in order to generate the idea on the environment, economic, social and governance characteristics of rural area in Malaysia. The related information regarding the road and highway development in Malaysia will also be part of the focal point in this phase. The information will be used to facilitate the analysis on the suitability of the existing green road rating tools with the local rural road condition in Malaysia.

4.2 Proposal of Criteria, Sub-criteria and Elements

The information and input from the literature review and the comparative review on the established the common criteria, sub-criteria, and elements will be used in MyGreen RRI. Previous researches on the green road and existing green road rating tools available globally and also green road tools in Malaysia were explored and studied as a reference to identify the suitable criteria to be used in MyGreen RRI. The elements from various green road rating tool models have been gathered and simplified in order to establish the criteria for MyGreen RRI as shown in the Table 1.

Table 1: Critical Criteria for Green Road Rating Tools

Green Road Rating Tool	Criteria	C	MT	WT	EN	EC	SC	IV	3R	COST	SH	GE	PM	DT
Greenroad [14]	Project requirements												√	
	Environment & water			√		√								
	Access and equity						√				√			
	Construction activities	√						√						
	Materials & resources		√		√				√	√				√
	Pavement technology		√						√	√				√
	Exemplary performance							√					√	
I-LAST [15]	Planning												√	√
	Design													√
	Environmental					√								
	Water quality			√										
	Transportation							√			√		√	
	Lighting						√	√			√			
	Materials		√					√	√					
	Innovation							√	√					
Green-LITES [16]	Construction	√											√	
	Sustainable sites	√					√				√		√	√
	Water quality			√							√			
	Materials resources		√						√					
	Energy and atmosphere				√	√								
	Innovation							√						

Green Road Rating Tool	Criteria	C	MT	WT	EN	EC	SC	IV	3R	COST	SH	GE	PM	DT
STARS [17]	Access mobility	√					√				√		√	
	Safety health										√			
	Equity													
	Economic benefit	√								√			√	
	Cost-effective									√				
	Climate & energy				√									
	Ecological function					√								
ENVISION [18]	Community context						√						√	
	Quality of life						√				√		√	
	Leadership												√	
	Resource allocation		√							√			√	√
BE ² ST [19]	Natural world					√								
	Climate & risk				√									
	Greenhouse gas emission											√		
	Energy use				√									
	Waste consumption		√	√					√				√	
	Water Consumption			√										
MyGHI [2]	Material reuse / recycling		√						√					
	Life cycle cost									√				
	Human health / safety						√				√			
	Sustainable design & construction activities	√											√	√
pHJKR (Jalan) [3]	Energy efficiency				√									
	Environmental & water management			√		√								
	Material & technology		√					√	√					√
	Social & safety						√				√			
	Sustainable site planning and management												√	√
	Pavement technologies		√					√	√					
pHJKR (Jalan) [3]	Environment and water			√		√								
	Access and equity						√						√	
	Construction activities	√												
	Material and resources		√										√	
	Innovation							√						
			7	10	7	6	7	9	10	9	6	10	1	17

C Construction; MT Material; WT Water; EN Energy; EC Ecosystem; SC Social; IV Innovation; 3R 3R; COST Cost; SH Social & Health; GE Gas Emission; PM Policies / Management; DT Design / Technology.

The comparison between criteria of the existing green road rating tools is tabulated in Table 1. Based on the critical literature on the criteria of the established global green road rating system, there are some

common criteria that can be found in every green rating tools. This is supported by [7] in their research on the green road rating tools. The literature findings stated that sustainable site, water efficiency, energy efficiency, materials and resources, and innovation are examples of the common criteria that often become the core attributes in most of the green rating tools. Although the advancement of technology development in the road and highway industry is constantly taking place, the core criteria mentioned usually remain the basis because the main interest is to compensate for sustainability development.

5. Conclusion

The sustainability and green elements play vital role in ensuring the socio-economic needs can be a part of the development across the globe. Thus, building and infrastructure development brings the linkages of socio-economic development which accelerate the economic growth and in parallel improve the quality of life. Since road is considered as an important infrastructure to link one places to another and commute the industrial product and the people, this lead to the requirement of assessment on green road development with suitable sustainability criteria. A comprehensive green road rating tool is needed to measure the level of the greenness of road with an assessment system in Malaysia. Simultaneously, the green road rating system helps the road development practitioners to have a clear understanding of the application of sustainable development. The absence of specific green road rating tools for the assessment of the largest network of the road in Malaysia is seen as the gap that needs to be filled with a systematic approach. Since Malaysia already have green road assessment for Toll expressway and Federal Highway, the establishment of MyGreen RRI is expected to act as a performance baseline standard for measuring the level of greenness for the current or new rural road in Malaysia. This green rating tool is expect resulted in high consideration on green criteria that suite the nature and social-economic of rural area in Malaysia. MyGreen RRI is not just a tool to measure the level of sustainability of a particular road development project, but also act as the guidance for the road development stakeholders towards the better infrastructure development of Malaysia. This MyGreen RRI manual can be used by the road stakeholders in Malaysia and across the globe. MyGreen RRI is a part of the sustainable development initiatives, thus, it is expected to contribute towards the implementation of sustainable development in Malaysia for the sake of bridging the development with the ecological needs.

References

- [1] Laurance, W F 2018 Conservation And The Global Infrastructure Tsunami: Disclose, Debate, Delay! Trends in Ecology & Evolution, <https://doi.org/10.1016/j.tree.2018.05.007>
- [2] LLM and UTM 2014 Malaysia Green Highway Index (MyGHI) Manual Version **1.0** Lembaga Lebuhraya Malaysia and Universiti Teknologi Malaysia
- [3] PWD Malaysia 2013 p.H. *Manual Penarafan Hijau JKR. Sektor Bangunan, Bangunan Sediaada Bukan Kediaman - KB2*. Jabatan Kerja Raya Malaysia. Kuala Lumpur; 0-12 p.
- [4] Brundtland, G.H. 1987. *Report of the World Commission on Environment and Development: Our Common Future*. Available at: <http://www.un-documents.net/our-common-future.pdf>
- [5] Muench S T *et al* 2010 Greenroads Rating System **1.0** (J.L. Anderson and S.T. Muench, Eds.). Seattle, WA: University of Washington
- [6] Rooshdi R *et al* 2014 An Evaluation Of Sustainable Design And Construction Criteria For Green Highway. *Proc. Environmental Sciences* **20**
- [7] Laurance W F *et al* 2015 Reducing The Global Environmental Impacts of Rapid Infrastructure Expansion. *Current Biology* **25**, 255-268
- [8] Malik S *et al* 2018 Ncia- Amb Masuk Kampung Project: A Paradigm of Opportunities and Challenges for Sustainable Rural Development. *Planning Malaysia: J. of the Malaysian Institute of Planners* **16** Issue 3 (208) 285 –296
- [9] Nikumbh K P, Aher P D 2017 Study of Green Highway Rating System. *International Research J. of Eng. and Technol. (IRJET)* **04** Issue 5

- [10] Clark M *et al* 2009 Green Guide for Roads Rating System. Degree Thesis. Worcester Polytechnical Institute
- [11] Suresh R, Padmanabhan V, 2015 Green Highways Rating System, *Int. J. of Science, Technol. &Mgt*, **4**, Special Issue 1
- [12] PWD Malaysia. 2018. *Road Statistics 2018 Edition*. (M. Z. B. M. Zain, M. I. Bin Mahmood, N. S. B. Abdullah, H. F. B. Hamzah, F. B. Abdullah, V. a/l Muniandy, Z. B. Hashim, Eds.) (2018th Ed.). Kuala Lumpur: Road Facilities Maintenance Branch, PWD Headquarters Kuala Lumpur. Retrieved from <https://www.jkr.gov.my/my/page/senarai-manual>
- [13] Balubaid S, Bujang M, Aifa W N, Raja Rafidah, Rooshdi R, & Muhammad Hainin, M R, 2015.] Assessment Index Tool for Green Highway in Malaysia. *J. Teknologi (Sc. and Eng.)*, 99–104 <https://doi.org/10.11113/jt.v77.6405>
- [14] Eisenman, A. A. P. 2012. Sustainable Streets and Highways: An Analysis of Green Roads Rating Systems
- [15] Illinois Department of Transportation. (2010), Illinois-Livable and Sustainable Transportation. I-LAST Rating System and Guide Version **1.0**
- [16] New York State Department of Transportation 2010. Green Leadership in Transportation and Environmental Sustainability. GreenLITES Project Design Certification Program. New York Version **2.1.0**
- [17] Dondero G, Rodgers K, Hurley P T, 2012 Developing a Comprehensive Sustainable Transportation Analysis Framework (9-10)
- [18] Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure, 2012 A Rating System for Sustainable Infrastructure. Envision™ Guidance Manual, USA **2**
- [19] Lee J, Edil T B, Benson C H, Tinjum, J M, 2011, Use of BE2ST In-Highways for Green Highway Construction Rating In Wisconsin, Green Streets and Highways 2010